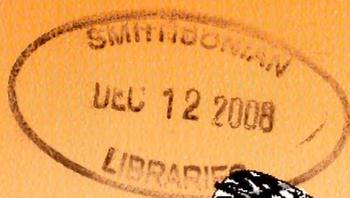


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NOTA

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# NOTA

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## Taxonomic variation in larval mandibular structure in Palaearctic Notodontidae (Noctuoidea)

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**Abstract.** The mandibles of the 1<sup>st</sup> to 5<sup>th</sup> instar larvae of 61 species belonging to 32 genera of Palaearctic Notodontidae from Ukraine and Primorskii krai (Far East of Russia) were examined with the use of a scanning electron microscope. The characters of the mandibular margin, retinaculum and mandibular carina are discussed. A comparative morphological analysis is provided for all these structures. Apomorphic and plesiomorphic states of the different characters are argued in relation to the different taxa. The results are compared to the recent classifications of Notodontidae.

**Zusammenfassung.** Die Mandibeln der ersten bis fünften Larvenstadien von 61 Arten und 32 Gattungen paläarktischer Notodontidae aus der Ukraine und dem Primorski Krai in Russland sind rasterelektronenmikroskopisch untersucht. Merkmale des Mandibelrandes, des Retinaculums und der Mandibelcarina werden diskutiert. Eine vergleichende morphologische Analyse wird für diese Merkmale gegeben. Die apomorphen und plesiomorphen Zustände der einzelnen Merkmale werden in Beziehung zu den einzelnen Taxa diskutiert. Die Ergebnisse werden mit rezenten Klassifikationen der Notodontidae verglichen.

**Résumé.** Les mandibules des chenilles de plusieurs Notodontidés paléarctiques ont été étudiés à l'aide du microscope électronique à balayage. L'étude est fondée sur les chenilles des stades I-V appartenant à 61 espèces de 32 genres provenant de l'Ukraine et de la Région d'Ussuri (au sud de l'Extrême est de la Russie). La morphologie des caractères tels que la marge mandibulaire, le retinaculum et la carène mandibulaire a été comparée. Une argumentation concernant les états de ces caractères en tant qu'apomorphies et plésiomorphies est fournie. Les récentes classifications des Notodontidés sont comparées en regard des résultats obtenus.

### Introduction

The mandibles of final instar notodontid larvae have been described in certain publications (Godfrey 1984; Godfrey et al. 1989; Miller 1991), but our knowledge concerning other instars, particularly the morphological peculiarities of the first instar, is insufficient. Faunal coverage is also inadequate; most information treats notodontid species from North America (Weller 1987; Dockter 1993). This study is an attempt to, at least partly, close this gap.

### Materials and Methods

This research is based on material that I have collected in Ukraine and Primorskii krai (Far East of Russia). Eggs were obtained from females captured in the field. Hatched larvae were reared to pupae. The epicrania left by caterpillars after moulting as well as fresh material stored in alcohol were studied. Mandibles were separated from the epicranium and then examined with a scanning electron microscope (SEM) as well as a binocular light microscope (MBS-9). The mandibular structures of 1<sup>st</sup> through 5<sup>th</sup> larval instars belonging to 61 notodontid species from the following genera were studied: *Euhampsonia* Dyar, *Furcula* Lamarck, *Uropygia* Staudinger, *Stauropus* Germar, *Cnethodonta* Staudinger, *Harpyia* Ochsenheimer, *Dicranura* Reichenbach, *Fentonia* Butler, *Drymonia* Hübner, *Notodonta* Ochsenheimer, *Peridea* Stephens, *Nerice*

Walker, *Semidonta* Staudinger, *Pheosia* Hübner, *Leucodonta* Staudinger, *Lophocosma* Staudinger, *Pheosiopsis* Bryk, *Shaka* Matsumura, *Pterostoma* Germar, *Ptilodon* Hübner, *Lophontosia* Staudinger, *Hagapteryx* Matsumura, *Allodonta* Staudinger, *Hexafrenum* Matsumura, *Epodonta* Matsumura, *Phalera* Hübner, *Spatalia* Hübner, *Gluphisia* Boisduval, *Pygaera* Ochsenheimer, *Gonoclostera* Butler, *Clostera* Samouelle and *Micromelalopha* Nagano. The taxonomic arrangement of these genera follows Schintlmeister (1989) (Table 1).

## Results

Table 1 gives a summary of the distribution of the character states found during my investigations of the mandibular margin, retinaculum, and mandibular carina of the investigated Palaearctic genera of Notodontidae.

**Mandibular margin.** The presence of mandibles with a serrate cutting edge in the first larval instar, which then becomes smooth in the last instar, has been previously recorded (Weller 1987; Godfrey et al. 1989). Miller (1991) considered this smooth mandibular margin of Notodontidae to be an apomorphic character of the family.

The 1<sup>st</sup> instar mandibular margin in most species possesses 6 acutely-angled denticles. These are either narrow or broad and they vary in length. The middle denticles are the largest, while the 6<sup>th</sup> is usually indistinct (Fig. 1).

First instar larvae show taxonomic differences in mandibular edge structure. First of all, there is a trend toward smoothing out of the cutting edge. Thus, in most species the first instar mandibular edge shows 6 acutely-angled narrow denticles (*Hagapteryx*, *Pheosiopsis*, *Furcula*, and others). Some species of Notodontinae have smooth, broad and more rounded denticles (e.g., *Pheosia*, *Phalera*, Fig. 2). In some taxa, the number of denticles is reduced to 4, the denticles are broad (perhaps due to fusion of separate denticles) and flattened. Thus, in genus *Cnethodonta* there are 4 large broad denticles (Fig. 3), while the denticles in species of *Stauropus* are almost indistinct (Fig. 4). Weller (1987: 189, fig. 2) recorded only 3 finger-like denticles for *Litodonta hydromeli* Harvey. Since the third denticle is broad, it is assumed to represent a fusion of two denticles.

My studies show that the mandibular margin of Notodontidae becomes smooth in the 2<sup>nd</sup> through 5<sup>th</sup> instars (Fig. 5). However, in some genera serrate mandibles do not completely disappear by the 2<sup>nd</sup> instar, but instead gradually disappear during subsequent instars, becoming absent by the final instar. For example, *Clostera*, *Gonoclostera*, *Pygaera*, *Micromelalopha*, and *Gluphisia* have 6 denticles in the 1<sup>st</sup> instar (Figs 6, 7) and retain 5 or 6 of them in the 2<sup>nd</sup> instar, though they become broader (Fig. 8). These genera have a smooth mandibular margin beginning in the 3<sup>rd</sup> instar.

In *Nerice* and *Dicranura*, 6 denticles persist in the 2<sup>nd</sup> instar. In *Nerice* they are short and rounded (Figs 9, 10) in the 2<sup>nd</sup> instar, but are expressed as 6 fused but distinct denticles in subsequent instars (Fig. 11). In *Dicranura*, the 2<sup>nd</sup> instar shows 5 or 6 indistinct denticles (Fig. 12). The mandibular margin in the 3<sup>rd</sup> instar is expressed as 5 fused less distinct denticles (Fig. 13), while the 4<sup>th</sup> instar mandibular edge is wavy (Fig. 14).

Tab. 1. Character states of the larval mandibles of Palaearctic Notodontidae.

Species	Mandibular margin			Retinaculum	Mandibular carina
	1 <sup>st</sup> instar	2 <sup>nd</sup> instar	3–5 <sup>th</sup> instars		
<i>Euhampsonia cristata</i> (Butler)	6A	S	S	2 i, L	E
<i>Euhampsonia splendida</i> (Oberthür)	6A	S	S	2 i, L	E
<i>Furcula furcula</i> (Clerck)	6A	S	S	2 i, L	E
<i>Furcula bicuspis</i> (Borkhausen)	6A	S	S	2 i, L	E, M
<i>Furcula bifida</i> (Brahm)	6A	S	S	2 i, L	E
<i>Uropygia meticolodina</i> (Oberthür)	6A	S	S	2 i, H	E
<i>Stauropus fagi</i> (Linnaeus)	4B	S	S	1 i, L	E, M
<i>Stauropus basalis</i> Moore	4B	S	S	1 i, L	E
<i>Cnethodonta griseocens</i> Staudinger	4B	S	S	1 i, L	E, M
<i>Harpya milhauseri</i> (Fabricius)	6A	S	S	2 i, L	E
<i>Harpya umbrosa</i> (Staudinger)	6A	S	S	2 i, L	E
<i>Dicranura ulmi</i> (Denis & Schiffermüller)	6A	T	W**	3 i, H	M
<i>Fentonia ocypte</i> (Bremer)	6A	S	S	2 i, L	E
<i>Drymonia dodonaea</i> [Denis & Schiffermüller]	6A	S	S	2 i, L	E
<i>Notodonta torva</i> (Hübner)	6A	S	S	2 i, L	E
<i>Notodonta dromedarius</i> (Linnaeus)	6A	S	S	2 i, L	E
<i>Notodonta dembowskii</i> Oberthür	6A	S	SW	2 i, L	E
<i>Notodonta tritophus phoebe</i> (Siebert)	6A	ST	S	2 i, L	E
<i>Notodonta ziczac</i> (Linnaeus)	6A	S	S	2 i, L	E
<i>Peridea anceps</i> (Goeze)	6A	S	S	2 i, L	E
<i>Peridea lativitta</i> (Wileman)	6A	S	S	2 i, L	E
<i>Peridea elzet</i> Kiriakoff	6A	S	S	2 i, L	E
<i>Peridea graeseri</i> (Staudinger)	6A	S	S	2 i, L	E

Tab. 1. Continuation.

Species	Mandibular margin			Retinaculum	Mandibular carina
	1 <sup>st</sup> instar	2 <sup>nd</sup> instar	3-5 <sup>th</sup> instars		
<i>Peridea moltrechii</i> (Oberthür)	6A	S	S	2 i, L	E
<i>Peridea oberthueri</i> (Staudinger)	6A	S	S	2 i, L	E
<i>Nerice davidi</i> Oberthür	6A	T	T	2 i, H	M
<i>Nerice leechi</i> Staudinger	6A	T	T	2 i, H	M
<i>Semidonta biloba</i> (Oberthür)	6A	S	S	2 i, L	E
<i>Pheosia tremula</i> (Clerck)	6B	S	S	2 i, L	E
<i>Pheosia gnoma</i> (Fabricius)	6B	ST	S	2 i, L	E, M
<i>Pheosia rimosa</i> Packard	6B	S	S	2 i, L	E
<i>Leucodonta bicoloria</i> (Den. & Schiffermüller)	6A	S	S	2 i, L	E
<i>Lophocosma atriplaga</i> Staudinger	6A	S	S	2 i, L	E
<i>Pheosopsis cinerea</i> (Butler)	6A	S	S	2 i, L	E
<i>Shaka atrovittatus</i> (Bremer)	6A	S	S	2 i, L	E
<i>Pterostoma palpina</i> (Clerck)	6A	ST	S	2 i, L	E
<i>Pterostoma sinicum</i> Moore	6A	S	S	2 i, L	E
<i>Pterostoma griseum</i> (Bremer)	6A	S	S	2 i, L	E
<i>Ptilodon capucina</i> (Linnaeus)	6A	S	S	2 i, L	E, M
<i>Ptilodon hoegei</i> (Graeser)	6A	S	S	2 i, L	E
<i>Ptilodon cucullina</i> (Denis & Schiffermüller)	6A	S	S	2 i, L	E
<i>Ptilodon ladislai</i> (Oberthür)	6A	S	S	2 i, L	E
<i>Lophontostia cuculus</i> (Staudinger)	6A	S	S	2 i, L	E
<i>Hagapteryx admirabilis</i> (Staudinger)	6A	S	S	2 i, L	E
<i>Allodonta plebeja</i> (Oberthür)	6A	S	S	2 i, L	E, M
<i>Hexafrenum leucodera</i> (Staudinger)	6A	S	S	2 i, L	E, M

Tab. 1. Continuation.

Species	Mandibular margin			Retinaculum	Mandibular carina
	1 <sup>st</sup> instar		3–5 <sup>th</sup> instars		
	1 <sup>st</sup> instar	2 <sup>nd</sup> instar			
<i>Epodonta lineata</i> (Oberthür)	6A	ST	SW	2 i, L	E
<i>Phalera bucephala</i> (Linnaeus)	6B	S	S	2 i, L, H	M
<i>Spatalia argentina</i> (Denis & Schiffermüller)	6A	S	S	2 i, L	E
<i>Spatalia doerriesi</i> Graeser	6A	S	S	2 i, L	E
<i>Spatalia plusiotis</i> (Oberthür)	6A	S	S	2 i, L	E
<i>Spatalia dives</i> Oberthür	6A	S	S	2 i, L	E, M
<i>Gluphisia crenata</i> (Esper) <sup>***</sup>	6A	T	S	3–4 i, L	E
<i>Pygaera timon</i> (Hübner)	6A	T	S	4 i, L	M
<i>Gonoclostera timoniorum</i> (Bremer)	6A	T	S	2 i, L	E
<i>Clostera curtula</i> (Linnaeus)	6A	T	S	2 i, L	M
<i>Clostera albosigma curtuloides</i> (Erschoff)	6A	T	S	2 i, L	M
<i>Clostera pigra</i> (Hufnagel)	6A	T	S	2 i, L	M
<i>Clostera anachoreta</i> [Denis & Schiffermüller]	6A	T	S	2 i, L	M
<i>Clostera anastomosis</i> (Linnaeus)	6A	T	S	2 i, L	M
<i>Micromelalopha troglodyta</i> (Graeser)	6A	T	S	2 i, L	M

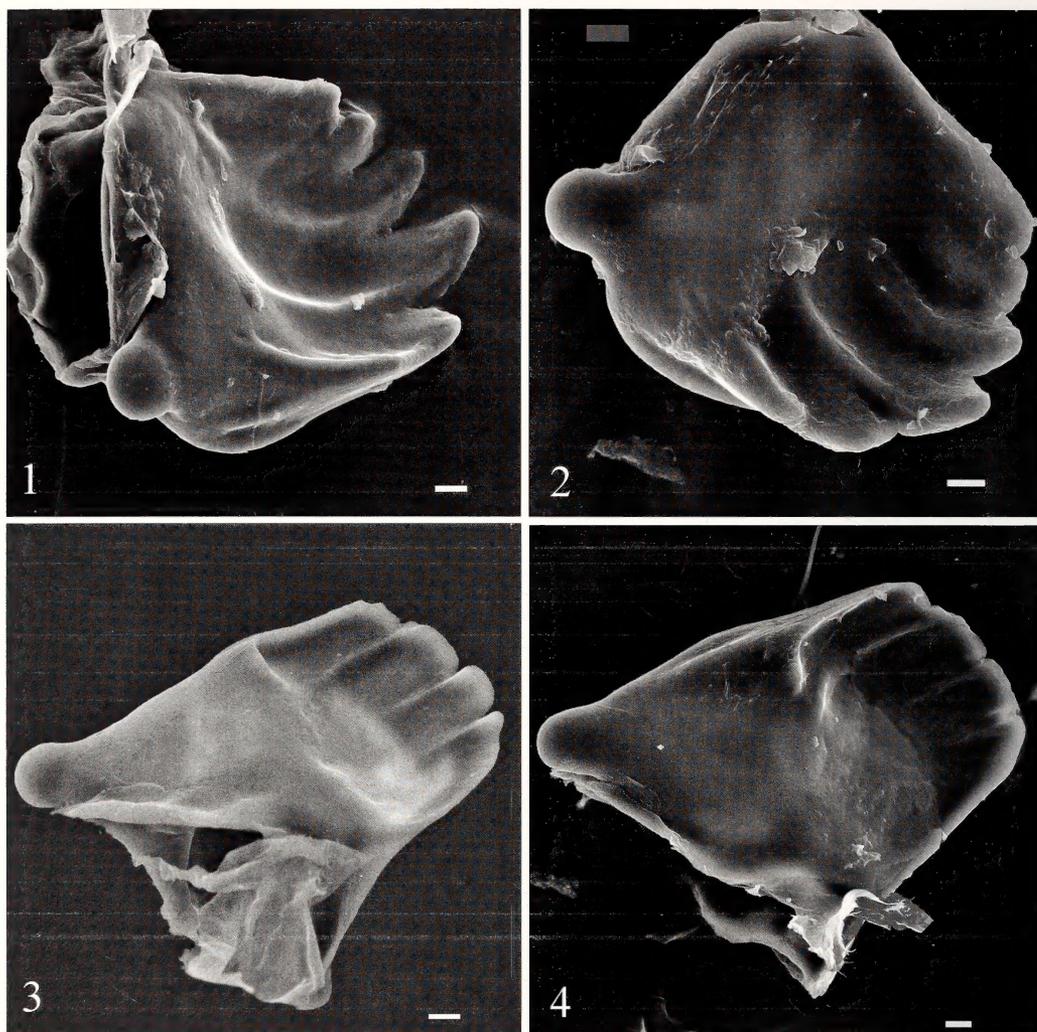
Mandibular margins with 6 acutely-angled narrow denticles (6A), with 6 broad, flattened denticles (6B), with 4 broad, flattened denticle (4B), smooth (S), toothed (T), or wavy (W).

Retinaculum flattened or with small projection (L) or with large, high comb (H). The presence of a retinaculum in the 1<sup>st</sup> instar (1i), in the 2<sup>nd</sup> instar (2i), in the 3<sup>rd</sup> instar (3i), in the 4<sup>th</sup> instar (4i).

Mandibular carina weakly expressed (E) or clearly expressed (M). Average situation between two extremes (ST, SW, EM).

\*\* The mandibular margin in the 3<sup>rd</sup> instar is expressed as 5 fused, less distinct denticles, while the 4<sup>th</sup> instar mandibular edge is wavy.

\*\*\* did not have the 3<sup>rd</sup> instar larva and I do not know its characteristics.

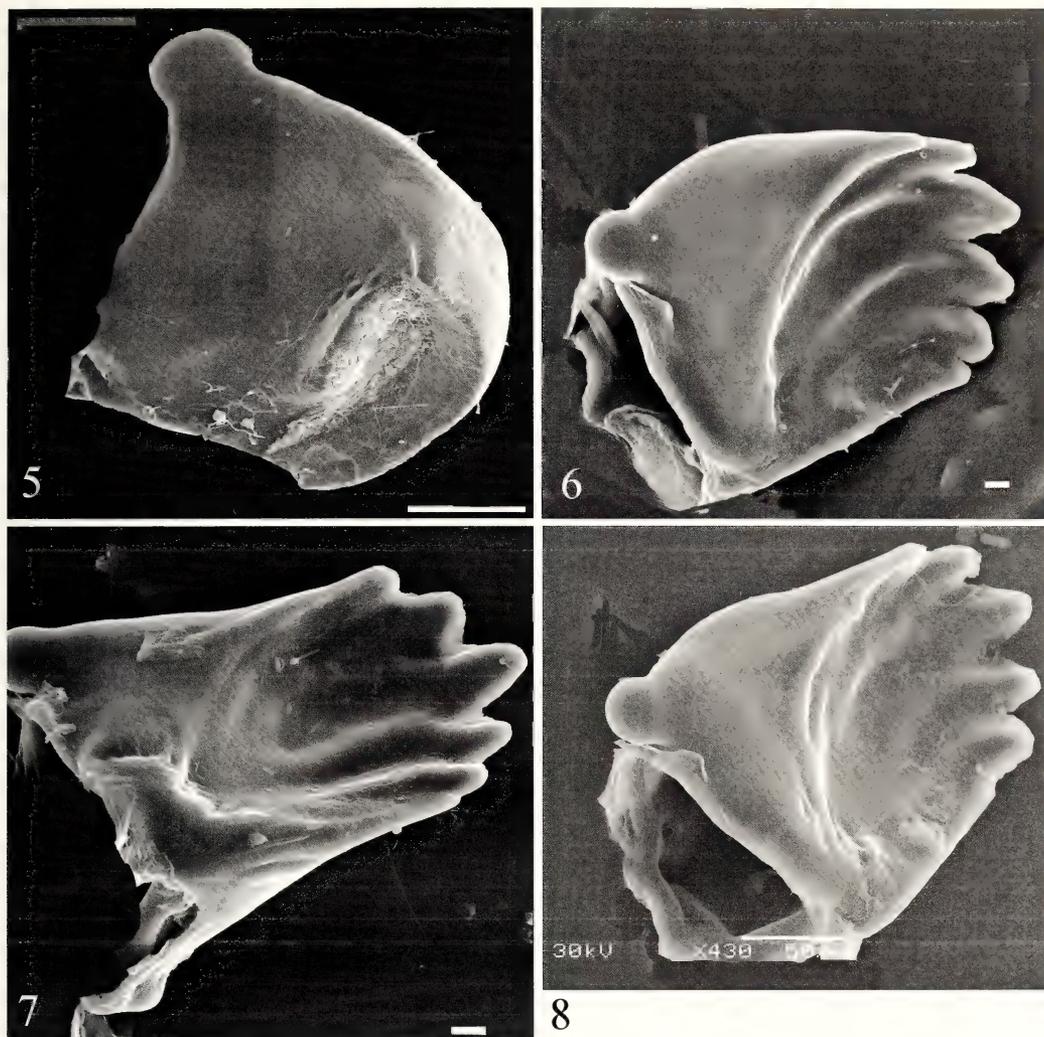


**Figs 1–4.** Oral surface of mandibles of 1<sup>st</sup> instar Notodontidae larvae. **1.** *Ptilodon hoegei* (left mandible, 600 ×). **2.** *Phalera bucephala* (left mandible, 720 ×). **3.** *Cnethodonta griseascens* (right mandible, 600 ×). **4.** *Stauropus fagi* (right mandible, 480 ×).

Dockter (1993: 37, 38, Fig. 8) pointed out that in 1<sup>st</sup> instar larvae of *Heterocampa guttivitta* Walker the “third and fourth teeth have flanges on the bases of their ventrolateral edges”. My studies of 1<sup>st</sup> instar larvae show that most species in which the mandibles have acutely-angled narrow denticles, also have a large medial comb on the inner surface. These imitate “flanges” on separate denticles (Figs 9, 15, 16).

**Retinaculum.** The mandibles of Notodontidae have a retinaculum located on the oral surface. My investigations show that the retinaculum is not yet formed in the 1<sup>st</sup> instar, except in the highly specialized genera *Stauropus* and *Cnethodonta*, where it is distinct but not sclerotized (Figs 3, 4).

Dockter (1993) noted the presence of a retinaculum in the 2<sup>nd</sup> instar for two species of *Heterocampa* Doubleday from North America. The Palearctic species I studied have a

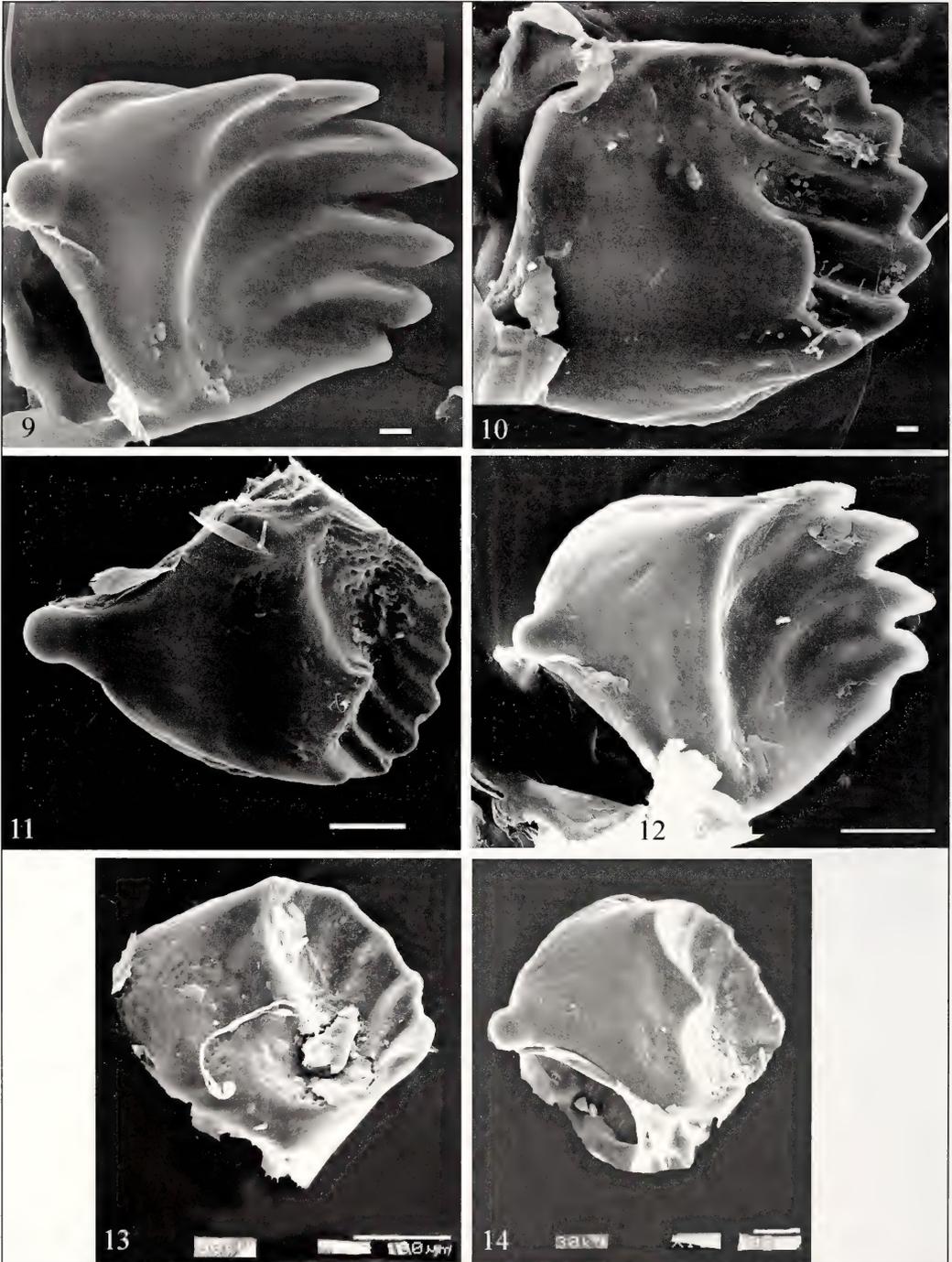


**Figs 5–8.** Oral surface of right mandible of Notodontidae larvae. **5.** 4<sup>th</sup> instar *Gonoclostera timoniorum* (220 ×). **6.** 1<sup>st</sup> instar *Clostera anachoreta* (480 ×). **7.** 1<sup>st</sup> instar *Pygaera timon* (600 ×). **8.** 2<sup>nd</sup> instar *Pygaera timon* (430 ×).

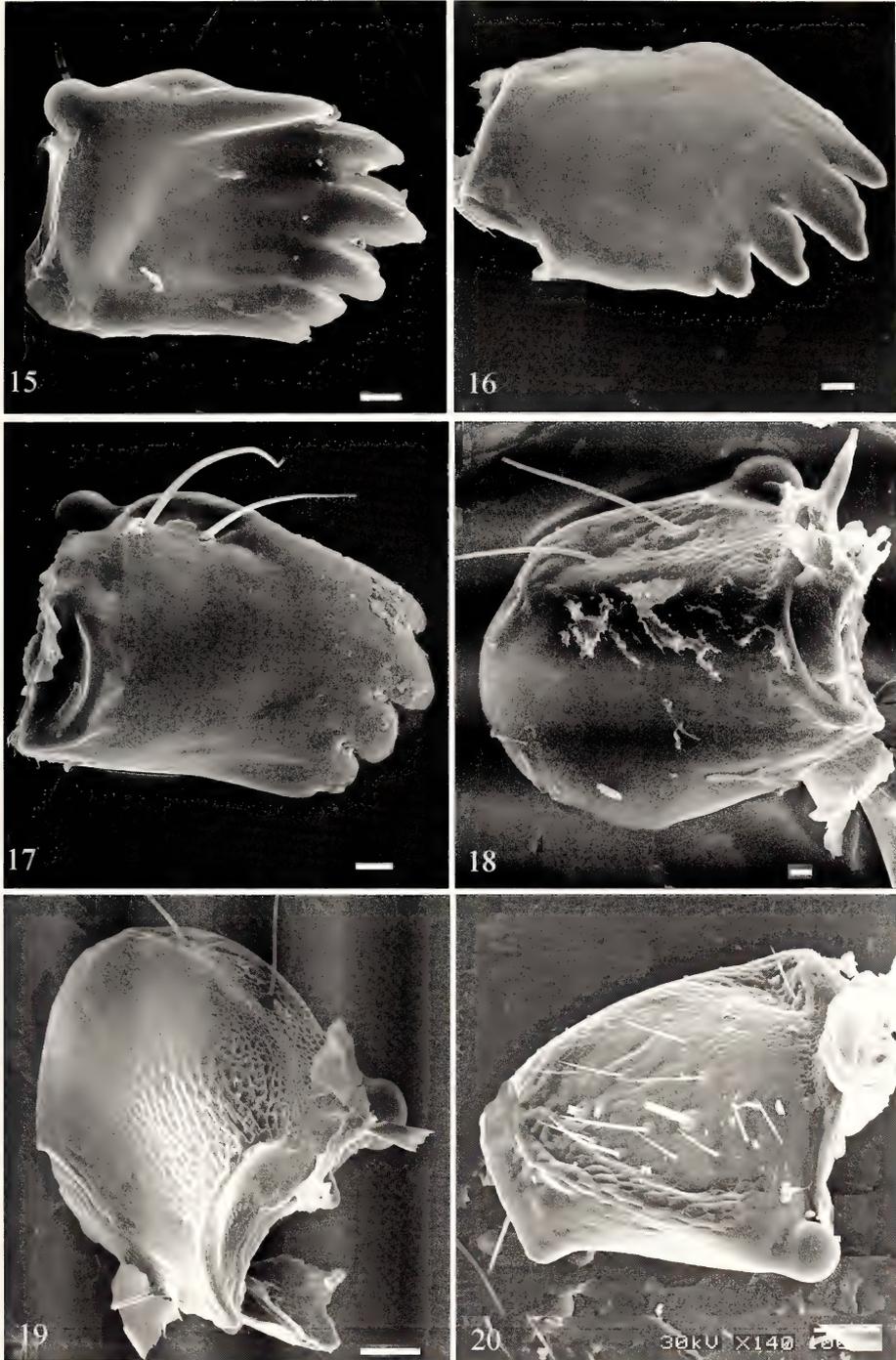
well sclerotized retinaculum in the 2<sup>nd</sup> instar which becomes more heavily sclerotized in the 4<sup>th</sup> and 5<sup>th</sup> instars, thus providing additional strength for the mandibular cutting edge. Rarely the retinaculum appears not in the 2<sup>nd</sup> but in the 3<sup>rd</sup> instar (*Dicranura*) and even in the 4<sup>th</sup> (*Pygaera*).

The retinaculum may be flattened (*Pterostona*, *Micromelalopha*, *Gonoclostera*, and others, Fig. 5), with a small projection (*Semidonta*, *Euhampsonia* and others), or with a large, high comb (*Uropygia*, *Dicranura*, *Nerice*, Figs 11, 14), which increases in the 3<sup>rd</sup> and 4<sup>th</sup> instars.

**Mandibular carina.** The presence of a mandibular carina and its disposition on the ventrolateral mandibular surface of some species of Notodontidae has been noted by Miller (1991: 124, 125, Figs 395–397). My studies show that this structure looks like a



**Figs 9–14.** Oral surface of mandibles of Notodontidae larvae. **9–11.** *Nerice davidi* (right mandible). **9.** 1<sup>st</sup> instar (660 ×). **10.** 2<sup>nd</sup> instar (440 ×). **11.** 3<sup>rd</sup> instar (160 ×). **12–14.** *Diceranura ulmi*. **12.** 2<sup>nd</sup> instar (right mandible, 450 ×). **13.** 3<sup>rd</sup> instar (left mandible, 230 ×). **14.** 4<sup>th</sup> instar (right mandible, 110 ×).



**Figs 15–20.** Surface of mandibles of Notodontidae larvae. **15.** Oral surface of right mandible of 1<sup>st</sup> instar *Clostera pigra* (660 ×). **16.** Lateral surface of left mandible of 1<sup>st</sup> instar *Furcula bifida* (600 ×). **17.** Lateral surface of left mandible of 1<sup>st</sup> instar *Notodonta torva* (780 ×). **18.** Part of mandibular carina (above side) of right mandible of 2<sup>nd</sup> instar *Spatalia dives* (440 ×). **19.** Part of mandibular carina (above side) of right mandible of 4<sup>th</sup> instar *Uropygia meticulodina*. **20.** Ventrolateral surface (area limited by mandibular carina) of left mandible of 4<sup>th</sup> instar *Dicranura ulmi* (140 ×).

comb, limited to the ventrolateral surface of the mandible (see Fig. 20). Most genera of Notodontidae have a more or less developed carina (Figs 17–20) and only some have a clearly expressed carina (*Dicranura*, *Phalera*, *Nerice*, *Clostera*, and others). This character is difficult for taxonomic interpretation.

**Mandibles with secondary setae.** Gardner (1943) and Miller (1991) noted the presence of secondary setae on the mandibles of Thaumetopoeinae. I found secondary setae on the mandibles in 4<sup>th</sup> and 5<sup>th</sup> instar larvae of *Dicranura* (Fig. 20), but nowhere else among the taxa studied.

## Discussion

The classification of the Notodontidae is in dire need of improvement. In the systems proposed by different authors an uncertainty about the number of subfamilies as well as the classification of their genera remains until now. The recent classifications of the Notodontidae (Tikhomirov 1981; Schintlmeister 1985; Miller 1991) have the best argumentations. Now I want to show how the results of my original investigations agree or disagree with the above-mentioned classifications.

The larval mandibles of the majority of the investigated genera of Notodontidae are uniform. Their mandibular margin possesses 6 acutely-angled denticles in the first instar, which then becomes smooth in the 2<sup>nd</sup> through 5<sup>th</sup> instars. Such structure is present in 21 genera, namely *Euhampsonia*, *Furcula*, *Uropygia*, *Harpyia*, *Fentonia*, *Drymonia*, *Notodonta*, *Peridea*, *Semidonta*, *Leucodonta*, *Lophocosma*, *Pheosiopsis*, *Shaka*, *Pterostoma*, *Ptilodon*, *Lophontesia*, *Hagapteryx*, *Allodonta*, *Hexafrenum*, *Epodonta*, and *Spatalia*. In this case my data are mostly coordinated with the system of Tikhomirov (1981) where these genera, except *Furcula* are included into subfamily Notodontinae. Genus *Furcula* in the classifications of Tikhomirov (1981) and Schintlmeister (1985) is placed in the derived subfamily Cerurinae. On the other hand, Miller (1991) transferred this genus to subfamily Notodontinae, in tribe Dicranurini. My data of the larval mandible structure do not contradict this opinion.

The placement of genus *Harpyia* in the Notodontinae by Tikhomirov (1981) is supported by characters of the structure of the larval mandibles whereas other peculiarities of the larva, egg, and pupa characterize this genus as highly specialized (Dolinskaya 1986, 1987 a, c; Dolinskaya & Plushch 2003), which is reflected in the classifications proposed by Schintlmeister (1985) and Miller (1991). The first author placed this genus into subfamily Stauropinae while the second included it into the Heterocampinae, Stauropini.

Genera *Pheosia* and *Phalera* as well as the above-mentioned 21 genera are characterized by mandibles with 6 acutely-angled denticles in the first instar; however, they are not narrow and acute, but broad and flattened. Tikhomirov (1981) included both genera into subfamily Notodontinae and noted that *Pheosia* is characterized by the highest specialization among the Notodontinae. The genus is characterized also by a rather specialized sculpture of the egg chorion (Dolinskaya 1987 b, c). The taxonomic position of the genus is intended to be investigated further. There are two opinions concerning the position of genus *Phalera* in the notodontid classification. Tikhomirov (1981) consid-

ers that it must be included within the Notodontinae while the other authors suggested that it belongs to the Phalerinae (Schintlmeister 1985; Miller 1991).

Genera *Stauropus* and *Cnethodonta* have flattened, broad mandibles with 4 denticles in the 1<sup>st</sup> instar. I consider this state to be apomorphic because most representatives of the outgroup (Noctuidae, Lymantriidae, Arctiidae) have the mandibular edge with 5–6 acutely-angled, narrow denticles in the 1<sup>st</sup> instar. Besides, these genera have a retinaculum in the 1<sup>st</sup> instar. In this case my conclusions are consistent with those of the other authors. Miller (1991) included these two genera into the Heterocampinae, Stauropini, while Schintlmeister (1985) and Tikhomirov (1981) placed only genus *Stauropus* into their Stauropinae. Tikhomirov (1981), based on characters of the functional morphology of the genitalia retains *Cnethodonta* in the less advanced Notodontinae, i.e. *Cnethodonta* is regarded by him as the less advanced genus relative to *Stauropus*, and this fact is also corroborated here (the denticles of the 1<sup>st</sup> instar larvae are less flattened).

In genera *Clostera*, *Gonoclostera*, *Pygaera*, *Micromelalopha*, *Gluphisia*, *Dicranura*, and *Nerice*, as opposed to the other notodontid larvae, the serrate mandibles do not disappear in the 2<sup>nd</sup> instar and there is a smooth process of their transformation to the last instar. I consider such state to be plesiomorphic because of the presence of mandibular denticles in 1–5<sup>th</sup> instars in most representatives of the outgroup. The mandibular margin becomes smooth in the 3<sup>rd</sup> instar in *Clostera*, *Gonoclostera*, *Pygaera*, *Micromelalopha*, and *Gluphisia*. In the 4<sup>th</sup> instar of *Dicranura* the mandibular edge becomes sinuous. In *Nerice* the mandibular edge looks like 6 fused distinct denticles until the 5<sup>th</sup> instar. The above-mentioned genera have common characters as well as specific peculiarities.

For example, *Clostera*, *Pygaera*, *Micromelalopha*, *Dicranura*, and *Nerice* have a well expressed carina. In *Gonoclostera* and *Gluphisia* the mandibular carina is weakly expressed. *Pygaera*, *Gluphisia*, and *Dicranura* may be united by the absence of the retinaculum in the 2<sup>nd</sup> instar, whereas in the rest of the genera this structure is present. Besides that, *Clostera*, *Pygaera*, and *Micromelalopha* have the retinaculum with only a small projection while *Dicranura* and *Nerice* have a large, high comb. In addition, *Dicranura* have secondary setae on the mandibles in the 4<sup>th</sup> and 5<sup>th</sup> instars.

Concerning genera *Clostera*, *Gonoclostera*, *Pygaera*, and *Micromelalopha* my data coincide with the classifications of the three above-mentioned authors. In the classifications of Tikhomirov (1981) and Schintlmeister (1985) these genera are included into the primitive subfamily Pygaerinae. Miller (1991) placed into this subfamily only genus *Clostera* and said that following further investigation genera *Micromelalopha*, *Pygaera*, and *Gonoclostera* perhaps will be included into Pygaerinae also. It must be noted that the mandibular denticles of *Micromelalopha* in the 2<sup>nd</sup> instar are rather broadened, flattened, and rounded in comparison with those of *Clostera*, *Gonoclostera*, and *Pygaera*. I consider this state of the denticles to represent an apomorphy for this genus.

*Gluphisia* requires additional research. The peculiarities of the mandibles and pupa (Dolinskaya 1986, 1989) show similarities with genus *Clostera*, *Gonoclostera*, *Pygaera*, and *Micromelalopha*. The data that I obtained do not match with any of the published classifications. Packard (1895) placed *Gluphisia* into the separate subfamily Gluphisiinae; Tikhomirov (1981) and Miller (1991) into subfamily Notodontinae.

Schintlmeister (1985) placed *Dicranura* into the derived Stauropinae together with *Harpyia* and *Stauropus*. The results of my studies are not concordant with this point of view. I consider that *Dicranura* has a complex of primitive attributes that are characteristic of the Pygaerinae and Thaumetopoeinae, as well as a complex of specialized features that are characteristic only to the genus. Thus, it is necessary to undertake more detailed investigations.

The position of genus *Nerice* in the Notodontidae remains unclear. Among all known classifications its status is discussed only by Packard (1895) and Tikhomirov (1981) who include it into the Notodontinae.

Summarizing the above-discussed characters of the Notodontidae it can be concluded that the morphology of the larval mandibles allows to unravel related groups within the family. The genera with more specialized morphology, as a rule, possess apomorphic states of the mandibular characters. However, the reconstruction of the Notodontidae phylogeny is not the main goal of the present paper, and a well-argued classification should be based on a phylogenetic analysis involving a complex of characters, including larval, but also characters of the eggs, pupae, and imagos.

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**James P. Tuttle 2007: The Hawk Moths of North America. A Natural History Study of the Sphingidae of the United States and Canada.** – The Wedge Entomological Research Foundation, Washington, DC. – ISBN 978-0-9796633-0-7. xviii + 253 pp., 23 pls. US\$ 90.00.

Sphingids are among the most easily recognized moths. The adults are among the largest and fastest flying lepidopterans and they are well known for hovering at flowers. Sphingids received considerable attention in pre-Linnean times already by Maria Sibylla Merian (1705) as well as 150 years later by the founders of evolutionary theory, Charles Darwin (1862) and Alfred Russel Wallace (1867), which undoubtedly stimulated subsequent research on the group. Today, sphingids belong to the best studied groups of Lepidoptera. Much anatomical and physiological knowledge on the order has been made available by studies on one of the most famous laboratory animals, *Manduca sexta* (Linnaeus, 1763). Also, a recent revisionary checklist of the 1,272 world species (Kitching & Cadiou 2000) and detailed identification books for all continents are available, including for North America (Hodges 1971). The book published by James P. Tuttle focuses on the natural history of North American sphingids. It starts with an introductory chapter on historical literature, taxonomy, and structure of the book. Part one focuses on general biogeography, morphology, life history and ecology, natural enemies, collecting and rearing, and is illustrated with line drawings and black and white photographs. Part two, the main chapter of the book, contains the species accounts, which start with an introduction for each genus. The species treatments are structured into general comments, distribution (including a map illustrating the distribution in North America), habitat, adult diagnosis, variation, biology, immature stages, and rearing notes. Drawings of the pupae and black and white photographs of larvae and adults are added for some species. The middle of the book contains the colour plates of photos of pinned and spread adults as well as live larvae. The book is completed by an appendix of sphingid parasitoids, an alphabetical index of institutional collections, a list of cited references, as well as entomological and botanical indices. Having reared nearly all of the species himself, James P. Tuttle describes in detail the life histories of the 125 North American sphingids, including their larval host plants. Applying the biological species concept (BSC), he found that *Erinnyis domingonis* (Butler, 1875) is conspecific with *E. obscura* (Fabricius, 1775) and *Protambulyx carteri* Rothschild & Jordan, 1903 with *P. strigilis* (Linnaeus, 1771). Based on adult characters and life histories, Tuttle re-establishes the genus *Lintneria* Butler, 1876 and transfers 21 species of the “*Sphinx eremitus* species group” into it, and he supports several taxonomic changes introduced by former authors. European Lepidopterists will find some familiar species in the book: *Hyles galli* (Rottemburg, 1775) and *H. lineata* (Fabricius, 1775), which are native to North America, and *H. euphorbiae* (Linnaeus, 1758), which was introduced into North America as a biological control agent for *Euphorbia* species (Euphorbiaceae). Several genera, such as *Sphinx* Linnaeus, 1758, *Hemaris* Dalman, 1816, *Smerinthus* Latreille, 1802, and *Proserpinus* Hübner, 1819 have representatives in the Nearctic and Palaearctic regions, and some of these are so conspicuously similar in morphology that they should be compared in more detail to assess their relationships: *Ampelophaga rubiginosa* Bremer & Grey, 1853 from the eastern Palaearctic and *Darapsa* Walker, 1856 from the Nearctic, and *Phyllosphingia dissimilis* (Bremer, 1861) from the eastern Palaearctic and *Amorpha juglandis* (Smith, 1797) from the Nearctic. With this book, Tuttle might have set a further stimulus in order for sphingids to become once more a model group of Lepidoptera, in studies of Holarctic biogeography, and as a good example of what can be added to our mainly morphology-based taxonomic knowledge, when studying life histories and applying the BSC. Beside sphingid collectors and taxonomists, I recommend the book to anybody interested in holarctic biogeography and the BSC.

MATTHIAS NUSS

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## Functional morphology of the male genitalia in Gelechiidae (Lepidoptera) and its significance for phylogenetic analysis

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**Abstract.** The main directions of the evolutionary transformation of some genital structures are demonstrated on the basis of morphoclines. Due to the adequate stability in position of the muscles in the copulatory apparatus the functional morphological method is sufficiently reliable in solving taxonomic and phylogenetic problems. Some important misinterpretations of the homology in genital structures and incorrect coding in matrices for cladistic analyses are discussed, highlighting the significance of functional morphological investigations for taxonomic and phylogenetic analyses.

### Introduction

The present research is focused on preparatory work for any cladistic analysis based on morphological data, namely the work necessary to unravel the homology of the structures (in the present work, genital structures), the directions of their evolutionary transformations, and the coding of the character states for cladistic analysis.

In some families of Lepidoptera (Tineidae: tribe Archimeessiini; Scythrididae: species-groups within genus *Scythris* Hübner; Gelechiidae: tribe Litini\*; Lasiocampidae: subfamilies Gastropachinae, Lasiocampinae, etc.) the derived taxa often represent small relatively homogeneous groups morphologically, the copulatory apparatus of which is strongly diverged and transformed during evolution. The taxonomic arrangement of these groups into a natural system of subordinated monophyletic groups encounters numerous morphological difficulties caused by the following. On the one hand, there are convergent similarities in non-homologous genital structures based on their similar functions, and, on the other hand, there are appreciable differences in homologous structures.

Without deep comparative morphological analysis of transformations in the copulatory apparatus both cases account for the misinterpretation of homologies in the genital structures. This leads to mistakes in character coding for cladistic analysis and subsequent misunderstanding of monophyletic groups.

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\* The synonymy Litini Bruand, 1859 (=Teleiodini Piskunov, 1973; = *Exoteleiini* Омелько, 1999) was established in Ponomarenko (2005). After designation of the *Tinea nanella* Denis & Schiffermüller, 1775 as type species for *Lita* Kollar, 1832 (Nye & Fletcher 1991: 174), the genus *Recurvaria* Haworth, 1828 is treated as senior objective synonym of the last name. The genus *Recurvaria* is related to the genus *Teleiodes* Sattler, 1960 and belong to the same tribe. The family name Litidae Bruand, 1859, established on the name *Lita* Kollar, 1832 is available according ICZN, 1999, Art. 12.2.4. and Litini Bruand, 1859 must be considered as senior synonym of Teleiodini Piskunov, 1973. Besides, the results of comparative morphological analysis confirmed the absence of the morphological hiatus between groups of genera related to *Teleiodes* Sattler, 1960 (type genus for Teleiodini Piskunov, 1973) and *Exoteleia* Wallengren, 1881 (type genus for Exoteleiini Omelko, 1999). Therefore, *Exoteleiini* Omelko, 1999 was synonymized with *Teleiodini* Piskunov, 1973.

Often a simple comparison of the genitalia does not allow to solve the above-mentioned problems. The establishment of the homology of any structure (or organ) is based on three main criteria, the formulation of which can be traced back to A. Remane (1956):

(1) similarity in position (topological criterion), (2) structural similarity, and (3) presence of transitional forms.

Every genital sclerite is part of the skeleton-muscular system of the copulatory apparatus and its modification correlates with changes of other parts of that system. The functioning of genital structures is assisted by musculature and so the tracing of the skeleton's transformation is impossible without studying the musculature morphology.

The functional morphological method is based on the fact that the muscular system in genitalia is more conservative and generally has the same morphology in groups of related genera. Usually a muscle keeps the same position even after a deep transformation of the associated sclerite morphology, so the method is the key to understand the origin of genital structures and helps to trace their transformations. My studies of the skeleton-muscular apparatus of the male Gelechiidae and my comparative morphological analysis (Ponomarenko 1992, 2004, 2005) allowed to unravel the main misinterpretations of the homology of genital sclerites. The most important of them are discussed in the present work and illustrated on the morphoclines of transformation. The muscle nomenclature follows Kuznetsov & Stekolnikov (2001) with changes from Ponomarenko (2005).

## Material and methods

The conclusions of the present work on the evolutionary tendencies in transformations of the genital structures are based on large material that was analyzed during slightly less than 20 years of gelechiid moths studies. At present I know the morphology of more than 400 gelechiid genera. Genera from related families were also studied (mainly Scythrididae and Cosmopterigidae) for determination of the genital character states. For the present study the material used came from the collections of Gelechiidae kept in the Zoological Institute of RAS (Sankt-Petersburg, Russia), the Zoological Museum of the Institute of systematics and ecology of animals of SB RAS (Novosibirsk, Russia), the Natural History Museum (London, UK), the Zoological Museum of Helsinki University (Finland), the Osaka Prefecture University (Japan), the National Institute of Agro-Environmental Sciences (Tsukuba, Japan), the Center for Insects Systematics (Chuncheon, Korea), the 'Muzeul de Istorie Naturala Grigore Antipa' (Bucharest, Romania), the 'Museum für Naturkunde der Humboldt-Universität' (Berlin, Germany), and my own material collected in the Far East of Russia (1989–2005), South Korea (1995, 1996), Japan (1998, 2000), Finland (1999), and Ukraine (2001, 2005). The list of species examined representing the main morphological groups within Gelechiidae and of which the genital musculature was studied, is presented as Tab. 1. Detailed descriptions of their functional genital morphology were published in the following series of papers (Ponomarenko 1992, 1995, 1997, 2004, 2005).

**Tab. 1.** List of the species for which the functional morphology of the genitalia was studied.**Anomologini**

- Deltophora korbi* (Caradja, 1920)  
*Metzneria inflamatella* (Christoph, 1851)  
*Isophrictis anthemidella* (Wocke, 1871)  
*Ptocheuusa paupella* (Zeller, 1847)

**Apatetrini**

- Apatetris kinkerella* (Snellen, 1876)  
*Apatetris elaeagnella* Sakamaki, 2000  
*Metanarsia modesta* Staudinger, 1871

**Aristoteliini**

- Aristotelia subdecurtella* (Stainton, 1859)  
*Chilopselaphus fallax* Mann, 1867  
*Megacraspedus separatellus* (Fischer von Röslerstamm, 1844)  
*Sitotroga cerealella* (Olivier, 1789)  
*Polyhymno obliquata* (Matsumura, 1931)  
*Xystophora psammitella* (Snellen, 1884)  
*Caulastrocecis furfurella* (Staudinger, 1870)  
*Psamathocrita osseella* (Stainton, 1860)  
*Bryotropha terrella* (Denis et Schiffermüller, 1775)

**Pexicipiini**

- Pexicipia malvella* (Hübner, 1805)  
*Platyedra subcinerea* (Haworth, 1828)  
*Harpagidia magnetella* (Staudinger, 1870)

**Gelechiini**

- Neofriseria peliella* (Treitschke, 1835)  
*Evippe albidorsella* (Snellen, 1884)  
*Athrips mouffetella* (Linnaeus, 1758)  
*Gelechia rhombella* (Denis et Schiffermüller, 1775)  
*Gelechia anomorcta* Meyrick, 1926  
*Psoricoptera arenicolor* Omelko, 1999  
*Mirificarma eburnella* (Denis et Schiffermüller, 1775)  
*Filatima autocrossa* (Meyrick, 1936)  
*Holcophora statices* Staudinger, 1871  
*Aroga velocella* (Duponchel, 1838)

**Gnorimoschemini**

- Gnorimoschema valesiella* (Staudinger, 1877)  
*Caryocolum fischerella* (Treitschke, 1833)

**Litini**

- Recurvaria nanella* (Denis et Schiffermüller, 1775)  
*Parastenolechia collucata* (Omelko, 1988)  
*Protoparachronistis initialis* Omelko, 1986  
*Exoteleia dodecella* (Linnaeus, 1758)  
*Stenolechia gemmella* (Linnaeus, 1758)  
*Schneidereria pistaciella* Weber, 1957  
*Teleiodes saltuum* (Zeller, 1878)  
*Carpatolechia fugacella* (Zeller, 1839)

**Anacampsini**

- Anacampsis populella* (Clerck, 1759)  
*Syncopacma cincitella* (Clerck, 1759)  
*Sophronia sicariella* (Zeller, 1839)  
*Prolita sexpunctella* (Fabricius, 1794)  
*Mesophleps silacella* (Hübner, 1796)  
*Crossobela trinitella* (Herrich–Schäffer, 1856)

**Brachmiini**

- Brachmia dimidiella* (Denis et Schiffermüller, 1775)

**Dichomeridini**

- Helcystogramma triannulella* (Herrich–Schäffer, 1854)  
*Acompsia cinerella* (Clerck, 1759)  
*Dichomeris japonicella* (Zeller, 1877)  
*Dichomeris rasilella* (Herrich–Schäffer, 1855)  
*Dichomeris oceanis* Meyrick, 1920  
*Acanthophila lucistriaella* Ponomarenko et Omelko, 2003

**Chelariini**

- Neofaculta ericetella* (Geyer, 1832)  
*Nothris verbascella* (Denis et Schiffermüller, 1775)  
*Encolapta tegulifera* (Meyrick, 1932)  
*Paralida okinawensis* Ueda, 2005  
*Hypatima rhomboidella* (Linnaeus, 1758)  
*Faristenia quercivora* Ponomarenko, 1991  
*Faristenia furtumella* Ponomarenko, 1991.  
*Dendrophilia mediofasciana* (Park, 1991)  
*Bagdadia claviformis* (Park, 1993)

**Anarsiini**

- Ananarsia lineatella* (Zeller, 1839)  
*Anarsia halimodendri* (Christoph, 1877)

My studies of the skeleton of the gelechiid copulatory apparatus were conducted according to traditional methods of lepidopterological investigations. The maceration of the soft tissues was realized by boiling the abdomens in a 10% aqueous solution of KOH. The genitalia were then placed in glycerin for examination and later into euparal for permanent preservation.

My studies of the functional morphology were conducted on specimens mainly fixed in 70% alcohol. Their dissection followed the method described by V.I. Kuznetsov and A.A. Stekolnikov (2001). The flexibility in dry specimens was obtained by the author's method. The abdomens were soaked in 10% lactic acid (2-hydroxypropanoic acid,  $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$ ) during 15–24 hours at less than 40° C. Before dissection every specimen was stained in an aqueous solution of eosin.

The skeleton-muscles apparatus of the male genitalia was studied with Carl Zeiss and Nikon SMZ-10 microscopes under magnifications of 120–160. During dissection an image of every layer was taken with a Nikon Coolpix 8700 digital camera.

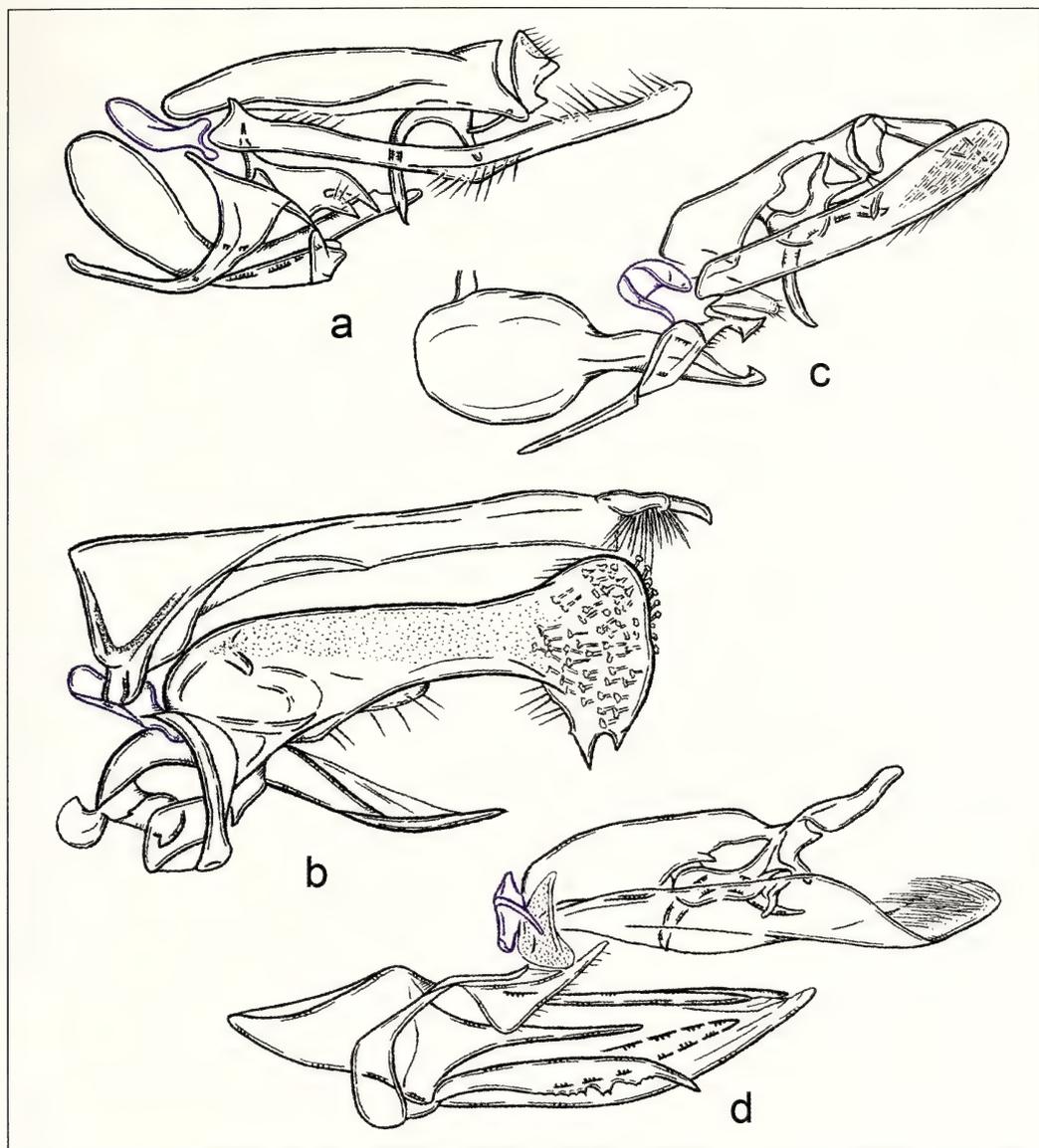
### Abbreviations

<i>Muscles:</i>	$m_2$	abductor muscles of valva
	$m_3$	muscles of median plate (juxta)
	$m_4$	adductor muscles of valva
<i>Genital structures:</i>	aed	aedeagus
	ccl	cucullus
	ejac.d	ejaculatory ductus
	gl	gland (r.gl: right gland, l.gl: left gland)
	gl.d	glandular ductus
	gld	glandiductor
	gn	gnathos
	jux	juxta
	man	manica
	pl.jn	place of junction with same process of left valva
	prt.sc	parategminal sclerite
	sacc	saccus
	scl	sacculus
	teg	tegumen
	tr	transtilla
	unc	uncus
	vvl	valvella
vnc	vinculum.	

## The homology of some “problematic” parts of the male genitalia in Gelechiidae

### Transformation of the tegumen

There are two sclerites in the male genitalia of the subfamily Dichomeridinae that are placed laterally between the tegumen and vinculum and anterior of the valva (Figs 1 a–d). Hodges (1986) proposed for them the descriptive term “appendix appendicular”



**Fig. 1.** Gelechiidae, male genitalia. **a.** Chelariini: *Bagdadia claviformis* (Park); **b.** Anarsiini: *Ananarsia bipinnata* (Meyrick); **c.** Dichomeridini: *Helcystogramma lutatella* (Herrich-Schäffer); **d.** Dichomeridini: *Dichomeris derasella* (Denis et Schiffermüller); parategminal sclerite shown by blue.

in the Dichomeridini, which does not indicate their origin. Omelko (1999) treated them as sacculus in tribe Chelariini and partly as tegumen and as derivative of the vinculum in Dichomeridini. Kaila (2004), commenting his cladistic analysis and character states wrote “... the appendix appendicular was interpreted to be homologous to valval costa.” Summarizing the above-mentioned three opinions, one can ask: Are the “appendices appendiculares” homologous to parts of the tegumen, vinculum, or to parts of the valva?

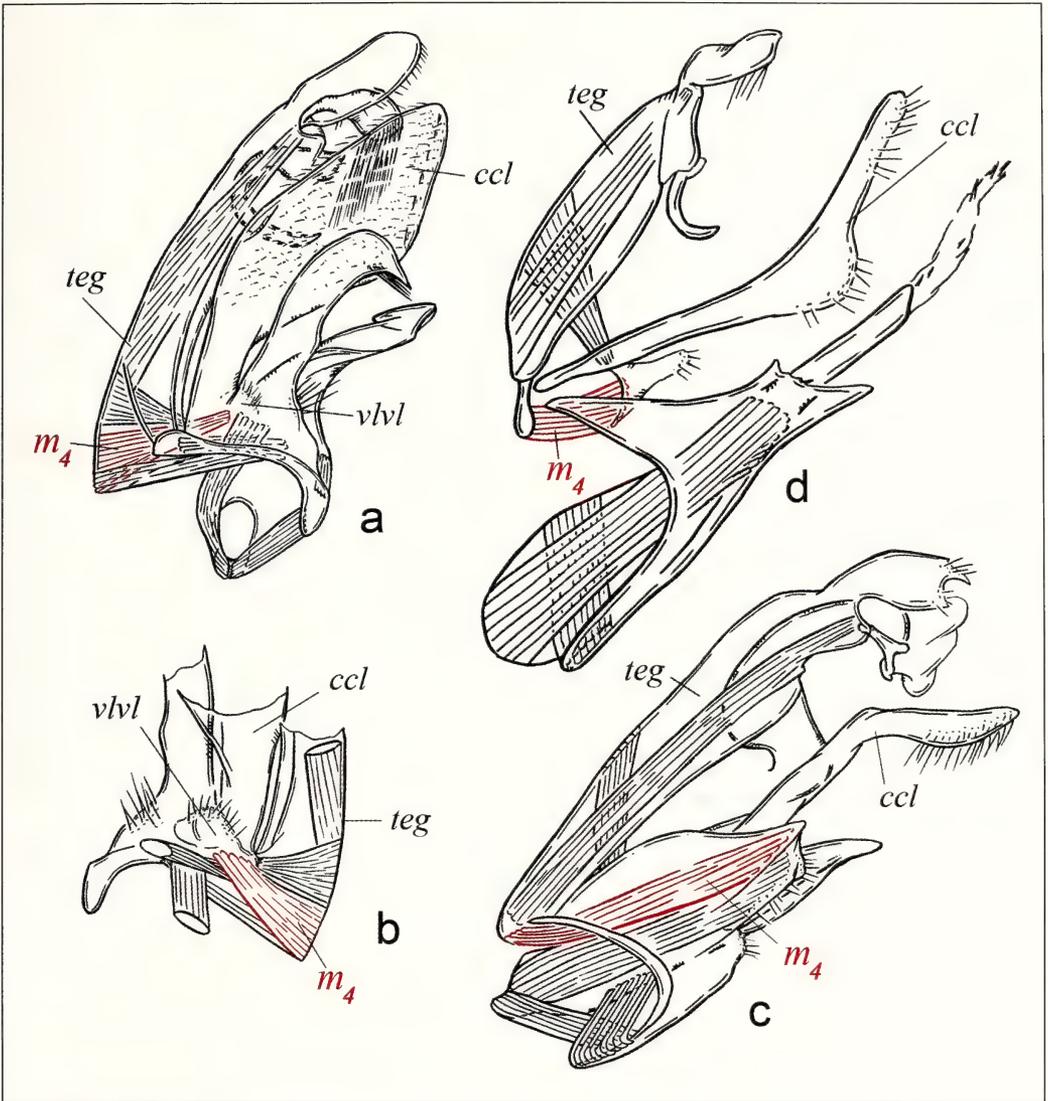
The anterolateral parts of the tegumen are apodemes for muscle  $m_4$ , which is the adductor of the valva (Figs 2 a–d). Modifications of these parts of the tegumen are caused by the functioning of the valvae and correlated with transformations of the latter. Wide investigations in Gelechiidae allowed to trace the transformation of the anterolateral parts of the tegumen within the family (Figs 3 a–g). In many genera of Gelechiidae, as in other families, Agonoxenidae, Ethmiidae, Oecophoridae, Coleophoridae, Momphidae, Scythrididae, belonging to the superfamily Gelechioidea (after Hodges, 1998), or superfamilies Elachistoidea, Coleophoroidea and Gelechioidea (after Kuznetsov & Stekolnikov, 2001), the muscles  $m_4$  are attached to the tegumen, therefore the state illustrated on Figs 3 a, b was treated as initial. In some groups within the family (*Caryocolum* Gregor et Povolný, *Syncopacma* Meyrick, *Mesophleps* Hübner, *Crossobella* Meyrick) the anterolateral parts of the tegumen are elongated (Fig. 3 c) and reminiscent of the pedunculi in other groups of Microlepidoptera (for example in Tortricidae). This state of the anterolateral parts of the tegumen, obviously, can be considered as intermediate between the above-mentioned initial state and separate sclerites, found in subfamily Dichomeridinae. The connection of the separate sclerites and the anterolateral parts of the tegumen with the muscles  $m_4$  is the base for establishing their homology. These sclerites were named parategminal (Ponomarenko 1992), thus indicating their origin. The presence of separate sclerites connected with muscles  $m_4$  is one of the main diagnostic characters for Dichomeridinae, consisting of Anarsiini, Chelariini, and Dichomeridini (Figs 3 d–g, outlined by blue square).

Within Dichomeridinae the parategminal sclerites have undergone strong modification from rounded lateral plates (tribes Anarsiini and Chelariini, and genera *Acompsia* Hübner, *Scodes* Hodges, and *Helcystogramma* Zeller of tribe Dichomeridini) to complicated sclerites connected not only with muscles  $m_4$ , but also supporting androconial structures (genera *Dichomeris* Hübner, *Acanthophila* Heinemann of Dichomeridini). The modification of the parategminal sclerites in the genus *Acanthophila* Heinemann into long bands is linked to a change of the muscles  $m_4$  function which, due to their contraction, causes sclerites rotating around their longitudinal axis and unrolling a bunch of modified, hair-like scales (Fig. 3 g).

Thus, parategminal sclerites connecting with muscles  $m_4$  and originated from the anterolateral parts of the tegumen in tribes Anarsiini, Chelariini, and Dichomeridini, are homologous in all of these tribes. The presence of separate parategminal sclerites (apomorphy 32) allows to support subfamily Dichomeridinae as a monophyletic group (Fig. 8, shown by blue oval).

## Genital glands

The valvae within Gelechiidae demonstrate a wide diversity in shape, from rounded and large to narrow and sharp, from inflated with modified setae to flat, often bearing processes and lobes with strong and long setae. Besides that, one of the evolutionary tendencies in the transformation of the valvae in the Gelechiidae is their division into separate cucullus and sacculus. Different states of the latter are found in different groups within the family. The rich morphological diversity of the valvae probably



**Fig. 2.** Gelechiidae, male genitalia. **a, b.** *Platypedra subcinerea* Haworth (a. lateral view; b. anterior part from inner side); **c.** *Gelechia anomorcta* Meyrick; **d.** *Syncopacma cinctella* Clerck.

caused that any sclerite placed between the tegumen and vinculum was recognized as the valva or part of it.

Within a large group of genera of tribe Litini (*Recurvaria* Haworth, *Coleotechnites* Chambers, *Exoteleia* Wallengren, *Chorivalva* Omelko, *Stenolechia* Meyrick, *Parasstenolechia* Kanazawa, *Nuntia* Omelko, *Schneidereria* Weber, *Teleiodes* Sattler, *Carpatolechia* Capușe, *Pseudotelphusa* Janse, and *Altenia* Sattler) a pair of rounded formations, each connecting with a channel piercing the sclerotized structures and often strongly inflated basally have been found (Figs 4, 5). The sclerotized structures have an opening at their apex. Similar paired organs were found in *Pogochaetia* Staudinger,

*Tila Povolný*, and *Agonochaetia Povolný* (tribe Gnorimoschemini). The identification of this organ as gland was based on the correspondence of its general morphology (round body and ductus with opening) with that of an organ described in primitive Lepidoptera (Kristensen 1984; Scoble 1992; Hallberg & Poppy 2003).

Since the soft tissues are digested during maceration in KOH, the rounded glandular bodies and glandular ductus were never found in the genitalia and the attention of the scientists was attracted only to the sclerotized distal parts of the described glands. Before the present investigation these parts took various names in the above-mentioned genera: “valva”, “cucullus”, “valvella”, “filament”. In the course of my research I found that the discussed parts were not homologous to any part of the valva. Since these sclerotized structures support the glandular ductus the name “glandiductors” was proposed for them (Ponomarenko 2005).

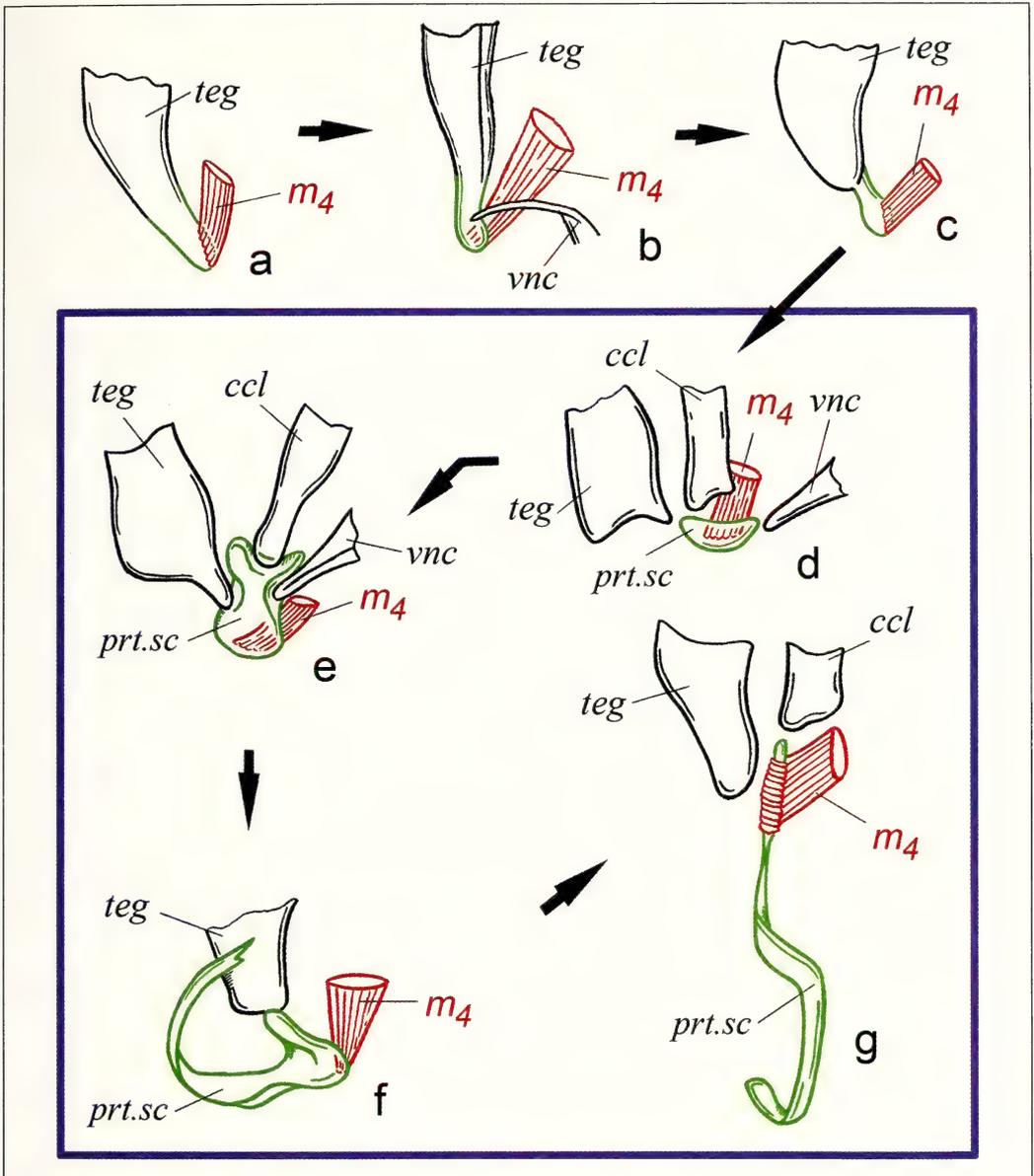
During my comparative morphological analysis it was possible to reveal the tendency in the change of the glandiductors' position. Originally they probably were positioned medially to the cuculli and were fused with them basally (Figs 6 c, d, 7 a, b). Within the tribe Litini one can see the lateral removing of these structures and replacement of slightly sclerotized cuculli by them (Figs 6 b, 7 c). In some genera of the Litini the cucullus is still present (Fig. 6 c, marked by blue), but it has lost its function to hold the female during copulation. The described transformation is closely linked with the main evolutionary tendency in the valva's transformation within Gelechiidae. This tendency is directed toward the loss of the basic valva's role of holding the female during copulation which is caused by the fusion of the valvae with other structures of the genitalia and often accompanied by a reduction of the valval musculature (Ponomarenko 2005).

The transformation of the glandiductors within the Gelechiinae is not limited to the example considered above and should be subjected to a special investigation. The illustrations of the male genitalia of *Chionodes* Hübner, *Sattleria Povolný*, and *Tila Povolný* (Sattler 1947: figs 7–18; Pitkin & Sattler 1991: fig. 66; Povolný 2002: figs 473, 474) allow to imagine several directions of glandiductor transformation within the subfamily: their replacement dorsally and junction over the aedeagus, their ankylosis with the cuculli, or their reduction to perforated plates in the anellus zone.

In genus *Mirificarma* Gozmány the glandular body is unpaired and asymmetric and the glandular ductus, arising from it, penetrates the long so-called filament with two small lobes outlining the excretory opening (Fig. 5 c).

In *Gelechia* Hübner and *Psoricoptera* Stainton, which are very close to *Mirificarma* in genitalic morphology, the glands have not been found. However, in some species of *Gelechia* the membranous sac is placed where the medial valvar processes (transtilla) are fused. The similarity of the membranous sac in these genera was already noted by Pitkin (1984).

The homology of these new organs (genital glands) cannot be doubted; they not only occupy the same position, but they are also connected with the abductor muscles of the valvae ( $m_2$ ) in all mentioned genera, as the transtilla in *Gelechia* and *Psoricoptera* (Figs 6 a, b). Genus *Neofriseria* Sattler, which is related to genus *Gelechia*, attracts the attention by its long twisted processes on the medial side of each valva (Figs 5 d, e, marked in green). The abductor muscles of the valvae ( $m_2$ ) arise from the dorsal arched part



**Fig. 3.** Transformation of the anterolateral parts of tegumen within family Gelechiidae. **a.** *Gelechia* Hübner, **b.** *Psoricoptera* Stainton; **c.** *Syncopacma* Meyrick, **d.** *Neofaculta* Gozmány, **e.** *Hypatima* Hübner, **f.** *Dichomeris* Hübner, **g.** *Acanthophila* Heinemann. Direction of transformation is shown by arrow. Genera belonging to Dichomeridinae are outlined by blue square.

of these processes, which is evidence for their homology with the medial processes of the valvae in other genera close to *Gelechia*, including genus *Mirificarma*, which has a well-developed gland. The distal part of the processes in *Neofriseria* is dilated, with a gutter-like concavity and both are joined medially by a membranous sac. The peculiarities of the long twisted processes on the medial side of the valvae in *Neofriseria*

allow to hypothesize on the genesis of the above-described glands. I presume that they originated from the ectoderm by invagination of the wall in processes like those of *Neofriseria*, and that there were originally two of them. The confirmation of this hypothesis is the presence of the paired glandular bodies and ducti in most of the genera in which they were found. Genus *Tila*, with its basally joined glandular bodies and two glandiductors, probably holds a transitional position to *Mirificarma*, which has an asymmetric unpaired gland, as a result of the fusion of the originally paired glandular bodies.

The position of muscles  $m_2$ , enclaspings the inflated bases of the glandiductors (Fig. 7 b), allows to presume their performance of two functions. The first of them (mentioned above) is supporting the glandular ductus. The second function of the glandiductors is implied also by their position: in many genera they are placed over the aedeagus and positined in the same direction. Being inserted in the ductus bursae along with the aedeagus, they take part in the fixation of the female during copulation by moving outwardly due to the traction of muscles  $m_2$ . Thus, the glandiductors not only support the glandular ductus but functionally compensate for rudimentary or reduced cuculli.

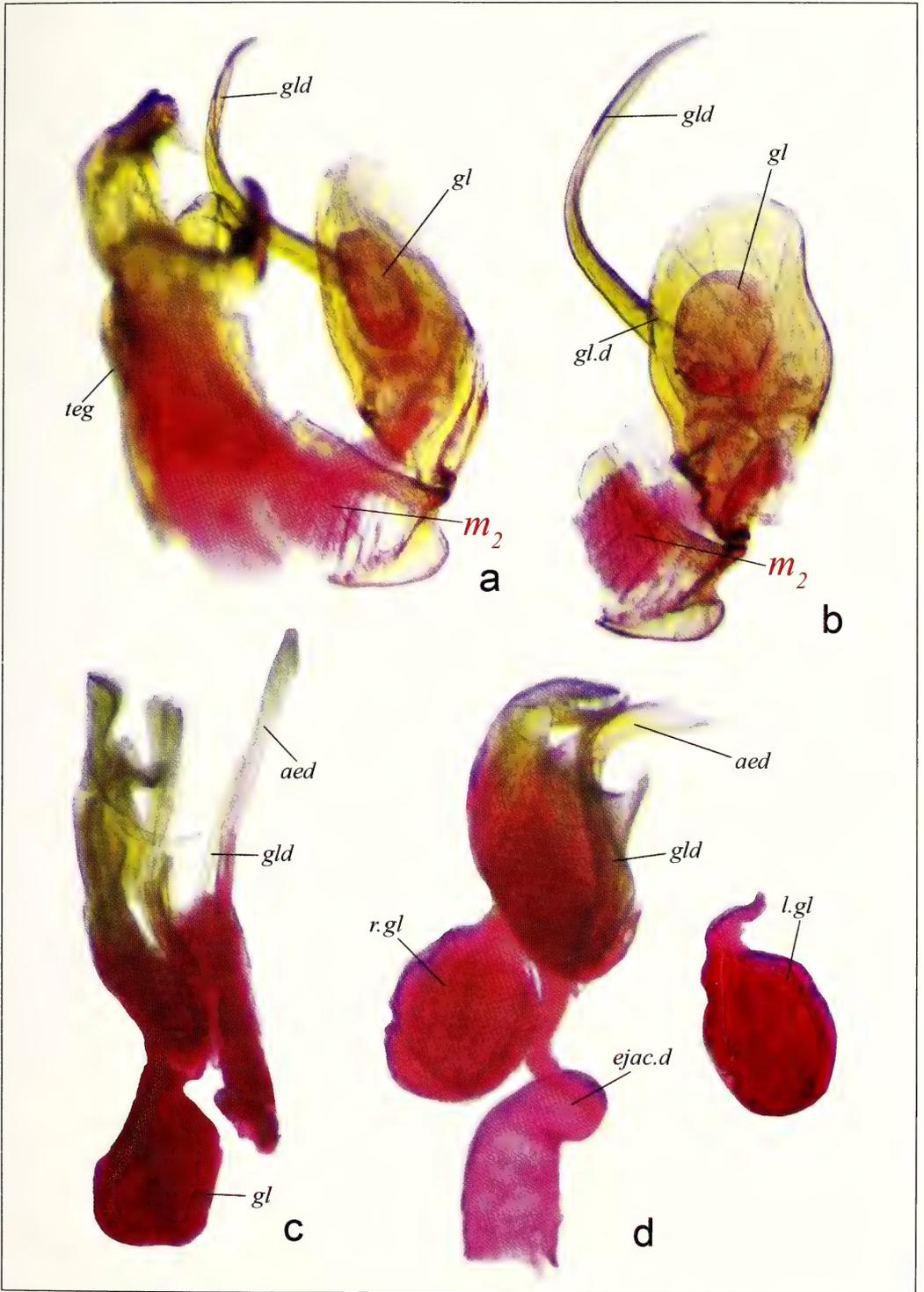
In summary, the presence of glands in the genitalia should be estimated to be a common specialization of tribes Gelechiini, Gnorimoschemini, and Litini inherited from a common ancestor and secondarily lost by some of their representatives. Thus, the presence of the described glands could be considered as a basal synapomorphy for the subfamily Gelechiinae (Fig. 8, shown by green oval).

### The transformation of the juxta

The ground plan of the skeleton-muscular apparatus of the genitalia in Lepidoptera, analysed in details by Kuznetsov & Stekolnikov (2001) and Kristensen (2003), is characterized by the presence of a sclerotized median plate (juxta) in the ventral part of the anellus and connected with muscles  $m_3$ . The position of this ventral sclerite and its connection with muscles  $m_3$  are characteristic for many families of Microlepidoptera. Therefore, the homology of the separate median plate (juxta) connected with muscles  $m_3$  in the gelechiid genera related to *Apatetris* Staudinger and *Brachmia* Hübner and in genera of the Chelariini and Anarsiini (Figs 9 a–c, 10 a), and the juxta in other families of Microlepidoptera is obvious.

The juxta belongs to the phallic functional morphological complex (Ponomarenko 2004, 2005). It is impossible to consider the function and transformation of any structure of this complex separately from the other ones, especially the most important of them, the aedeagus. The general tendency in evolutionary transformation of the aedeagus within Gelechiidae is its junction with the ventral part of the genitalia (with vinculum and juxta; or with vinculum, juxta, and sacculi) till their ankylosis into one sclerite. The later stage is typical for most specialized groups within the family. Such groups were used for introducing new terminology in lepidopterological morphology and the source of misinterpretations of the structures' homology.

The variety of opinions on the homology of the “ventral sclerite” in the male genitalia of gelechiid moths requires to consider this problem in detail. The descriptive term



**Fig. 4.** Photo of male genitalia with glands of genital segments. **a, b.** *Teleiodes saltuum* (Zeller) (a. genitalia in lateral view, b. gland); **c.** *Mirificarma eburnella* (Denis et Schiffermüller); **d.** *Schneidereria pista-ciella* Weber.

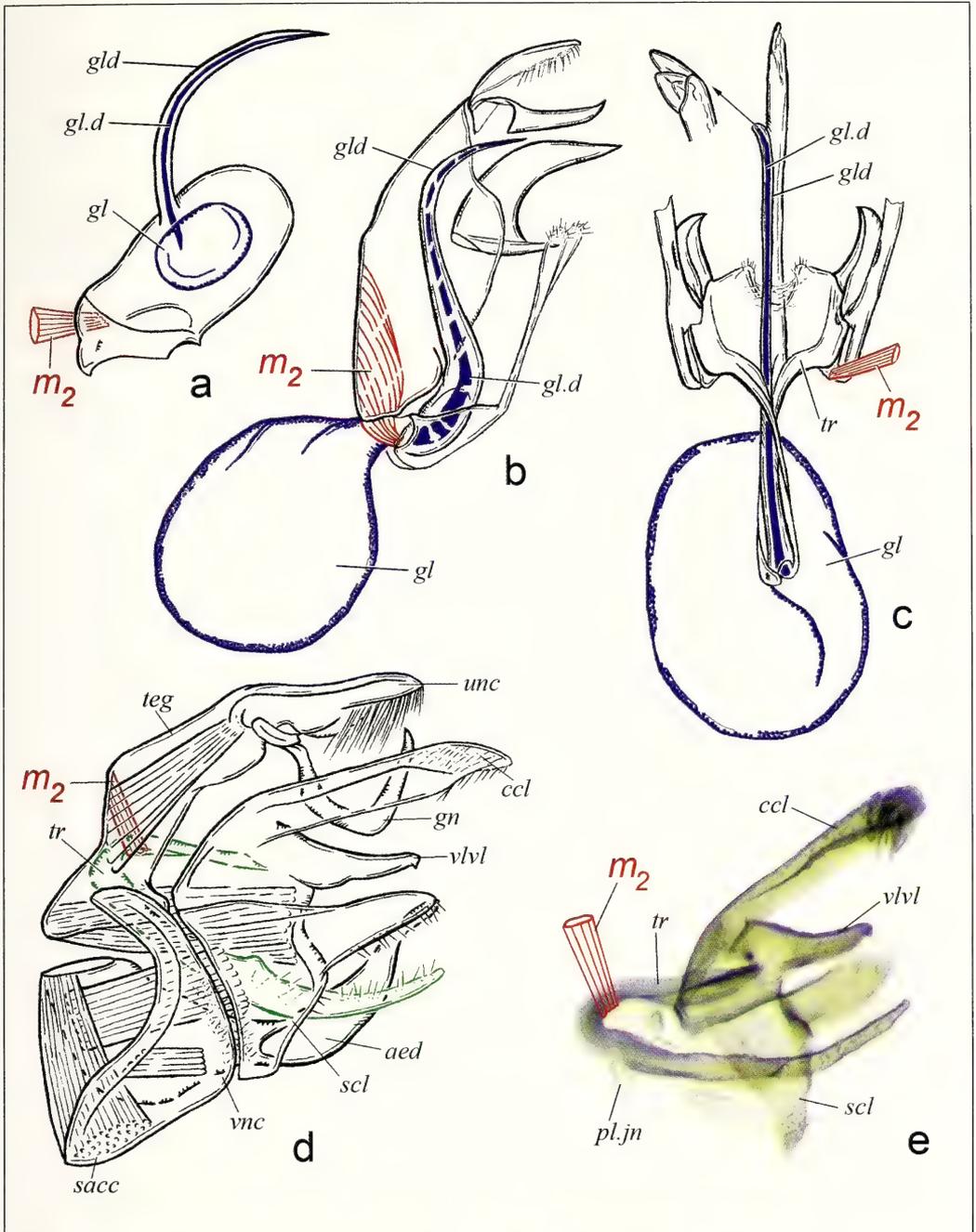
“ventral sclerite” was used by V.I. Piskunov (1981) in the tribe Dichomeridini. Ronald H. Hodges (1986) used the traditional term “juxta” in the same tribe. Omelko (1991) treated the ventral sclerite as a “juxta” in tribes Chelariini and Anarsiini only, but in tribe Dichomeridini he associated this sclerite with the distal processes of the sacculi. The term “sicae” was used by Park (1994) and later by Hodges (1998) following Heinrich (1920). Kaila (2004) in his cladistic analysis of Gelechioidea mentioned “... the sicae were not coded separately from the modification of the sternum 8 of Cosmopterigidae and Scythrididae” thus associating the term “sicae” to parts of the abdomen that do not belong to the genitalia. This conclusion was based on the genital morphology of *Pexicopia malvella* Hübner, belonging to the Pexicopiini (Gelechiidae).

The origin of the sclerite placed ventrally in the male genitalia of the Dichomeridini is unravelled in an analysis of the evolutionary transformation of the ventral part of the male genitalia in the subfamily Dichomeridinae. One of the directions of transformation of the juxta within this subfamily consists in its fusion with the median side or posterior margin of the vinculum, which is revealed in more specialized genera of the Chelariini (*Dendrophilia* Ponomarenko, *Empalactis* Meyrick, *Bagdadia* Amsel) and genera from of the Dichomeridini with more generalized morphology (*Helcystogramma* Zeller) (Figs 9 e, 10 b). The juxta, as a result of its fusion with the vinculum, loses its ability to the free mobility correlated with a weakening and reduction of muscles  $m_3$ . This transformation is shown on Fig. 10. On the base of this morphocline the homology of the ventral sclerite, fused with the posterior margin or median surface of the vinculum in specialized genera of Dichomeridini and with the juxta in other representatives of the subfamily is established.

The described transformation also takes place in other groups of Gelechiidae and it is possible to find examples with different stages of this process: juxta joined with vinculum and still connected with muscles  $m_3$ ; juxta fused with vinculum with reduced muscles  $m_3$  (Fig. 9 d) and presence of muscles  $m_3$  with absence of juxta. A study of the functional morphology in genus *Pexicopia* Common shows that the “ventral sclerite” should be considered as the fused vinculum+juxta, of which the homology is confirmed by the position and attachment of muscles  $m_3$  (Fig. 9 f) and phallic muscles  $m_{5a}$ ,  $m_{5b}$  and  $m_6$  (Ponomarenko 2005: 110, fig. 28), originally arising from those sclerites in genera with a more generalized morphology. The separate vinculum and juxta as well as the derivative vinculum+juxta are parts of the 9th genital segment and cannot be treated as homologous to the modified 8th sternum in Cosmopterigidae and Scythrididae.

### **Incorrect homologies of the genital structures in cladistic analyses of Gelechioidea**

As a result of functional morphological analysis, the homology of some genitalic structures has been reconsidered and evolutionary transformations within the family were revealed. Investigations on the homology of genital sclerites would be incomplete without an overview of the use of these characters in recently published cladistic analyses and their coding.



**Figs 5 a–e.** Glands of genital segments. **a.** *Teleiodes saltuum* (Zeller), **b.** *Schneidereria pistaciella* Weber, **c.** *Mirificarma eburnella* (Denis et Schiferrmüller). **d, e.** *Neofriseria peliella* (Treitschke), skeleton-muscular apparatus of the male genitalia. **d.** lateral view, **e.** right valva, view from inner side.

As shown above, the parategminal sclerites of the Dichomeridinae, consisting of tribes Anarsiini, Chelariini, and Dichomeridini, have a common origin. They are homologous

to the anterolateral parts of the tegumen in other Gelechiidae and were separated from them along with muscles  $m_4$  during their evolutionary transformation. The parategminal sclerites are equal to the “appendix appendicular” in the Dichomeridini (only!).

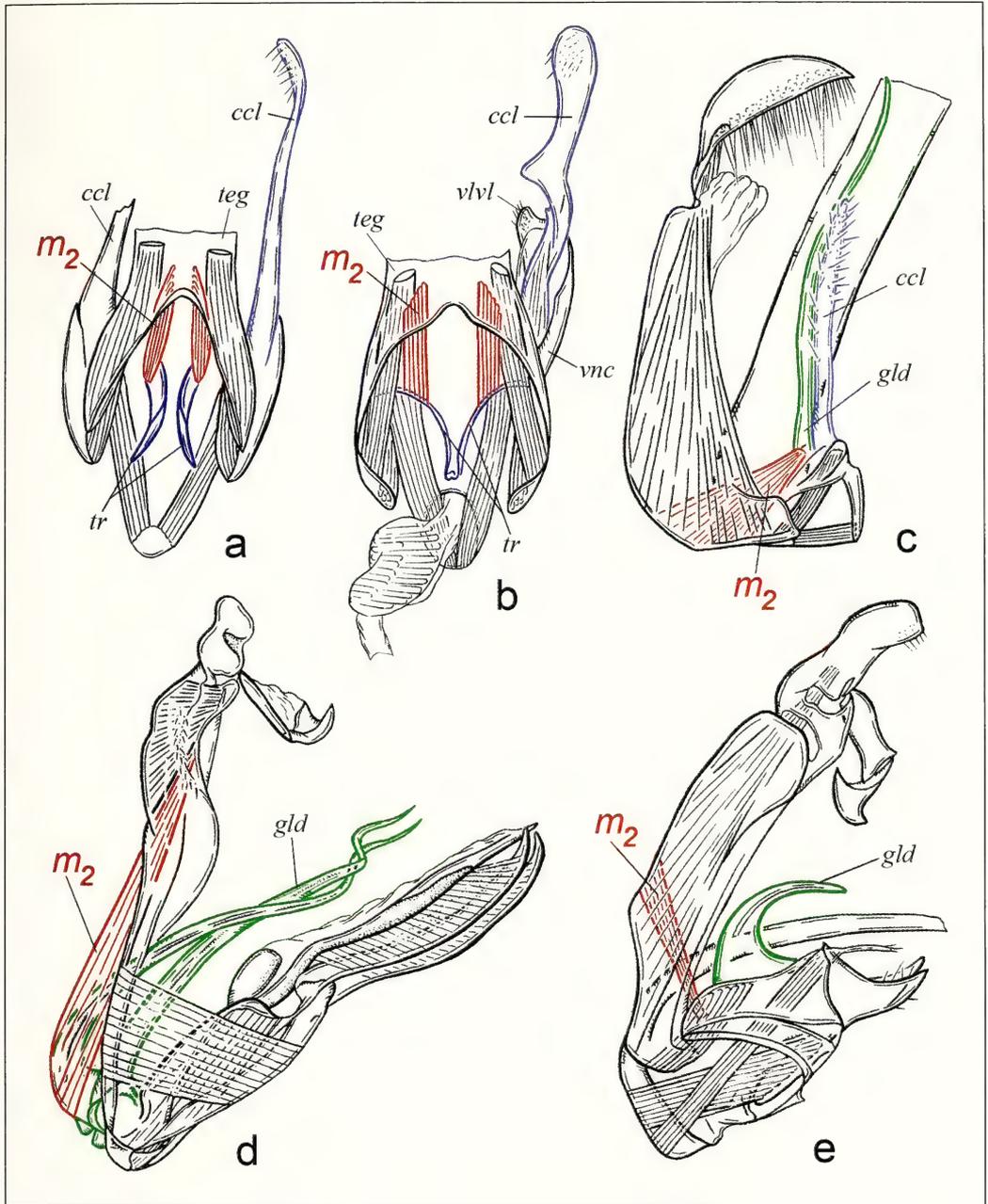
The term “appendix appendicular” introduced by Hodges (1986) for Dichomeridinae sensu stricto (Dichomeridini in my understanding) was used for any sclerites placed anterolaterally in the male genitalia of many groups within Gelechiidae, not only by the term’s author, but by other researchers as well. According to the functional morphological data the sclerites named “appendix appendicular” were not homologous structures; most often they are the transtilla in Apatetrini, Gelechiini and Gnorimoschemini, the anterolateral parts of the tegumen in Gelechiini and Pexicopiini, or the parategminal sclerites in Anarsiini and Dichomeridini. If the anterolateral parts of the tegumen and parategminal sclerites are both apodemes of muscles  $m_4$  and states of the same morphocline (see above, Fig. 3), the transtilla being the apodeme of  $m_2$  is not homologous to the anterolateral parts of the tegumen and parategminal sclerites.

This misinterpretation was the basis for an additional mistake in Kaila (2004), where characters 1 (valva without/with developed costa as free lobe) and 29 (appendix appendicular present/absent) of Hodges (1998) were fused and “the appendix appendicular was interpreted to be homologous to valval costa”.

As a result of the misinterpretation of the homology of these genital sclerites the character “appendix appendicular” was scored as present in the matrix for three subfamilies Gelechiinae, Dichomeridinae and Pexicopiinae and finally received the status of parallelism in Hodges (1998: character 29). In its reconsidered version and broadened interpretation that character found a place in the cladogram of Gelechioidea as an homoplastic synapomorphy for the branches Gelechiidae+Cosmopterigidae, Scythrididae and Coleophoridae (Kaila 2004: 329, character 101).

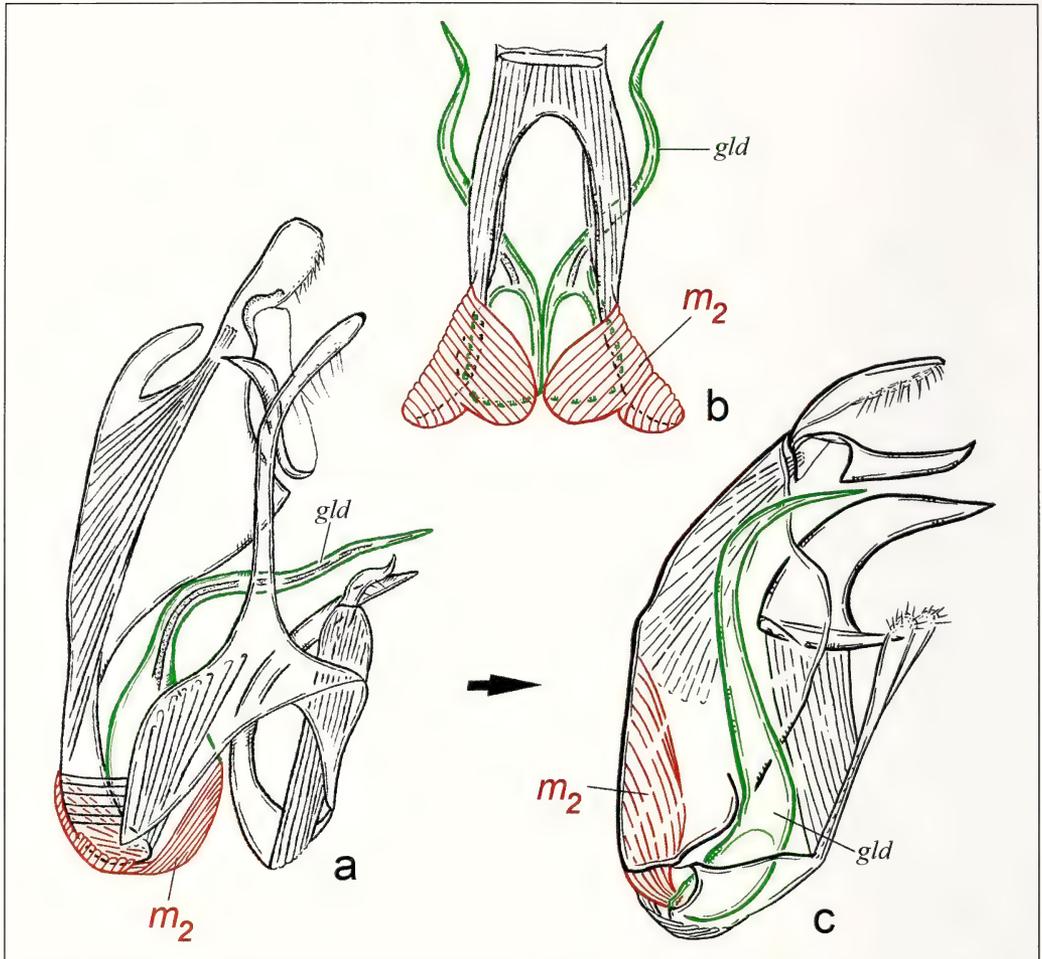
There is probably no reason to discuss the coding of this character in the matrix of Gelechioidea in Bucheli & Wenzel (2005), where, on the one hand, complexes of characters were uncritically used following previous authors, and, on the other hand, the matrix was filled in error. Referring to Hodges (1998), the authors indicated an absence of the appendix appendicular in Dichomeridinae instead of a presence, but no group was given that state of character in their matrix.

The next point of the present study is that the “ventral sclerite” of the vinculum in Dichomeridini was formed as a result of the evolutionary transformation of the typical juxta in other gelechiid moths (see morphocline on Fig. 10). Both states, free juxta and joined with vinculum correspond to the definition of the term “juxta” in Klots (1970): Juxta is a “sclerotized plate, often shield-shaped, ventrad of aedeagus, which it helps to support; strongly fastened to or fused with bases of sacculi and ventral part of vinculum; sometimes connected with anellus by a median rodlike process, which is often forked dorsally so as to surround aedeagus”. Hodges (1998), referring to Klots, reduced this definition and divided the states of this character into two: “free juxta present/absent” and “sicae (joined juxta and vinculum) absent/present”. This would not be a subject for discussion if every author using these states would be consistent in their coding. Firstly, it is necessary to emphasize that the term “sicae” was used by Hodges for the subfamily



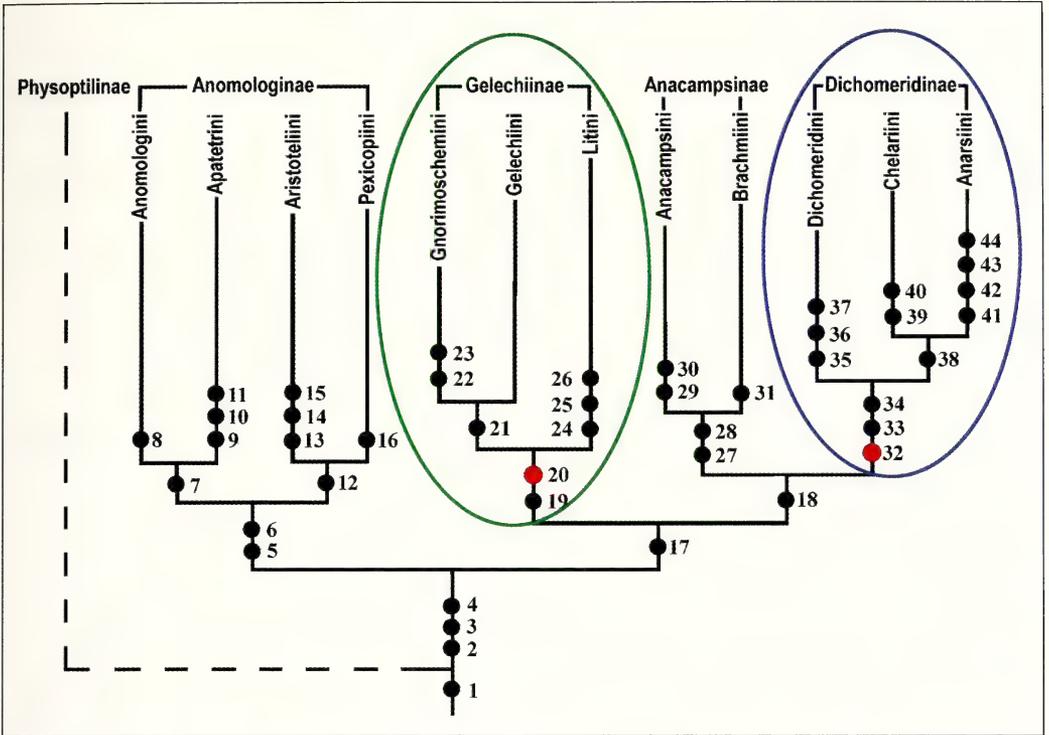
**Figs 6 a–e.** Position of muscle *m*, in the genera of Gelechiinae. **a.** *Psoricoptera arenicolor* Omelko; **b.** *Gelechia rhombella* (Denis et Schifferrmüller); valva, base of tegumen and aedeagus, dorsal view. **c–e.** Position of glanductors in Litini. **c.** *Carpatolechia fugacella* (Zeller), **d.** *Recurvaria nanella* (Denis et Schifferrmüller), **e.** *Stenolechia gemmella* (Linnaeus). Glanductors are shown by green, cucullus and transtilla marked by blue.

Dichomeridinae following Heinrich (1920), who had introduced it for unrelated groups (*Recurvaria* Haworth, *Tosca* Heinrich) and for nonhomologous structures. As for cod-



**Fig. 7.** Transformation of glandiductor position. **a, b.** *Parastenolechia collucata* Omelko (a. lateral view, b. dorsal view), **c.** *Schneidereria pistaciella* Weber. Glandiductors are shown by green. Direction of transformation is shown by arrow.

ing, the character state “juxta absent” (Hodges 1998: character 2 (1)) was indicated for subfamily Gelechiinae, in which the tribes Chelariini (including the *Anarsia*-group) and Anomologini (including *Apatetris* Staudinger and *Metanarsia* Staudinger) were included. All these groups have a free juxta with well developed muscles  $m_3$  (Figs 9 a, b; 10 a). On the other hand, the character state “sicae present” (Hodges 1998: character 7 (1)) in the matrix was indicated for subfamily Dichomeridinae only, whereas the term was introduced by Heinrich for the tribe Litini (=Teleiodini). Besides that, Hodges (1998) included genus *Brachmia* Hübner in his Dichomeridinae whereas it possesses a typical free juxta with well-developed muscles  $m_3$  (Fig. 9 c). The processes on the posterior margin of the vinculum in *Helcystogramma* Zeller are homologous to sacculi, not to the juxta. The juxta in this genus is represented by a bridle-like sclerite with attached muscles  $m_3$  and lacking any processes (Fig. 9 e). The so-called “sicae” in this

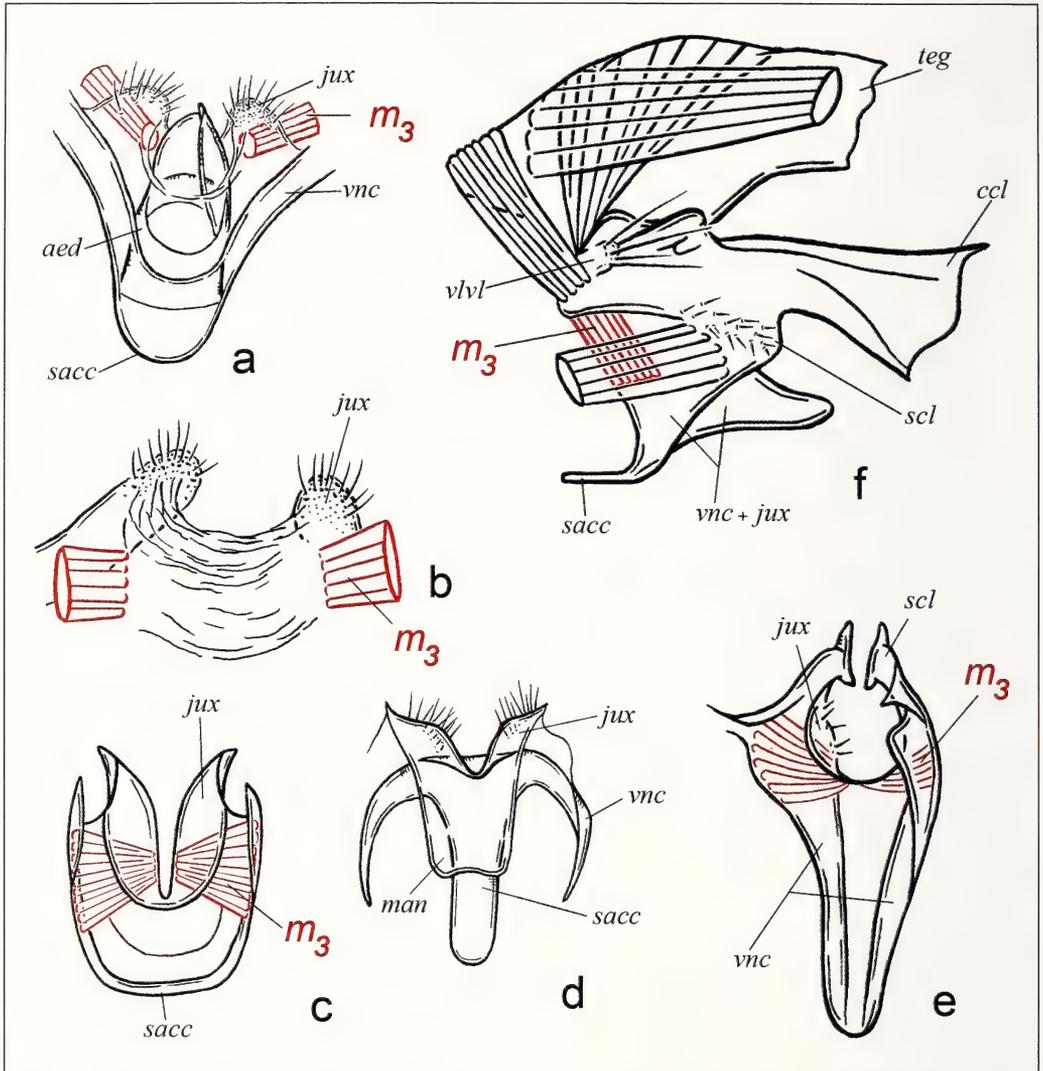


**Fig. 8.** Cladogram of the family Gelechiidae. Monophyletic groups, subfamilies Gelechiinae and Dichomeridinae, are shown by green and blue ovals. Synapomorphies marked by red: 20: presence of glands of the genital segment; 32: muscles  $m_4$  attached to separate parategminal sclerites. For remaining apomorphies see Ponomarenko (2005).

genus are absent. Additionally, the genera *Scodes* Hodges and *Acompsia* Hübner have neither juxta and processes on the vinculum. The large setaceous lobes in both genera are sacculi, which is confirmed by the position of the phallic muscles. Thus, really only one genus, *Dichomeris* Hübner, possesses “sicae” in male genitalia, but not in all species. This does not allow to treat the character state “sicae present” as a synapomorphy for the Dichomeridinae.

Bucheli & Wenzel (2005) did not reconsider the states of these characters and in coding them they completely followed Hodges (1998). The extrapolation of the term “sicae” to sternum 8 of the visceral segments of the abdomen could be interpreted as an unfortunate misinterpretation, which found place in Kaila’s cladogram (2004) as a single “unique” synapomorphy for the Scythrididae+Gelechiidae+Cosmopterigidae (Kaila 2004: character 81 (1)).

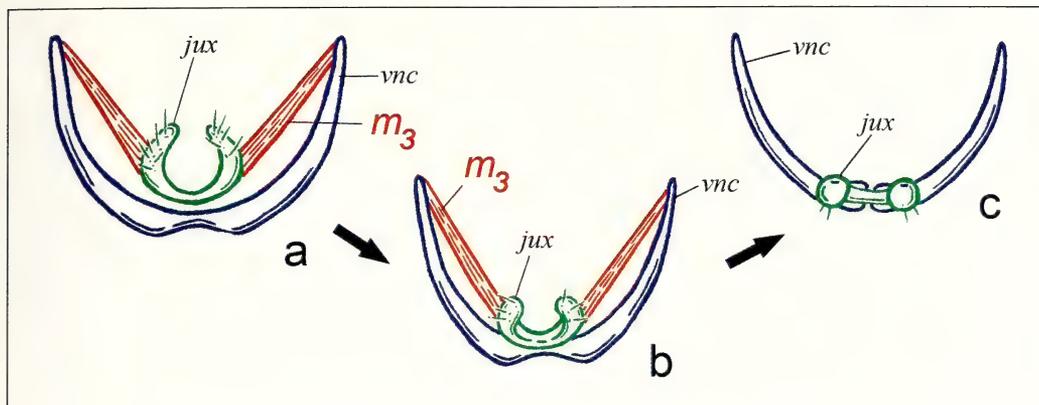
The last point is the newly discovered gland of the male genitalia. The sclerotized structures which support glandular ductus (or insert it) in the Gelechiinae were named glandiductors. They are not homologous to parts of the valva. One of the directions in the evolutionary transformation of the glandiductors was the lateral removing of these structures and replacement of the slightly sclerotized cuculli by them. The numerous



**Fig. 9.** Position of the juxta in Gelechiidae. **a.** *Apatetris kinkerella* (Snellen); **b.** *Metanarsia modesta* Staudinger; **c.** *Brachmia dimidiella* (Denis & Schiffermüller); **d.** *Gelechia rhombella* (Denis et Schiffermüller); **e.** *Helcystogramma triannulella* (Herrich-Schäffer); **f.** *Pexicopia malvella* (Hübner).

misinterpretations of the homology of the glandiductors are simply caused by their occupation of a lateral position in the male genitalia.

In summary, it is reasonable to conclude that the final results of any cladistic analysis directly depend not from the number of included characters, but from their quality. A careful comparative morphological analysis to understand the genital sclerites' homology and, as consequence, to correctly code the states of the characters and to critically select the characters to analyze represent a good guarantee to achieve believable results.



**Fig. 10.** Transformation of juxta position and reduction of the muscle  $m_3$ . **a.** *Hypatima* Hübner; **b.** *Den-drophilia* Ponomarenko; **c.** *Dichomeris* Hübner.

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## New data on Anomologini from Palaeartic Asia (Gelechiidae)

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**Abstract.** Two new genera of Gelechiidae, *Spiniphallellus* gen. n. and *Spiniductellus* gen. n., are described from mountain and desert areas of Palaeartic Asia. The new genera are placed in the Anomologini, and they are compared with relevant genera of that tribe. *Spiniphallellus* gen. n. includes three species: *S. desertus* sp. n. (Uzbekistan, Turkmenistan, Kazakhstan), *S. stonisi* sp. n. (Kazakhstan) and *S. fuscescens* (Turkey), and *Spiniductellus* gen. n. includes two species: *S. atraphaxi* sp. n. (Tadzhikistan) and *S. flavonigrum* sp. n. (Kazakhstan). The host plant is known only for *S. atraphaxi* sp. n., which was bred from *Atraphaxis pyrifolia* Bunke (Polygonaceae). The higher classification of the Gelechiidae, and especially the Anomologini is briefly reviewed. Arguments for describing these new taxa outside of a larger taxonomic framework are given, and we discuss why we describe new genera for the species instead of placing them in existing ones.

**Zusammenfassung.** Zwei neue Gattungen der Gelechiidae, *Spiniphallellus* gen. n. und *Spiniductellus* gen. n. werden aus Gebirgen und Wüsten des paläarktischen Asiens beschrieben. Die neuen Gattungen werden den Anomologini zugeordnet und mit den relevanten Gattungen dieser Tribus verglichen. *Spiniphallellus* gen. n. enthält drei Arten: *S. desertus* sp. n. (Usbekistan, Turkmenistan, Kasachstan), *S. stonisi* sp. n. (Kasachstan) und *S. fuscescens* (Türkei) und *Spiniductellus* gen. n. enthält zwei Arten: *S. atraphaxi* sp. n. (Tadschikistan) und *S. flavonigrum* sp. n. (Kasachstan). Die Nahrungspflanze der Larven ist nur von *S. atraphaxi* sp. n. bekannt, welche von *Atraphaxis pyrifolia* Bunke (Polygonaceae) gezüchtet wurde. Es wird ein kurzer Überblick über die Klassifikation der Gelechiidae und besonders der Anomologini und Argumente für die Beschreibung der neuen Taxa außerhalb einer größeren Revision gegeben und diskutiert, warum wir für die Arten neue Gattungen beschreiben, anstatt sie vorhandenen zuzuordnen.

### Introduction

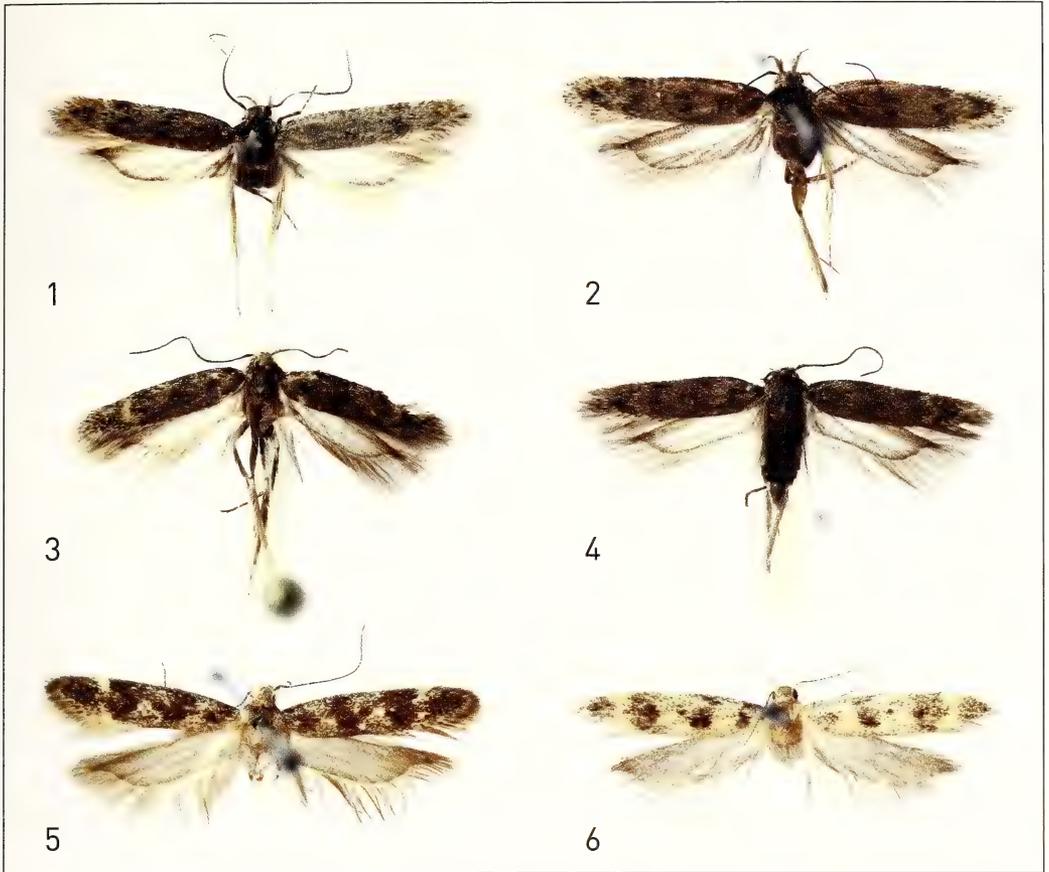
With more than 500 described genera and at least 4500 described and numerous undescribed species (Hodges 1998: 147) the Gelechiidae is the third largest family of Microlepidoptera. It is moreover one of the least known families. They have not been catalogued since Gaede (1937), and check lists have still not been published for all major zoogeographical regions.

Hodges (1986: 6–7) divided the Gelechiidae into three subfamilies, Gelechiinae, Dichomeridinae and Pexicopiinae, later adding the Physoptilinae (Hodges 1998: 147). Among these the Gelechiinae are again divided into a number of tribes, depending on authors. In an alternative classification Ponomarenko (2006: 377) argues for separating the Gelechiidae into five subfamilies: Physoptilinae, Anomologinae, Gelechiinae, Anacampsininae and Dichomeridinae. The new system of Gelechiidae proposed by Ponomarenko is based mainly on the study of the musculature of the male genitalia and, undoubtedly, is a very important step towards improving the system of Gelechiidae in general. At the generic and specific level very few global and relatively few regional revisions exist. This is especially the case for the Anomologini s. lat. There is no phylogenetic analysis at generic level, resulting in a more or less random classification. According to Ponomarenko's system the subfamily Anomologinae comprises four tribes: Anomologini, Apatetrini, Aristoteliini and Pexicopiini based on such apomor-

phies as dilated anterolateral parts of tegumen and valve fused with tegumen. Within this subfamily the clade Anomologini + Apatetrini is characterized by reduced gnathos and uncus. The tribe Anomologini is characterized by the synapomorphy of muscles m1 divided into two parts (m1a and m1b) and can be separated from the Apatetrini by having phallus sac-shaped and dilated throughout its length (Ponomarenko 2005: 64, 89; 2006: 377). In spite of using a new approach to the classification of Gelechiidae the above mentioned new definition of the Anomologinae leaves some unresolved problems. First of all, it is difficult to agree with including Pexicopiinae in Anomologinae: the former is characterized by many unique genitalic and external characters. Furthermore, the association of *Gladiovalva* Sattler, 1960; *Bryotropha* Heinemann, 1870; *Ornativalva* Gozmány, 1955; *Curvisignella* Janse, 1951; *Ivanauskiella* Ivinskis & Piskunov, 1980; *Filisignella* Janse, 1951 and some other genera with the Aristoteliini (Ponomarenko 2005: 72) seems very unusual. It is clear that the system of Anomologini s. lat., as well as Gelechiidae as a whole, should be considerably improved, based on world-wide detailed evaluation of characters of a much larger number of taxa, first of all at generic level. In this connection it is important to note that the Anomologini s. lat. is perhaps the most diverse tribe within the Gelechiidae, with many undescribed taxa even in Europe, and it is unlikely that this tribe can be revised within the foreseeable future. There is, however, a need for describing the diversity also of this group of Microlepidoptera. Below we describe two small groups of moths belonging here, representing five undescribed species from Central Asia and Turkey, which we place into two new genera. All these species share such 'traditional' characters of the Anomologini as reduced gnathos, relatively short valva closely connected to tegumen, short tegumen and well developed transtilla lobe (Piskunov 1975: 857; Povolný 1979: 44). Without a phylogenetic framework it is of course not possible to place these taxa in a correct position within the (non-existing) classification of the Anomologini. We are moreover aware of the increased risk for creating synonyms when describing new taxa in an unrevised group of moths. However, we find it important to describe and name the diversity of moths especially when, as in this case, these represent combinations of characters which are unusual in the Gelechiidae. By describing and illustrating such taxa we share our knowledge with the lepidopterist community, thereby making them known and available for future research. We also considered placing the new species in existing genera like *Gladiovalva* Sattler, 1960 and *Monochroa* Heinemann, 1870, respectively, to which the genera described below are related. There is a long tradition among gelechiid taxonomists of describing new species in 'well known' genera like *Telphusa* Chambers, 1872, *Gelechia* Hübner, 1825 or *Lita* Treitschke, 1833, where the unique characters of such species, however, become hidden among the numerous other species in these genera.

**The studied material came from the following institutions:**

- ZIN Zoological Institute, Academy of Sciences, St. Petersburg, Russia
- ZMUC Zoological Museum, Natural History Museum, University of Copenhagen, Denmark
- ZMUH Zoological Museum, University of Helsinki, Finland
- ZMKU Zoological Museum, University of Kiev, Ukraine



**Figs 1–6.** Adults of *Spiniphallellus* and *Spiniductellus* species (all except fig. 4 are holotypes). **1.** *Spiniphallellus desertus* sp. n. ♂, Uzbekistan. **2.** *Spiniphallellus stonisi* sp. n. ♂, Kazakhstan. **3–4.** *Spiniphallellus fuscescens* sp. n. ♂, Turkey. **5.** *Spiniductellus atraphaxi* sp. n. ♂, Tadjikistan. **6.** *Spiniductellus flavonigrum* sp. n. ♂, Kazakhstan.

## RESULTS

### *Spiniphallellus* gen. n.

Type species: *Spiniphallellus desertus* sp. n.

**Diagnosis.** Adult (Figs 1–4). Wingspan 14–18 mm. Labial palp with furrowed brush on underside of segment 2; segment 3 of same length as segment 2. Both wing pairs relatively short and broad. Hindwing with moderately pointed apex; central part white. Legs with black femur and lighter tibia and tarsus.

**Male genitalia** (Figs 7–9). Segment VIII posterior-laterally separated into sternum and tergum; sternum sub-rectangular to almost quadrangular, with more or less developed anterior emargination; tergum broadly tongue-shaped, anteriorly emarginated. Tegumen broader than long, anterior margin with strongly developed broad emargination, lateral flaps broad, sub-triangular, in *S. stonisi* a pair of dagger-shaped processes

medially in tegumen; uncus sub-oval or arrow-shaped sclerotized, mainly at margins; gnathos absent; valva broad, sub-triangular or prolonged, covered mainly distally and laterally with short strong or long hair-like setae; transtilla lobe small, digitate, large and rounded, or reduced; vinculum broad, posterior margin with deep triangular medial emargination; saccus short, rectangular or broadly rounded distally; phallus short, stout, medially with distinct lateral thorn, basal half flattened, distal part gradually narrowed, apex pointed.

**Female genitalia** (Figs 14–17). Segment VIII simple, sternum VIII with or without medial incision, almost entirely or partially sclerotized; papilla analis prolonged, sparsely covered with setae. Apophyses anteriores rod-like, slightly or distinctly longer than segment VIII. Antrum funnel-shaped or rounded, opened on anterior margin of sternite VIII; ductus bursae long and slender without sclerotized colliculum; corpus bursae sub-oval; signum a sub-oval plate with more or less serrated margins.

**Distribution.** Turkey and Central Asia: Kazakhstan, Uzbekistan, Turkmenistan.

**Life history.** Early stages and host plant unknown.

**Remarks.** All examined specimens are more or less greasy. This is especially characteristic for species whose larvae are internal feeders in roots, stems or fruits.

The genitalia of the new genus can be associated with a group of genera related to *Monochroa* Heinemann, 1870, namely *Eulamprotes* Bradley, 1971, *Metzneria* Zeller, 1839, *Ptocheuusa* Heinemann, 1870 and *Isophrictis* Meyrick, 1917, all having short valvae covered with setae and a transtilla lobe. The new genus differs from them in having phallus without cornuti and a well developed uncus in the male genitalia. The phallus of *Spiniphallellus* is moreover without a ‘window’, a character which according to Sattler (1979: 269) is characteristic of *Deltophora* Janse, 1950, *Eulamprotes* and *Monochroa*.

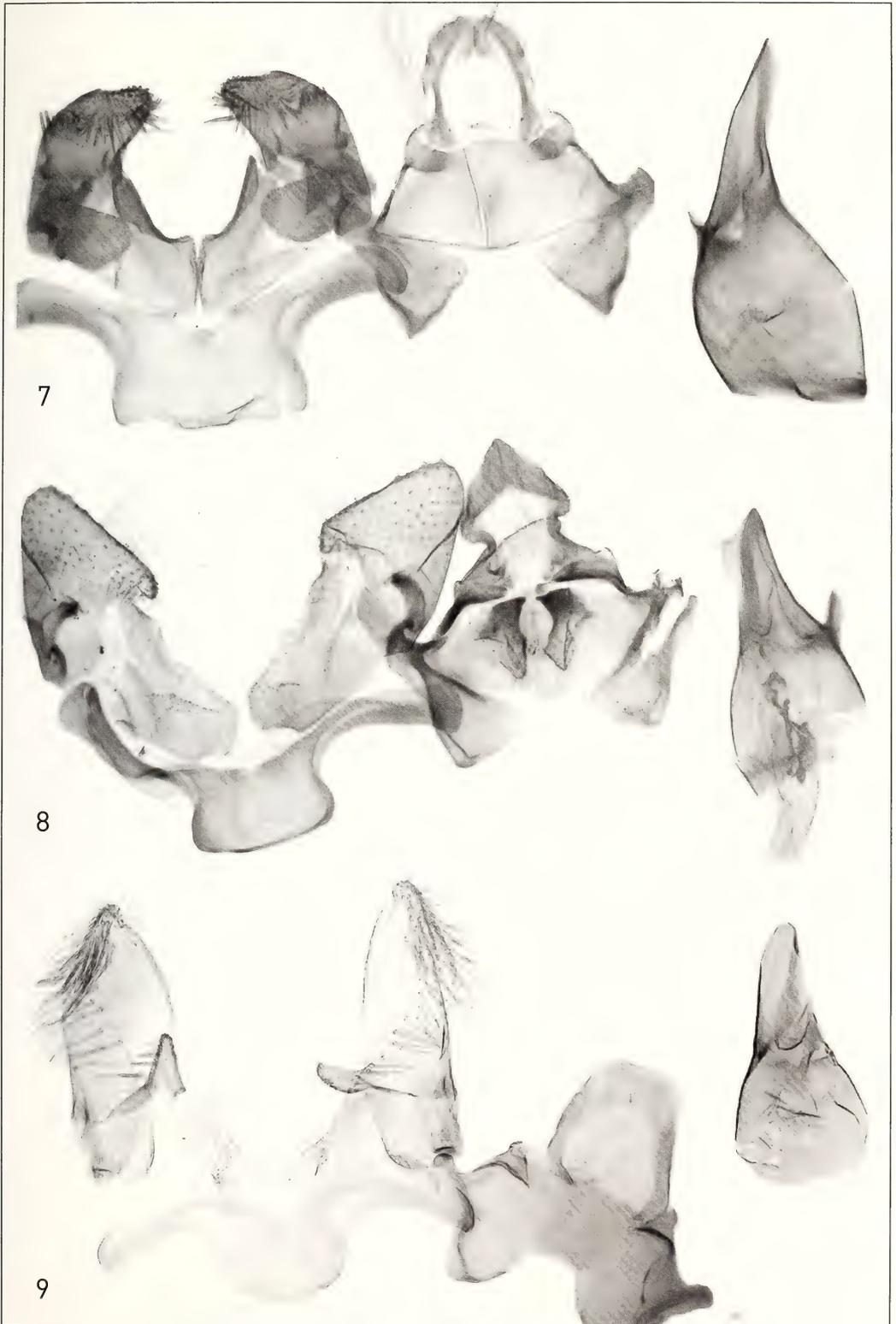
**Etymology.** The new genus is named after its spined phallus (Latin: *spinae* – spine).

### *Spiniphallellus desertus* sp. n.

**Material.** Holotype: ♂, **Uzbekistan** ‘Ajakguzhumdy 40 km O | Dzhing. [ildy] Kyzylkum | Zabello 16 v [1]965’ ‘gen. prep. 60/06 ♂’ [in Russian] (ZIN). – Paratypes: ♀, ‘Ajakguzhumdy 40 km O | Dzhingildy Uzbek.[istan] | Falkovitsh 3 vi [1]966’ ‘gen. prep. 520/07 ♀’ [in Russian]; ♀, ‘Ajakguzhumdy 40 km O | Dzhing.[ildy] Kyzylkum | Pastuhov 23 v [1]965’; ♀, ‘Ajakguzhumdy 40 km O | Dzhingildy Kyzylkum | Pastuhov 26 v [1]965’ [in Russian]; ♂, ‘Ajakguzhumdy 40 km O | Dzhing.[ildy] Kyzylkum | Falkovitsh 17 v [1]965’; ♂, ‘Ajakguzhumdy 40 km O | Dzhingildy Uzbek.[istan] | Falkovitsh 3 vi [1]966’ [in Russian]; ♂, ‘Kyzylkum, Uzbek.[istan] | Zhamansai | Falkovitsh 25 v [1]966’ [in Russian] (ZIN); ♀, [**Turkmenistan**] ‘Turkm.[enskaya] SSR, Badkhyz | kord.[on] Kyzylzhar | na svet | 30 v [1]981 V. Pechen’ ‘gen. prep. 60/06 ♀’ [in Russian] (ZMKU); ♀, ‘**Kazakhstan** | okr.[estnosti] g.[oroda] Aralsk | 11.06.2000 | O. Pak leg’ ‘gen. prep. 525/07 ♀’ [in Russian] (ZMKU).

**Diagnosis.** Adult (Fig. 1). Wingspan 16–18 mm. Labial palp cream-white, somewhat mottled with brown; tip of segment 3 blackish brown. Antenna black, ringed with light grey. Head and tegula blackish brown mottled with grey-brown; thorax almost black. Forewing blackish brown with a faint cover of light grey, especially at costal and apical part; black stigmata in middle of wing hardly visible; light grey-brown scales in fold;

**Figs 7–9.** Male genitalia of *Spiniphallellus* species. **7.** *S. desertus* sp. n., holotype (gen. prep. 60/06), Uzbekistan. **8.** *S. stonisi* sp. n., holotype (gen. prep. 63/06), Kazakhstan. **9.** *S. fuscescens* sp. n., holotype (gen. prep. 2977), Turkey.



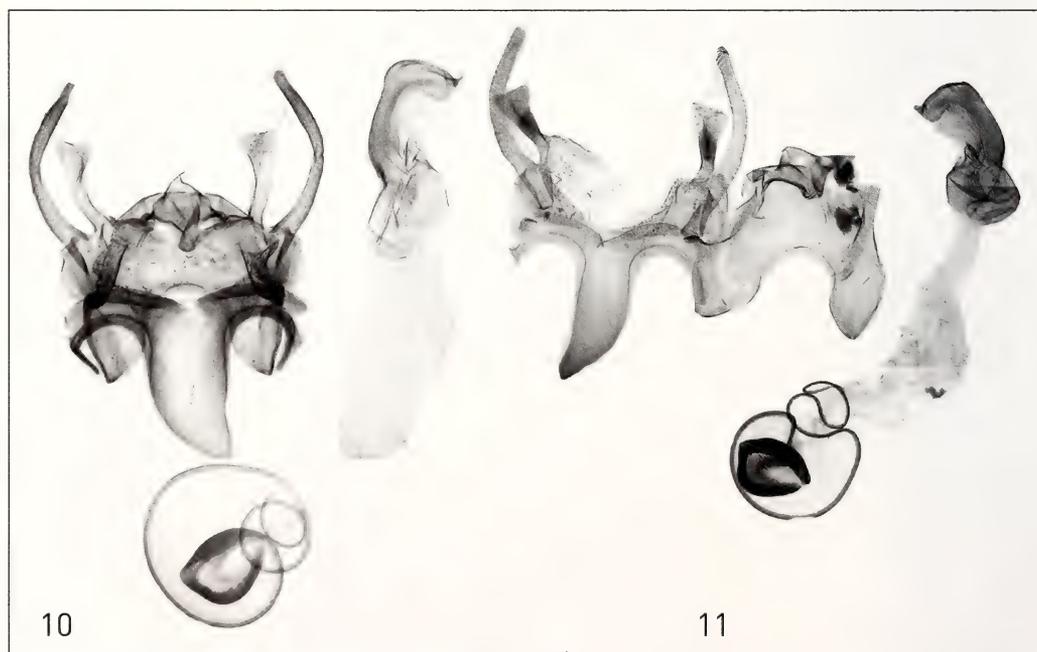
basal half of cilia blackish, apical half light grey. Hindwing white with black margins and veins. The white hindwings having only the margins and veins darker is characteristic for this species.

**Male genitalia** (Fig. 7). Sternite VIII sub-rectangular, with broad sub-triangular anterior emargination, posterior margin broadly rounded; tergite broadly tongue-shaped, anterior margin distinctly broad emarginated. Posterior margin of tegumen laterally with two small flaps; uncus sub-oval, sclerotized only at margins and with two short, inwardly bent digitate processes at posterior end; valva shorter than tegumen, triangular, curved inwards, with apex narrowed and covered with strong short setae; transtilla lobe broad, rounded; posterior margin of vinculum with broad, suboval medial emargination; saccus short and broad, rectangular; phallus medially with distinct lateral thorn, basal half flattened, distal part relatively slender, tapered apically.

The species differs from *S. fuscescens* in the distally curved valva and the broad, rounded transtilla lobe; from *S. stonisi* it differs in the shape of the uncus.

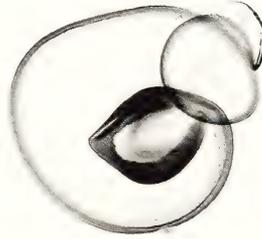
**Female genitalia** (Figs 14–16). Segment VIII broader than long, with broad triangular anterior emargination. Apophyses anteriores straight, about 4 times shorter than apophyses posteriores and distinctly longer than segment VIII. Sternum VIII not divided, with paired sclerotized diffuse lateral patches at base of apophyses anteriores; anterior margin of sternum VIII oblique, strongly sclerotized; periostial lobes small, prolonged; antrum funnel-shaped weakly sclerotized; ductus bursae long and slender; corpus bursae sub-oval; signum a sub-oval plate with serrated margins.

For separation from *S. fuscescens* see under that species.

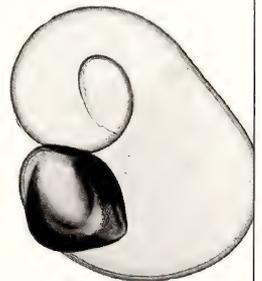
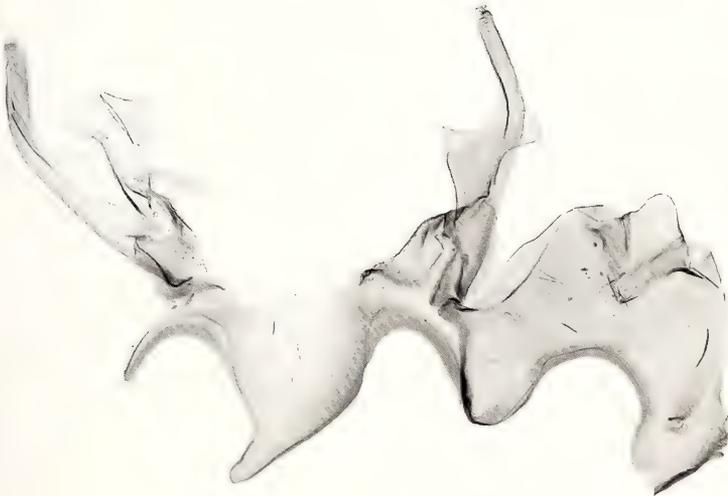


**Figs 10–13.** Male genitalia of *Spiniductellus* species. **10.** *S. atraphaxi* sp. n., holotype (gen. prep. 142/07). **11.** *S. atraphaxi* sp. n., paratype (gen. prep. 66/06), Tadjhikistan. **12.** *S. flavonigrum* sp. n., holotype (gen. prep. 143/07), Kazakhstan. **13.** *S. flavonigrum* sp. n., paratype (gen. prep. 5359), Kyrgyzstan.

12



13



**Variation.** There is some variation in the shape of antrum in specimens from different localities.

**Distribution.** Uzbekistan, Turkmenistan, S Kazakhstan.

**Life history.** Early stages and host plant unknown. It is possible that the larvae are internal feeders. Adults fly from mid-May to mid-June.

**Etymology.** The specific name refers to the species distribution in desert areas (Latin: *deserta* – desert).

***Spiniphallellus stonisi* sp. n.**

**Material.** Holotype: ♂, **SE Kazakhstan** ‘Tian Shan, 90 km E | Tschimkent, H = 1300m | Aksu Dzhabagly | 8.8.87 R. Puplesis’ gen. prep. 63/06 ♂ (ZIN).

**Diagnosis.** Adult (Fig. 2). Wingspan 17 mm. Segment 2 of labial palp cream-white mottled with light brown; segment 3 blackish brown, darkest at tip. Antenna black. Head and tegula blackish brown mottled with grey-brown; thorax almost black. Forewing covered with light grey, dark grey-tipped scales and mottled with blackish brown; black stigmata in fold and at 1/3 and 2/3 in middle of wing, with second plical directly below first discal; faint, black costal and tornal spots followed by light scales; cilia grey with black cilia line. Hindwing grey, with central part white.

This species can be separated from *S. desertus* by its darker hindwings, and from *S. fuscescens* by its slightly larger size and the more distinct black stigmata in the forewings.

**Male genitalia** (Fig. 8). Segment VIII as in *S. desertus*. Posterior margin of tegumen sparsely covered with long hair-like setae, laterally with two elongate flaps; medially in tegumen paired, dagger-shaped processes; uncus arrow-shaped; valva broad, triangular, with distinct cucullus, covered with short setae; transtilla lobe reduced; vinculum broad, posterior margin with deep triangular medial emargination; saccus short, rectangular; phallus with distinct medial thorn, distal part relatively broad, gradually tapered distally.

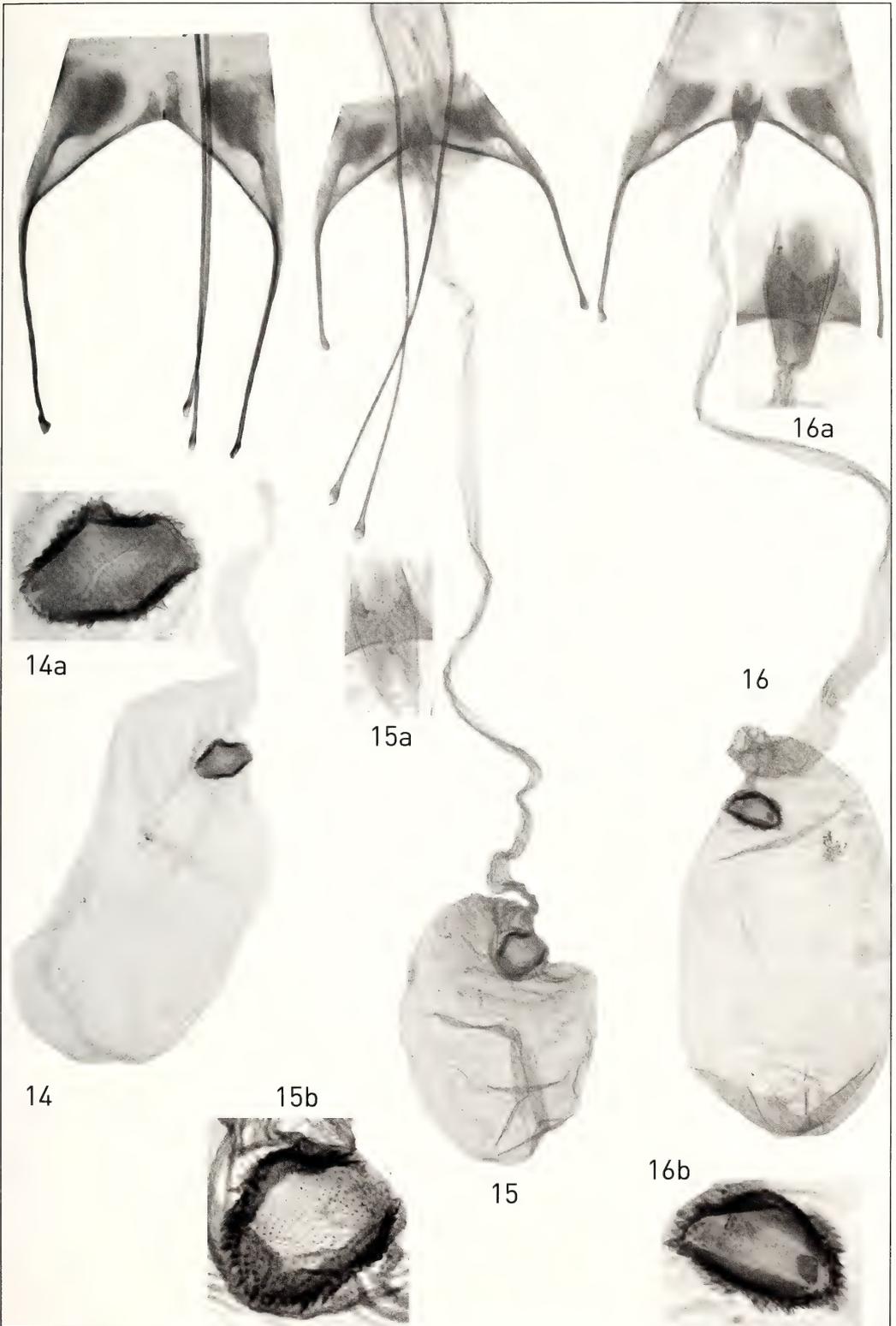
*S. stonisi* differs from its congeners by the arrow-shaped uncus, triangular valva and reduced sacculus.

**Female.** Unknown.

**Distribution.** Only known from the type locality in the mountains of SE Kazakhstan.

**Life history.** Early stages and host plant unknown. The holotype has been collected in early August at an altitude of 1300 m.

**Etymology.** The new species is named after prof. Jonas Rimantas Stonis (formerly Puplesis) of the Vilnius Pedagogical University, Lithuania who collected the holotype.



***Spiniphallellus fuscescens* sp. n.**

**Material.** Holotype: ♂, 'Turkey, Agri | 45km W Kagizman | 1450 m, 24.vii.1989 | leg. Fibiger & Esser' 'Gen. prep. | No 2977♂ | H. Hendriksen' (ZMUC). – Paratypes: 1♂, 1♀, Gümüşhane, Pirnakapan, 1800 m, 19.vii.1989, M. Fibiger & N. Esser leg., gen. prep. 6226♀, H. Hendriksen (ZMUC); 1♂, 1♀, Erzurum, 14.vi.2001, H. Ozbek (ZMKU, ZMUC).

**Diagnosis.** Adult (Figs 3–4). Wingspan 14–15 mm. Labial palp cream-white, more or less mottled with fuscous brown; segment 3 blackish brown. Antenna black, indistinctly lighter ringed. Head and tegula blackish brown, more or less overlaid with light grey-brown; thorax almost black. Forewing covered with light grey, blackish-tipped scales and mottled with brown; black stigmata in middle of wing indistinct; light brown scales in fold and as a faint, oblique fascia at 3/4; basal half of cilia blackish, apical half grey. Hindwing grey, with central part whitish grey.

**Variation.** The colour of the forewing may look blackish or brownish depending on the amount of light brown scales.

For separation from *S. desertus* and *S. stonisi* see under these.

**Male genitalia** (Fig. 9). Sternite VIII almost quadrangular with moderately slight anterior emargination; posterior margin of tegumen laterally with two small flaps; uncus sub-oval, sclerotized only at margins; valva elongate, covered mainly distally with long hair-like setae, apically weakly curved inwards; transtilla lobe small, digitate; posterior margin of vinculum with deep triangular medial emargination; saccus short, distally broadly rounded; phallus short, with middle lateral thorn, basal half flattened, distal part gradually narrowed apically.

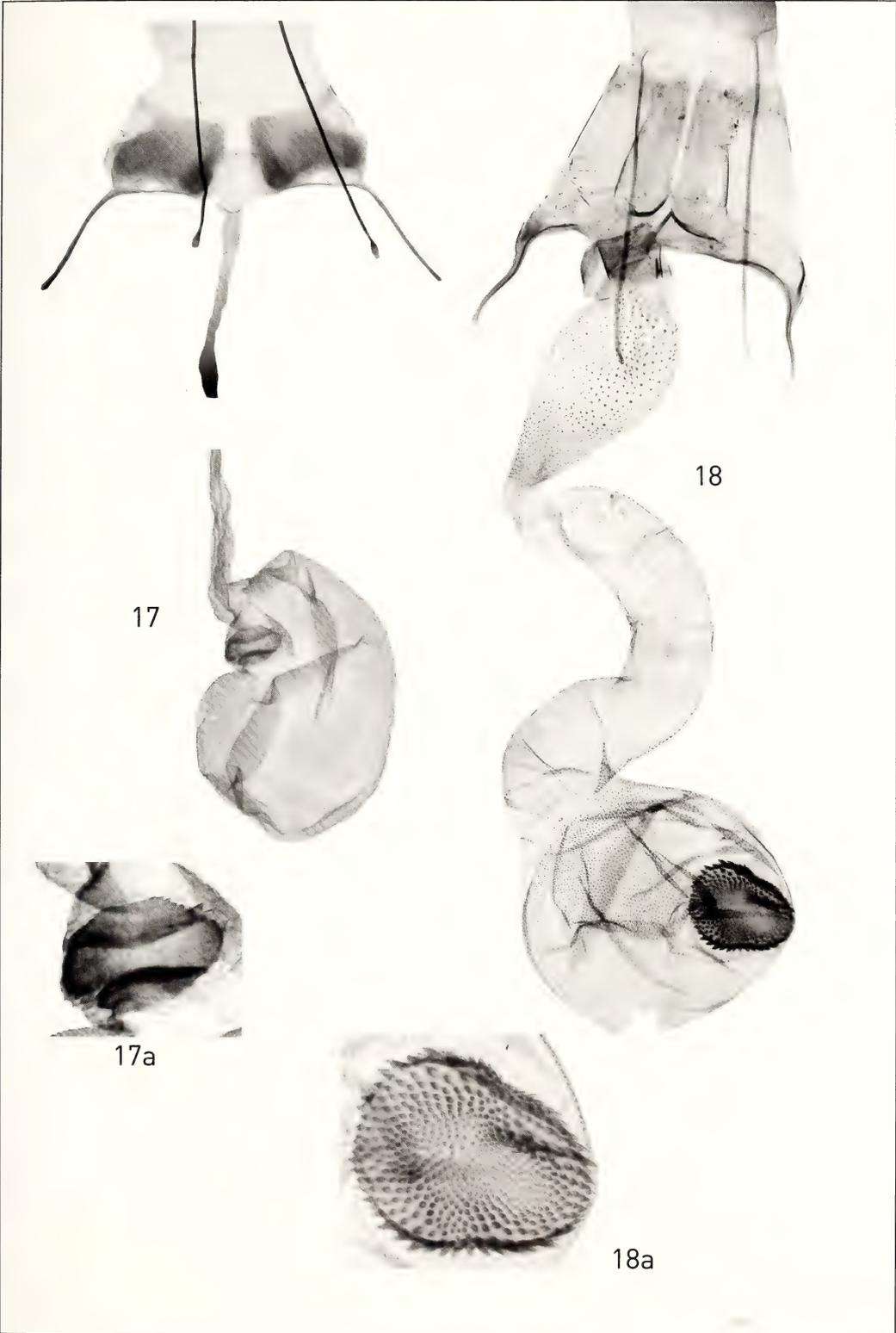
The species is well recognizable by the elongate valva and the digitate transtilla lobe.

**Female genitalia** (Fig. 17). Segment VIII narrowly sclerotized dorsally and almost entirely sclerotized ventrally, about half as long as broad. Apophyses anteriores straight, about 3.5 times shorter than apophyses posteriors and about 1.5 times longer than segment VIII. Sternite VIII divided by medial incision gradually broadened anteriorly into two sub-quadrangular plates; antrum weakly sclerotized, rounded; ductus bursae long and slender; corpus bursae sub-oval; signum a sub-oval plate with weakly serrate margins. Differs from *S. desertus* in the shorter and more entirely sclerotized segment VIII without anterior emargination and in the rounded rather than funnel-shaped antrum.

**Distribution.** Known from three provinces in NE Turkey.

**Life history.** Early stages and host plant unknown. Adults have been collected from middle of June to last part of July at altitudes between 1450 and 1800 m. They are attracted to light.

**Etymology.** The new species is named after uniformly dark brown forewing (Latin: *fuscus* – dark).



***Spiniductellus* gen. n.**

Type species: *Spiniductellus atraphaxi* sp. n.

**Diagnosis.** Adult (Figs 5–6). Wingspan 15–16 mm. Labial palp falciform; segment 2 smoothly scaled on lower surface; segment 3 longer than segment 2.

**Male genitalia** (Figs 10–13). Segment VIII laterally separated into sub-rectangular tergite and distally rounded sternite. Tegumen broad and short, length exceeds width about 1.5 times, anterior margin deeply sub-oval emarginated, lateral flaps prolonged, weakly pointed; uncus small, triangular; gnathos triangular, consisting of paired weakly sclerotized and apically connected sclerites; valva exceeds uncus considerably, slender, weakly curved, of equal width or with strongly developed basal process; sacculus about three-quarters or two-thirds length of valva, basally slender, strongly expanded in apical half, top bone-shaped, with or without additional medial flap; vinculum broad; sacculus well developed, asymmetrical, sub-triangular or prolonged, subapical portion narrow; coremata present in at least one species; phallus stout, flattened basally, strongly curved in distal quarter, top weakly broadened, rounded with small curved tip, ductus ejaculatorius with long, coiled, strongly sclerotized lamina.

**Female genitalia** (Fig. 18). Segment VIII simple, weakly sclerotized; papilla analis prolonged, sparsely covered with setae. Apophyses anteriores weakly curved, about 3.5 times shorter than apophyses posteriores and about 2.5 times shorter than segment VIII. Sternite VIII weakly sclerotized, sub-trapezoid, length slightly exceeds width, posterior margin with deep narrow medial incision towards anterior margin, perostial lobes prolonged with distinctly sclerotized anterior margin; antrum a well sclerotized quadrangular belt, ductus bursae relatively broad, posterior part abundantly spined, anterior part of ductus bursae and corpus bursae with minute spines; corpus bursae round, signum a sub-rounded plate densely covered with small thorns.

**Distribution.** Central Asia: SE Kazakhstan, Kyrgyzstan, Tadzhikistan.

**Life history.** Early stages undescribed. *S. atraphaxi* has been bred from *Atraphaxis pyrifolia* Bunke (Polygonaceae). Adults have been collected in July and August at altitudes between 950 and 2500 m.

**Remarks.** The new genus takes a rather isolated position within Anomologini, differing from most other genera in the abundantly spined posterior part of the ductus bursae, the signum plate being densely covered with small thorns, the well developed, bone-shaped sacculus and the apically strongly curved phallus. Only the genus *Gladiovalva* shares such characters as a weakly asymmetrical sacculus, short and weakly developed gnathos and ductus ejaculatorius with long, coiled, strongly sclerotized lamina in the male genitalia, as well as sub-rounded serrated signum and posteriorly sclerotized ductus bursae in the female genitalia. *Spiniductellus* differs from *Gladiovalva* in the long, well developed sacculus, presence of triangular gnathos, stout and distally strongly curved aedeagus in the male genitalia; the female genitalia of *Spiniductellus* differ from those of *Gladiovalva* in the minutely spined posterior part of ductus bursae. The presumed relationship of these two genera may be indirectly confirmed by their (known) host-plants belonging to the Polygonaceae. *Atraphaxis spinosa* is known as a host plant also for *Gladiovalva igorella* Falkovitsh & Bidzilya, 2003.

**Etymology.** The new genus is named after its spined ductus bursae (Latin: *spinae* – spine).

***Spiniductellus atraphaxi* sp. n.**

**Material.** Holotype: ♂, 'Tadzh. [ikistan] Gissarsk. [iy] chr. [ebet] | ushch. [elie] Kondara 1300 | Shernijazova' 'vyv. [odka] No. | G[usenitza] 3.5 K[ukolka] 12.5 V[ylet] 6.6 [1]971 | Atraphaxis pyrifolia [in Russian]' 'gen. prep. 142/07 ♂' (ZIN). – Paratypes. ♂, 'Kondara | 17.07. [19]76 | Lvovsky' 'gen. prep. 66/06 ♂' (ZIN).

**Diagnosis.** Adult (Fig. 5). Wingspan 15–16 mm. Segment 2 of labial palp cream-coloured mottled with dark brown, especially on lower and outer surface; segment 3 blackish brown with yellow tip. Antenna black, ringed with yellow-grey. Head cream-coloured mottled with light grey-brown; thorax and tegula concolorous with forewing. Forewing cream-coloured, overlaid with dark brown, especially at base, as two broad fasciae at 1/3 and 2/3 and in apical part; two blackish brown patches in middle of wing between the two broad fasciae; costal and tornal spots cream-yellow, more or less fused; cilia grey with black base and light tip. Hindwing grey with light grey cilia. Hindleg almost unicolorous cream-white.

Worn specimens lose the dark brown scales and hence become more or less cream-coloured with some dark brown patches.

**Male genitalia** (Figs 10–11). As under genus description. Valva slender, weakly curved, of equal width; sacculus about two-thirds length of valva, bone-shaped, without additional medial flap; saccus prolonged, subapical portion narrow.

Differs from *S. flavonigrum* in the slender valva being of equal width, and the apically narrower sacculus.

**Female.** Unknown.

**Distribution.** Tadzhikistan.

**Life history.** Early stages undescribed. The holotype was bred from *Atraphaxis pyrifolia* Bunke (Polygonaceae) at 1300 m altitude; according to the label information the larva was found 3.05, pupation took place 12.05, and adults emerged 6.06.1971. The paratype was collected in mid-July.

**Etymology.** The new species is named after the host plant of its larva.

***Spiniductellus flavonigrum* sp. n.**

**Material.** Holotype: ♂, 'Yu [zhnyi] **Kazakhstan** | z. [apovednik] Aksu-Dzhabagl [y] | Seksjaeva 7.8.1987 [in Russian]' 'gen. prep. 143/07 ♂' (ZIN). – Paratype: 1♀, 43°24'N 75°02'E, Dzhabul'skaya obl., 70 km NNE Frunze, 950 m, rocky slope, 15.viii.1990, L. Kaila & K. Mikkola leg., gen. prep. 5360♀, H. Hendriksen (ZMUH); 1♂, 41°25'N 76°20'E, 30 km E Naryn, 2500 m, steppe slope, 29.vii.1990, L. Kaila & K. Mikkola leg., gen. prep. 5359♂, H. Hendriksen (ZMUH).

**Diagnosis.** Adult (Figs 6). Wingspan 15–16 mm. Labial palp cream-coloured mottled with some dark brown scales, especially on lower and outer surface of segment 2 and on basal ¾ of segment 3. Antenna blackish brown, ringed with yellowish. Head cream-coloured; thorax and tegula concolorous with forewing. Forewing cream-coloured, mottled with dark brown; base, apical area and two broad fascia at 1/3 and 2/3 dark

brown; a distinct black spot in middle of wing posterior to fascia at 1/3; a cream-yellow fascia posterior to fascia at 2/3; cilia dark grey. Hindwing grey with light grey cilia. Worn specimens lose the dark brown scales and hence become more or less cream-coloured with some dark brown patches.

This species is very similar to *S. atraphaxi*. From the limited material available it seems to differ in being somewhat lighter from less dark brown scales.

**Male genitalia** (Figs 12–13). As under genus description. Basal half of valva with broad medial triangular flap, distal part narrow, curved, rounded apically; sacculus bone-shaped, about three-quarters length of valvae, with more or less expressed emargination in apical part; saccus well developed, sub-triangular; coremata present.

**Variation.** The studied specimens differ slightly in the length of distal narrow portion of valva, width and shape of the top of sacculus as well as in its medial flap, which is well developed in the specimen from Kazakhstan and almost completely reduced in the one from Kyrgyzstan. Moreover both specimens vary in the shape of saccus, which is broad sub-triangular or prolonged. We believe that the latter variation is due to mounting technique.

**Female genitalia** (Fig. 18). See genus description.

**Distribution.** SE Kazakhstan, Kyrgyzstan.

**Life history.** Early stages and host plant unknown. Adults have been collected in late July and in August. The female paratype was attracted to light on a rocky slope at 950 m altitude, while the male paratype was attracted to light on a steppe slope at 2500 m altitude.

**Etymology.** The new species is named after the colours of its wing pattern (Latin: *flavo* – yellow; *nigro* – black).

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## On the rediscovery of *Ethmia discrepita* (Rebel, 1901) with remarks on brachyptery in females of *Ethmia* (Ethmiidae)

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**Abstract.** Brachyptery in the female of *Ethmia discrepita* (Rebel, 1901) is discussed. New data on the flightless female and a distribution map for the species are given. A lectotype of *Psecadia discrepita* Rebel, 1901 is designated and transferred from the collection of St. Petersburg State University to the Zoological Institute of the Russian Academy of Sciences (St. Petersburg, Russia). This male and the male and female paralectotypes are figured. The female genitalia are described.

**Резюме.** В статье рассмотрен уникальный для семейства Ethmiidae факт брахиптерии самок *Ethmia discrepita* (Rebel, 1901). Приводятся новые данные по строению гениталий и жилкованию крыльев нелетающей самки, а также по распространению этого малоизвестного вида. Обозначены типовые экземпляры, найденные при изучении коллекции Санкт-Петербургского государственного университета (переданные впоследствии на хранение в Зоологический Институт Российской Академии Наук). Приводятся изображения типовых экземпляров и гениталий паролектотипа.

### Introduction

At the end of March 2005 I collected a couple of unusual *Ethmia* specimens *in copula* during an expedition to the south of the Orenburg Region, in the Dombarovka district (Russia). Moths were characterized by distinct sexual dimorphism; female had strongly shortened forewings and rudimentary hindwings. Copulation was observed in the evening, on a dry stem of wormwood (*Artemisia* sp.), and lasted more than one hour. Later, the two moths were identified as *Ethmia discrepita* (Rebel, 1901) (Figs 1–2). The description of the species was based on two males and one female collected at the end of April in the Orenburg province in 1892. The sexual dimorphism of the species was mentioned by Rebel (1901a) himself and the detailed description of the brachypterous female was originally given as follows (here translated): "... *Psecadia Discrepita* n sp. ♂ ♀. I am giving here also a description of an unusual sexual dimorphism of a European species ... It has rudimentary forewings with strongly concave outer margin but weakly pointed apex, and cilia come from here directly to terminal angle. Also, both black points are distinct here, but one at the end of the middle cell comes much further outwards. Hind wings are reduced to very small rounded lobes (about 1 mm long and 0.5 mm wide). Expanse 7.3–8.5 mm, female 2.8 mm. Size ♂ 15–18, ♀ 7 mm...". We can add to the description that the abdomen of the female has yellow intersegmental lateral spots.

Rebel (1901a) also writes that he didn't keep the type specimens; he had borrowed the moths from St. Petersburg collector Mr. Hansen and they were probably returned back to Russia.

No indications on the whereabouts of the type specimens of *Ethmia discrepita* were given also in both large revisions of the Ethmiidae by Sattler (1967) and Danilevsky (1980). Sattler (1967) specified that the female of the species was known only from

the description of Rebel (1901a). Danilevsky (1980) also characterized the sexual dimorphism of the species and the presence of rudimentary wings in its female, but there were no references to specimens studied and therefore it is not quite clear if Danilevsky really saw any or just cited the original description of Rebel.

In searching for the types of *Ethmia discrepita* I examined all material of this species kept in the collection of the Zoological Institute of the Russian Academy of Sciences (ZISP, St. Petersburg, Russia). Along with my predecessors, I found no type specimens originating from the Orenburg Region in this Institute. However, I discovered three specimens of the species in the collection of St. Petersburg State University. They were 1 brachypterous ♀ and 2 ♂ (Figs 3–5) collected on 28–29<sup>th</sup> April 1892 in the south of the Orenburg Region («Orenb-g. mer.»). Thus, I have no doubts that these specimens were used by Rebel for describing the species and therefore shall be considered syntypes of *Psecadia discrepita*. All these specimens were transferred from St. Petersburg State University to ZISP. A lectotype of *Psecadia discrepita* is here designated for the purpose of nomenclatorial stabilization.

### Abbreviations

ZISP Zoological Institute of Russian Academy of Sciences (St. Petersburg, Russia)

### *Ethmia discrepita* (Rebel, 1901)

(Figs 1–3)

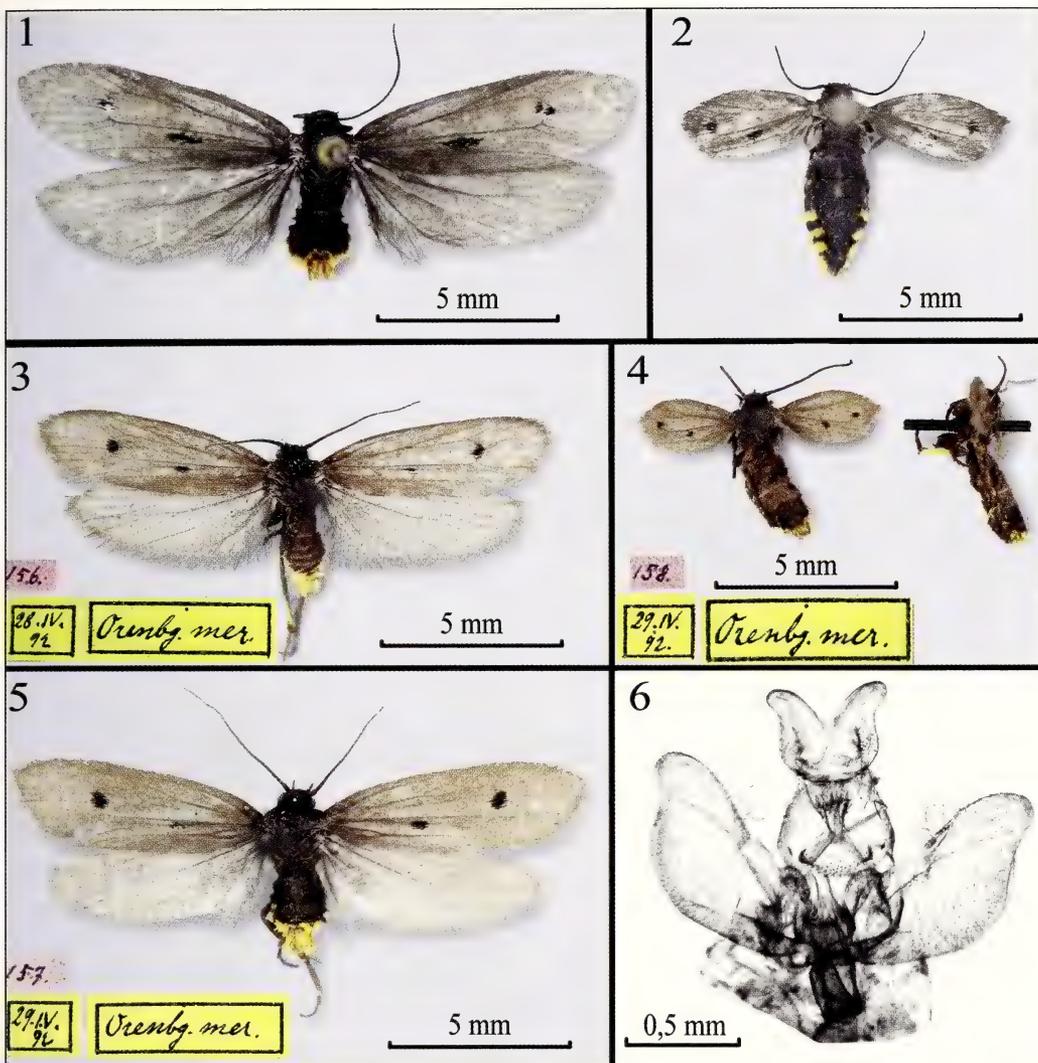
*Psecadia discrepita* Rebel, 1901a: 172. Type locality: [bei Orenburg] Orenburg Region, Russia.

References: Rebel 1901b: 68 (*Psecadia*); Sattler 1967: 88; Danilevsky 1969: 179; Danilevsky 1980: 324; Zagulajev 1981: 644; Dubatolov et al. 1997: 162; Anikin et al. 2007: 282 (*Ethmia*).

**Material.** Lectotype (here designated): ♂ *Psecadia discrepita* Rebel, 1901 '156' <pink rectangle, written in blue ink>, '28.IV.192' <yellow square written in black ink>, 'Orenb-g. mer.' <yellow rectangle written in black ink>, 'LECTOTYPUS. | ♂ *Psecadia discrepita* | Rebel 1901 | design. Shovkoon D. 2008' <red rectangle, printed in black ink> (in coll. ZISP). – Paralectotypes: 1 ♂ 1 ♀ same data (ZISP). – Additional material. 5 ♂ Guberli (ZISP). 1 ♂, 1 ♀ 21.05.2005, Russia, Orenburg Region, Dombrovskiy Distr., N 50°46'36", E 59°16'55", leg. Shovkoon D.F. (ZISP).

**Description of female.** Venation of forewing (Fig. 8) agreeing well with that of the male and Ethmiidae in general although R-Cu cell rather elongated and with very shortened veins connected with it ( $R_2$ - $R_3$ ,  $M_1$ - $M_3$ , both Cu). Hindwings reduced to very small rounded lobes (about 0.5 mm wide) with venation extremely simplified: traces of R-Cu cell and single vein (presumably R or M branch) hardly appreciable. Jugum and frenulum present but not coupling because of very small hindwing.

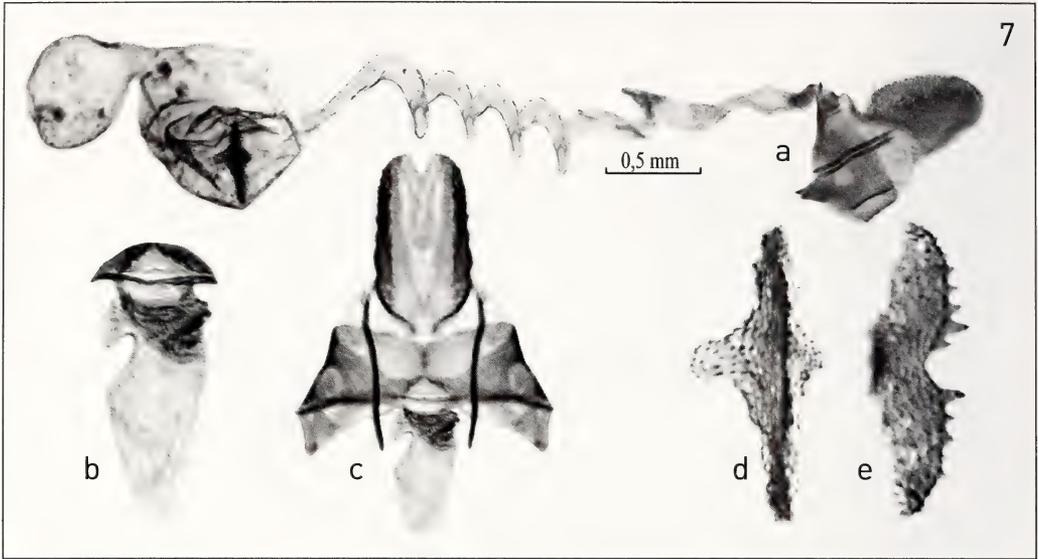
**Female genitalia** (Fig. 7). Papillae anales rounded, setose. Eighth tergite medially interrupted by membrane. Posterior apophyses slender, as long as papillae, anterior ones wedge-shaped and pointed (Figs 7, a, c), slightly longer than anterior apophyses of *Ethmia pyrausta* Pallas, 1771 (Sattler 1991). Antrum sclerotized with small sclerotized appendix (Fig. 7 b). Ductus bursae very long, spiral, with 5 complete turns. Corpus bursae rather large, spherical with big spherical appendix. Signum large, covered with more or less uniform teeth, asymmetric (Figs 7, d), in middle with roughly jagged crest (Fig. 7 e).



**Figs 1–6.** *Ethmia discrepita*. 1. Male and 2. Female, Dombarovka district of Orenburg Region (ZISP). 3. Male lectotype (ZISP). 4. Female paralectotype (ZISP). 5. Male paralectotype (ZISP). 6. Male genitalia of paralectotype of *Ethmia discrepita*.

**Comments.** The genitalia of the ♂ paralectotype (Fig. 6) are kept in a mixture of glycerol and ethanol, as are those of the female dissected. My examination confirms that the specimens whose genitalia were previously illustrated as belonging to *Ethmia discrepita* (Sattler 1967; Danilevsky 1980; Zagulajev 1981) are really conspecific with the types.

*Ethmia discrepita* belongs to the *pyrausta*-species group. The group was originally based on two taxa: *E. pyrausta* (Pallas, 1771) and *E. discrepita*. However, Pallas (1771) provided only scanty information in the original description of *E. pyrausta*. He wrote that the moths were found in the spring “Volga”. Owing to special research

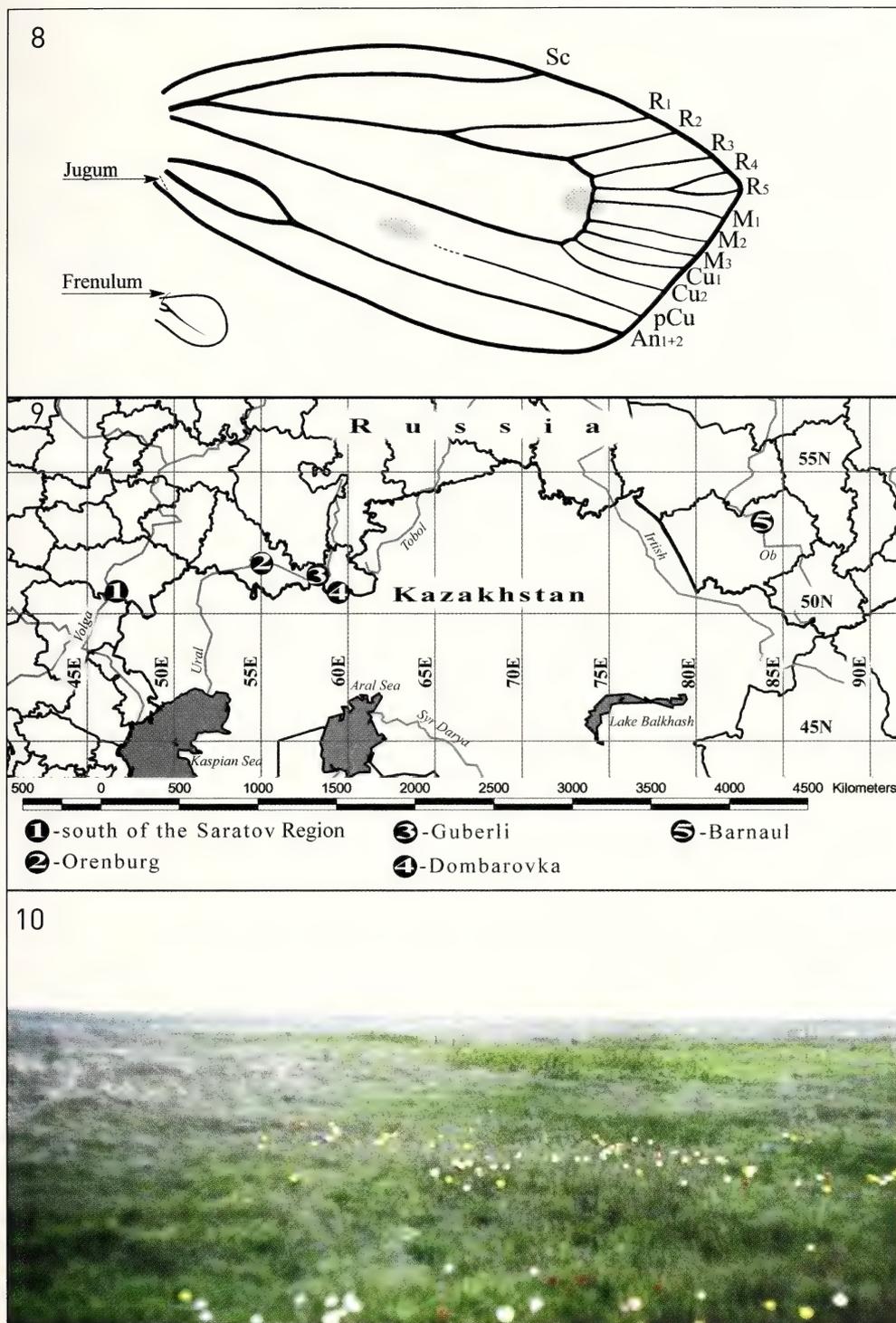


**Fig. 7.** Female genitalia of *Ethmia discrepitella*, moth from the Dombarovka district of the Orenburg Region. **a.** general view; **b.** ventral view; **c.** ostium and antrum; **d.** signum, dorsal view and right-side view.

efforts by S. A. Sachkov (1991) it is authentically known that *Ethmia pyrausta* was described from the vicinity of Samara and that the syntypes were collected in late April or the beginning of May, 1769.

**Distribution** (Fig. 9). The distribution of *Ethmia discrepitella* is little known and for a long time the species was considered to be endemic to the Orenburg Region, until new data concerning its presence in the Altai (Dubatolov et al. 1997) and in the Saratov Region (Anikin et al. 2007) became published. Unfortunately we did not have the opportunity to investigate this material. One male was found by V. Anikin (Anikin et al. 2007) in the south of the Saratov Region and two males were collected in the beginning of the 20<sup>th</sup> Century at Barnaul (now kept in Siberian Zoological Museum, Institute of Animal Systematic and Ecology, Siberian Division of Russian Academy of Sciences (Novosibirsk)). Most probably these moths were collected in the middle of May (Dubatolov et al. 1997).

**Life history.** Our moths (Figs 1–2) were collected in salt steppes (Fig. 9) where wormwood-gramineous assemblages growing on dark-chestnut soils prevail. The significant presence of wormwood (*Artemisia*) and salt-adapted vegetation gives a spotted character typical of southern steppes. The vegetation is mostly composed of *Stipa zaleskii* Wilensky, *S. capillata* L., *S. lessingiana* Trin. & Rupr., *S. korshinskyi* Roshev, *Festuca valesiaca* Gaud., *Koeleria gracilis* Pers., *Phleum phleoides* (L.) Karst. (all Poaceae), *Artemisia dracunculus* L., *A. austriaca* Jacq., *A. frigida* Willd. (all Asteraceae), *Caragana frutex* (L.) C. Koch (Fabaceae), *Thymus marshallianus* Willd. (Lamiaceae), *Thalictrum minus* L. (Ranunculaceae), and other plants. Also in May, tulips (*Tulipa* sp.) are flowering.



**Figs 8–10.** *Ethmia discrepitella*. **8.** Wing venation of female. **9.** Distribution map. **10.** The Orenburg steppe in May, where *E. discrepitella* occurs.

The close relationship of *E. discrepitemella* and *E. pyrausta* suggests similar or closely related host-plants for both. The larva of *pyrausta* feeds on species of *Thalictrum* (Sattler 1991). *Thalictrum minus* L. occurs in the locality, and it is possible that it is also a host-plant for the larva of *E. discrepitemella*.

**Discussion.** Since the original description the female brachyptery of *Ethmia discrepitemella* remained uncorroborated. Our findings confirm this unique attribute.

Brachyptery has evolved independently several times in moths. This phenomenon, which is almost entirely restricted to females, occurs in at least 26 of the 120 families (Heppner 1991; Sattler 1991). Kuznezov (1929), who studied wing reduction in Geometridae, and Sattler (1991), who reviewed wing reduction in Lepidoptera and analyzed implications of inability to fly, wrote that brachyptery in females of moths of the Northern Hemisphere is particularly found in winter, early vernal, and late autumnal species.

This phenomenon is present in other species of Ethmiidae. One more case of brachypterous female is known for *Ethmia charybdis* Powell, 1973. This moth is distributed in California, Nevada, and Mexico (Opler et al. 2006) and like *Ethmia discrepitemella*, it is found in the early spring (in the beginning of April). Also, as proposed by Danilevsky (1969), it can be expected that the female of the winter moth *Dasyethmia hiemalis* will be discovered to be brachypterous. In the original description of the species, Danilevsky (1969) remarks on the correlated simplification of the genital structures of the males of these species in connection with their cold habitat. Thus, *Ethmia discrepitemella* is not the unique representative of the family with brachypterous female.

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## The identity of *Pammene engadinensis* Müller-Rutz, 1920 (Tortricidae: Olethreutinae, Grapholitini)

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**Abstract.** Based on a genital dissection of the male holotype, the name *Pammene engadinensis* Müller-Rutz, 1920 was found to be a synonym of *Pammene agnotana* Rebel, 1914. This species is new to the fauna of Switzerland.

**Zusammenfassung.** Die Genitaluntersuchung des männlichen Holotypus zeigt, dass der Name *Pammene engadinensis* Müller-Rutz, 1920 ein Synonym von *Pammene agnotana* Rebel, 1914 ist. Diese Art ist neu für die Fauna der Schweiz.

### Introduction

In 1918 Thomann captured a single male Tortricidae specimen at Scuol (formerly called Schuls) in the lower Engadine Valley, Grisons, Switzerland, which he could not identify (Thomann 1956). The well-known microlepidopterist Müller-Rutz, to whom Thomann sent this specimen, judged it to be a new species and described it as *Pamene* [sic] *engadinensis* (Müller-Rutz 1920). No more specimens seem to have been found in the following years, and *engadinensis* remained a somewhat obscure taxon (Karsholt & Razowski 1996).

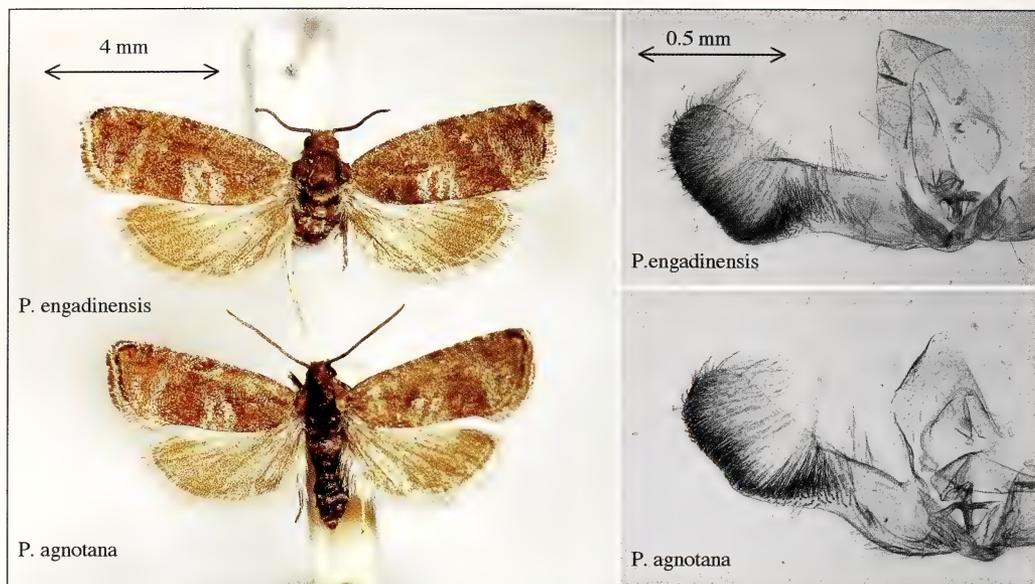
Danilevsky & Kuznetzov (1968) tried to obtain more information about the holotype, which they expected to be preserved in the Müller-Rutz collection at the Naturhistorisches Museum Basel. Their search was unsuccessful. Thus, based on the original description only, which was accompanied by a lithographed plate, they supposed *engadinensis* to be identical with *Pammene obscurana* (Stephens, 1834). This assumption was repeated by subsequent authors (e.g. Razowski 2003).

### Material

In the Thomann collection, now housed at the Bündner Naturmuseum at Chur, Switzerland, a single male specimen was detected. Its label, written by Thomann, reads: ‘engadinensis | Schuls | 19.V.18 Th.’. As the original description mentions 19.V.18 as the date of capture of the specimen described, and since Thomann collected only one specimen, there is no doubt that the male in the Thomann collection is in fact the holotype.

### Results

A genital dissection demonstrated that the shape of the valva does not match well the *obscurana* drawing published by Danilevsky & Kuznetzov (1968), even less the male *obscurana* holotype genital apparatus as published by Chambon (1999). Surprisingly,



**Fig 1.** Phenotypes and male genital characteristics. *Pammene engadinensis* Müller-Rutz, syn. n.: holotype, CH-Schuls, Grisons, 19.5.1918, Thomann leg.; *Pammene agnotana* Rebel: A-Ampass, Tyrol, 26.4.1971, leg. Burmann.

however, comparison with the shape of the valva of *Pammene agnotana* Rebel, 1914 as published by Danilevsky & Kuznetzov (1968), Razowski (2003) and especially Bradley, Tremewan & Smith (1979) revealed beyond reasonable doubt that the holotype of *Pammene engadinensis* is in fact a specimen of *Pammene agnotana* Rebel, under which *Pammene engadinensis* is hereby synonymized: *Pammene engadinensis* Müller-Rutz, 1920, **syn. n.**

The genital preparation is embedded in a water-soluble medium and attached to the pin carrying the specimen. It is deposited in the Thomann collection at the Bündner Naturmuseum Chur, Switzerland.

## Discussion

The identification of the *engadinensis* holotype as *P. agnotana* is further supported by its wingspan, which is 11 mm and thus lies well within the range for *agnotana* of 10.5–12 mm (Rebel, 1914) and 10–11 mm (Bradley, Tremewan & Smith 1979), while *obscurana* is larger: 12–14 mm (Bradley, Tremewan & Smith 1979), and 10–15 (average: 13) mm (Razowski 2003).

In addition, as already observed by Danilevsky & Kuznetzov (1968), the original description of *engadinensis* does not mention the black patch of elongate scales in the basal region of hindwing upperside which is present in *obscurana*, but indeed absent both in *engadinensis* and *agnotana*!

Dr P. Huemer, Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria, kindly allowed me to dissect a male specimen of *P. agnotana* from the Burmann collection

(Teriol. sept. Ampass, 26.4.71, leg. Burmann). The phenotype of this specimen as well as the genital apparatus match the *engadinensis* characteristics (Fig. 1).

As a side-issue it should be pointed out that the male genital drawing of *P. obscurana* published in Danilevsky & Kuznetsov (1968) and copied by Razowski (2003) markedly differs from the respective drawings both in Chambon (1999) and in Bradley, Tremewan & Smith (1979). Either Danilevsky & Kuznetsov's sketch represents a variant valva form or a different species altogether.

*Pammene agnotana* Rebel is new to the fauna of Switzerland. According to Karsholt & Razowski (1996) the species occurs in northern and eastern Europe but is absent from Italy and France. The population in the lower Engadin valley originates doubtlessly from postglacial immigration from the East along the well-known route through the Inn valley.

### Acknowledgements

I would like to thank Dr Jürg Paul Müller and Mr U. Schneppat, Bündner Naturmuseum Chur for their continuous support. Dr Peter Huemer, Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria, kindly provided comparative material, literature, and most valuable advice!

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**Wolfram Mey (ed.) 2007. The Lepidoptera of the Brandberg Massif in Namibia, part 2.** Esperiana Memoir, Schwanfeld 4. – 304 pp. – Hardcover, ISBN 3-938249-07-2. Price 99 €.

This book, as the title states, is the second and final part of the report of a series of expeditions to Namibia which took place in 2000 - 2002. The introductory section dealing with the area covered and the various expeditions was included in the first volume (Esperiana Memoir 1, 2004), which also contained 22 chapters dealing with different families of Lepidoptera. The bulk of the book comprises the systematic treatment of different families by 13 different European authors. Unlike the first part the Chapters are not numbered. The first one by W. Mey treats “Smaller families of microlepidoptera”. Four new species are described in the *Pseudurgis* group without assignment to a particular family. The same author deals with *Cecidosidae*, *Psychidae* (in collaboration with Sobczyk), *Copromorphidae*, *Phycitinae*, *Cossidae*, and smaller families of macrolepidoptera as well as butterflies. Descriptions of species are accompanied by line drawings of the genitalia and wing venation or other structures where relevant. In the back of the book colour plates give fine quality pictures of species newly described. Chrysopeleidae are treated by S. Sinev with black & white drawings of forewings and genitalia. Amphisbatidae, Oecophoridae and Depressariidae are by A. Lvovsky with line drawings and a coloured plate of two new species. Scythrididae were treated by B. Bengtsson in part 1 and supplementary data including pictures of type specimens in the Transvaal Museum Pretoria, illustrations of genitalia are monochrome photographs. Gelechiidae are by O. Bidzilia who refers to a large number of species. This family has been well studied compared with others in the region in the works of Janse but there are still many new taxa which are described and illustrated without any attempt formally to name them. Pyralinae are dealt with by P. Leraut with descriptions of 11 new species. Epipaschiinae are by W. Speidel with just one new species. The Phycitinae are tackled by W. Mey, this is a daunting task with 53 species of which 20 are named. In contrast with his other contributions the genitalia are illustrated by photographs rather than line drawings, the culcita being omitted, but since sensibly no new species are described this is not a serious omission. The adults of all these taxa are illustrated in colour, which seems extravagant, but will certainly assist other workers to make comparisons and be aware of their existence in Berlin. The macrolepidoptera families are dealt with in a similar way, although as one would expect a greater proportion of the species are named. The Metarbelidae by I. Lehmann contains descriptions of five new species and also a review of the family; Spingidae by U. Eitschberger includes just one new synonymy; Lasiocampidae by V. Zolotuhin has, as well as descriptions of new species, a checklist of four genera from the Afrotropical region with notes on each species. Arctiidae by L. Kühne is brief since there are few species. Noctuidae were treated by H. Hacker in Part 1, supplementary data are included with a review of Acontiinae and description of some new species. The final two chapters contain a checklist of all 669 species contained in the two books, of which 611 were produced by the Brandberg survey. Of these 124 are described as new to science and there are nine new genera. In addition a further 154 species are illustrated or described without being formally named as new species. The last chapter considers the diversity of Lepidoptera of the Massif in comparison with expectations and other parts of the region – for which there is little documentation. In an ideal world one would like to see new species described in the context of a revision of their group. In practice in a poorly known fauna this is not feasible. Papers naming one or two species scattered through the literature make life harder for future revisers; instead, here, in two volumes much new information is presented. These volumes, generously illustrated, make a significant contribution to our understanding of the Lepidoptera fauna of southern Africa. With many different authors treatment is bound to vary, in particular there are different decisions about when to describe a new species. When there is sufficient material of both sexes there is no problem. When there is just one sex or only the holotype further questions arise. The provisions of the Convention on Biodiversity make it desirable for type material to be deposited in the country of origin, for both security and ease of access to other researchers it is good if paratypes can also be deposited in another institution. The practice of illustrating, but leaving taxa unnamed, adopted by several authors seems helpful for long term stability. This volume, like part 1, is nicely bound with sewn sections. There is an additional loose page 164, but the only error in the original seems to be in the line spacing, which is not serious. The rich Afrotropical fauna is probably the least known of any region of the world. Any attempt to improve our knowledge and understanding is to be welcomed. The editor and authors deserve congratulations on getting their results published after such a comparatively short period of time.

## *Anthophila massaicae* sp. n. (Choreutidae) a remarkable case of parallel evolution

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**Abstract.** A new species of *Anthophila* Haworth, 1811 (Choreutidae) is described from East Africa which shows remarkable similarity to the Palaearctic *Anthophila fabriciana* (Linnaeus, 1767). The life history is described and comparisons are drawn between the species.

### Introduction

When I went to live in Kenya in 1998, at an altitude of 2,500 m just 70 km south of the equator, I was immediately struck by the familiar appearance of many moths, especially of the Geometridae, Larentiinae. This is in marked contrast with the fauna at lower altitude. I was again surprised to net a species which seemed like *Anthophila fabriciana* (Linnaeus, 1767). There is a local nettle, *Urtica massaica* Mildbr. (Urticaceae), which is described by Agnew & Agnew (1994) as “A painful stinger, often growing on abandoned tracks in montane forest areas, and often associated with the presence of buffalo, 2000–3400m.” It has indeed a more vicious sting than the European *U. dioica* Linnaeus, but fortunately its presence does not always indicate buffalo in residence! There was some near our house and when I searched it, there were larvae resembling *Aglais urticae* (Linnaeus, 1758) (later identified as the similar, but smaller *Antanartia abyssinica jacksoni* Howarth) as well as larvae of a species feeding in the same manner as *A. fabriciana* and with a very similar appearance. When reared these also superficially resembled *fabriciana*. Dissection and closer examination revealed that they were very different.

### *Anthophila massaicae* sp. n.

(Figs 1, 3, 5–8)

**Material.** Holotype ♂, ‘Kenya, Rift Valley | l. *Urtica massaica* | em. 20.xi.1999 | D.J.L. Agassiz’. – Paratypes: 3♂ same locality as holotype, em. i.vi.1999 (D.J.L.A. slide No. 873), em. 4.vii.1999 (D.J.L.A. slide No. 993), and (not bred) 13.ix.1998; 8♀ same locality, em. 20.vi.1999, em. 22.vi.1999 (2), em. 24.vi.1999, em. 25.vi.1999 (3) including (D.J.L.A. slide No. 995), em. 29.vi.1999 (D.J.L.A. slide No. 994). Also 2♂, 4♀ ‘Kenya: Central | Mweiga 2000m | 0° 19.5’ S, 36° 56’ E | l. *Urtica massaica* | em. 9–12.ix.2007 | D.J.L. Agassiz’. The holotype and 4 paratypes will be deposited in the National Museums of Kenya, Nairobi, 4 paratypes in the Natural History Museum, London, and the remainder in my collection.

**Diagnosis.** In posture and coloration the adult closely resembles *A. fabriciana* (Fig. 2), but this latter species has patches of white terminal cilia and on the hindwing there is a partial white subterminal line, also the abdominal segments are edged posteriorly with whitish scales. The genitalia of *fabriciana* are illustrated e.g. by Pierce & Metcalfe (1935) and Diakonoff (1986) and are much more elaborate in both sexes. The larvae of the two species and their mode of feeding are very similar.



Figs 1–2. Adults of *Anthophila*. 1. *A. massaicae* sp. n. 2. *A. fabriciana* (L.).

**Description of adult** (Fig. 1). Wingspan: 11–12 mm. Head fuscous mixed whitish, especially on face; labial palpus clothed with fuscous and whitish scales, segment 2 tufted beneath; antenna ringed black and white, male finely ciliate, female simple. Thorax and tegulae fuscous with scales tipped whitish. Forewing fuscous, a diffuse subbasal fascia consisting of a scattering of white scales, an irregular antemedian fascia, pale ochreous at costa then a broad scattering of white scales across wing, a similar postmedian fascia, further white scaling in subterminal area; terminal cilia fuscous but paler below apex; underside with markings along costa matching those on upperside. Hindwing fuscous, a dark fuscous cilia line; underside heavily irrorate white. Legs banded dark fuscous and white.

**Male genitalia** (Figs 6, 7). Uncus simple, gnathos absent, valva simple, clothed with long spines, saccus subtriangular, juxta with three prongs. Phallus slender and simple without cornutus. Tergite VIII with a narrow sclerotised bar.

**Female genitalia** (Fig. 8). Ostium a wide shallow cone, ductus long and narrow, corpus bursae ovate, some slight scobination especially posteriorly, signum near junction with ductus comprising a scobinate undulating ridge.

**Larva** (Fig. 3). When full fed about 12 mm in length, head honey-coloured, body dull pale green, a subdorsal row of raised black spots, one on each thoracic segment, two on each abdominal segment, a lateral row of black spots, one per segment, spiracles black with two or three setae, legs black

**Life history.** The larva lives in a slight web on the upper surface of leaves of *Urtica massaica* (Fig. 4). The pupa is in an opaque white cocoon

**Distribution.** Kenya, above 2000m. Recorded from both East and West of the Rift Valley.

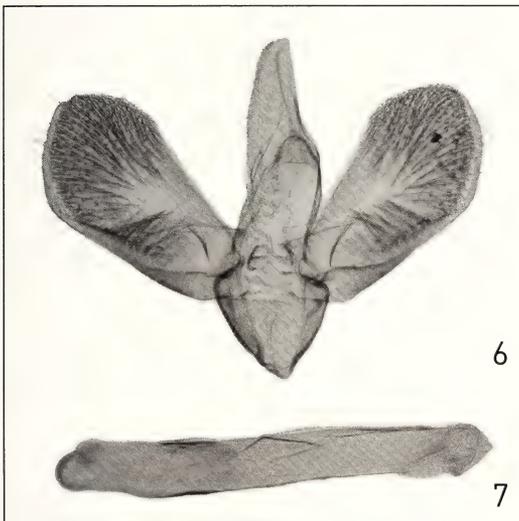
**Etymology.** the name is taken from the specific name of the host plant.

## Discussion

Seven species of *Choreutis* are listed in Vári et al. (2002) from Southern Africa. These were checked in the collections of the Natural History Museum, London and



**Figs 3–5.** Larva *Anthophila*. 3. *A. massaica* sp. n. 4. *A. fabriciana* (L.). 5. *Urtica massaica* with a web of *A. massaica* sp. n.

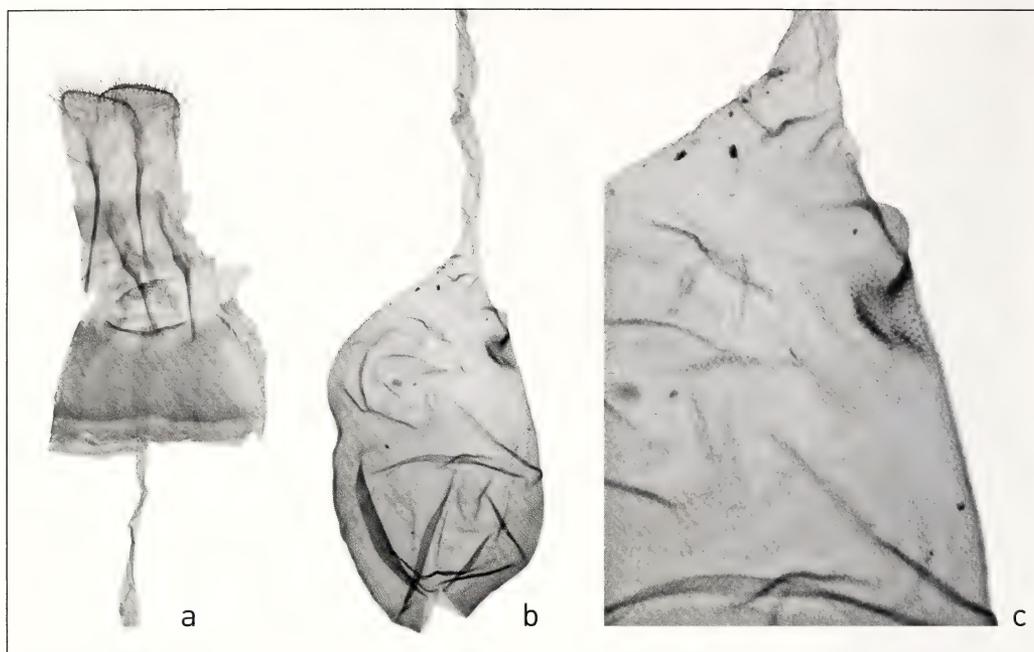


**Figs 6, 7.** Male genitalia of *A. massaica* sp. n. 6. Genitalia without phallus. 7. Phallus.

none matched this species. Nor did any other species appear similar. African Choreutidae have been little studied since Meyrick - I myself have taken eight other species of the *Choreutis/Anthophila* genus group in East Africa, seven of which do not match described species.

The new species is placed here in the genus *Anthophila* somewhat tentatively. Diakonoff (1986) uses various characters to separate the genera for Palaearctic species, but includes in *Anthophila* species with differing genitalia. Clarke (1969) lists 37 Meyrick species in the genus *Anthophila* which have widely differing genitalia. It is hard to know which are the most ancestral traits without a thorough revision of this family.

Convergent evolution is used to describe similar appearance and habits arising from creatures with widely separated phyletic lines; parallel evolution is the term used to describe similar species which are related, but have developed similarities after they have been isolated from each other. Clearly this is a case of parallel evolution, but the common roots of species in the Palaearctic and the Afrotropical regions must be a long time in the past. It is difficult to imagine what are the selective constraints which have caused moths to develop the same characteristics, whilst feeding on related plants in these two separate biogeographical regions.



**Figs 8a–c** Female genitalia of *A. massaicae* sp. n. **a.** Terminal abdominal segments and ductus bursae. **b.** Corpus bursae. **c.** Detail of signum.

Diakonoff (1986) writes (of *Anthophila*) “Also occurring in the United States with vicariant New World species.” In addition Ole Karsholt (pers. comm.) has found a similar species on nettle in Peru. It would be very interesting to know whether nearctic or neotropical species have gone through the same evolutionary process.

### Acknowledgements

I am grateful to Dr Klaus Sattler for advice in the preparation of this paper.

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## Contribution to the butterfly fauna of Yunnan, China (Hesperioidea, Papilionoidea)

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**Abstract.** The results of a lepidopterological (Hesperioidea, Papilionoidea) expedition to Yunnan, China in 2006 are presented. In Appendix I all butterfly and skipper species observed during the expedition are recorded in an increasing altitudinal gradient separated into four altitudinal classes, from 760 m to 3000 m. Some taxa mentioned in Appendix I are reviewed for reasons of taxonomy, distribution, or scarcity. The change in species composition from low to high altitude and the biogeography of some taxa with both Oriental and Palaearctic distributions are discussed. The faunal similarity between the different altitudinal classes was calculated and the interface between the Oriental and Palaearctic faunas in relation to latitude is briefly discussed. *Clossiana gong xizangensis* Huang, 2000, syn. n. is synonymized with *Clossiana gong charis* (Oberthür, 1891).

### Introduction

Our knowledge of the butterfly (including HesperIIDae) fauna of Yunnan (the southwest of the People's Republic of China) has increased in the last 10 years and many faunistic and taxonomic publications on the butterflies and skippers of this part of China are now available: Bozano (1999), Chou (1994), Della Bruna et al. (2002, 2004), Huang (2001, 2003), Huang & Wu (2003), Huang & Xue (2004), Tuzov & Bozano (2006), and Weidenhoffer et al. (2004). These workers have compiled a lot of data on the butterfly fauna of Yunnan, but much information remains to be gathered. In 2006 we had the opportunity to organize an entomological expedition to Yunnan to obtain additional evidence into the species composition, biogeography, and altitudinal succession of the butterflies in the transition zone between the Palaearctic and the Oriental regions. In addition, we were interested to obtain more faunistic data on lesser-known taxa in genera *Aporia* Hübner (Pieridae) and *Callerebia* Butler and *Lethe* Hübner (Nymphalinae). Our choice to visit Yunnan was motivated by its geographical position because in the south it borders on Vietnam, Laos, and Myanmar (previously called Burma) (Fig. 1). Southern Yunnan is mainly tropical and belongs to the Oriental biogeographical realm. In the north the climate becomes moderate and the fauna gradually changes from Oriental to Palaearctic. The gradient from south to north is from low (760 m) to high altitude (3000 m). These transitions are considered to be most interesting because the highest species diversity can be expected along this gradient.

### Material and Methods

All butterfly species mentioned here were collected between June 15 and July 5, 2006. No bait or pheromones were used. In the species lists (Appendices I and II) the visited localities are arranged in altitudinal order 760 m, 1700–2000 m, 2200–2400 m, and 2600–3000 m. The species are arranged in alphabetical order by family-group taxon

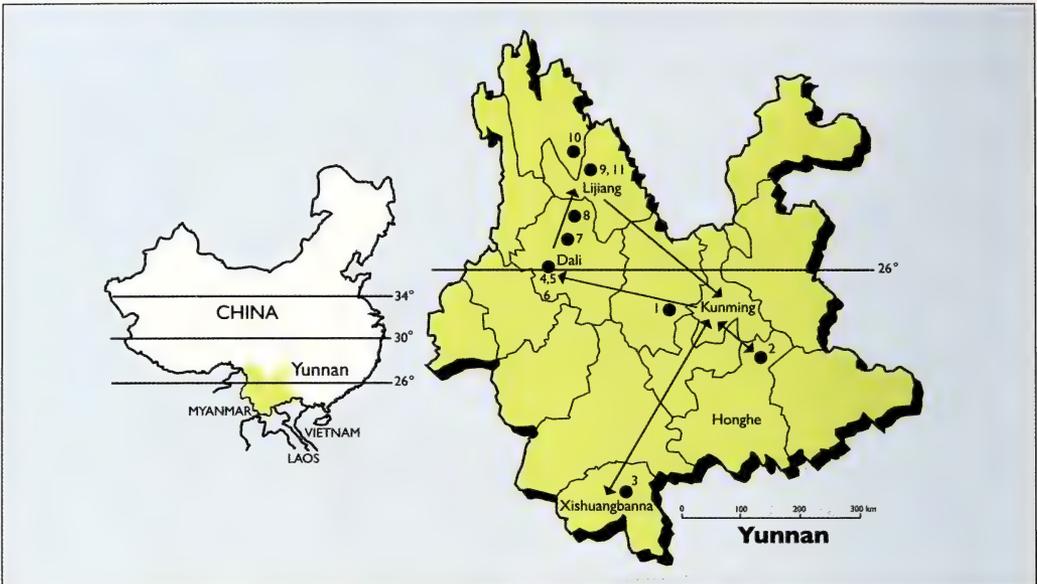


Fig. 1. Map of China and Yunnan; the black dots indicate our collecting localities.

to allow for a quick search. To the localities the mean collecting time is added in days or hours (pers. obs.). One collecting day refers to about 6 hours. Along the altitudinal gradient the effective collecting efforts were: 2.5 days (760 m), 2 days (1700–2000 m), 6.5 days (2200–2400 m), and 3.5 days (2600–3000 m). For the nomenclature we followed Bozano (1999), Della Bruna et al. (2002, 2004), Eliot & Kawazoé (1983), Huang (2001, 2003), Huang & Wu (2003), Huang & Xue (2004), Tuzov & Bozano (2006), Weidenhoffer et al. (2004), and for the Pieridae we also consulted the web site of Ziegler (2005). For general information the web site of Markku Savela (1999) was of great help. But we respected Mr Savela's view, indicated on his web site, of not using it as a taxonomic reference. For some species in genera like *Delias* Hübner, *Mycalesis* Hübner, *Ypthima* Hübner, and *Lycaenopsis* C. & R. Felder, the male genitalia were dissected. In *Satyrrium* Scudder some female genitalia were also dissected.

De Jong (1976) calculated a similarity coefficient between the butterfly faunas of the West Palearctic and Ethiopian regions according to the following formula:

FS =  $(a,b) / a + b - (a,b)$ , where: FS = faunal similarity

a = number of taxa restricted to region A

b = number of taxa restricted to region B

(a,b) = number of taxa common to A and B

This formula allows a quick comparison of resemblances between pairs of regions, though it may be less convenient for further statistical processing. A high coefficient indicates a highly similar faunas. A coefficient below 0.5 indicates hardly any similarity at all. We used this formula with our observations and compared the different altitude classes (see Table 3).

## Collecting localities

1. The Western Hills (Xishan), 30 km west of Kunming, 2200 m, 16 and 18 June 2006 (N 24.56.896, E 107.37.717). Mainly a forested park with flourishing trees and undergrowth. It stretches from north to south for about 40 km. Collecting time: 2 days.
2. Shilin, Stone Forest Reserve, 100 km southeast of Kunming, 1700 m, 17 June 2006 (N 24.49.111, E 103.19.649). This is actually a world of stone peaks, stalagmites, subterranean rivers, and underground limestone caves. This typical karst physiognomy takes the form of a forest of stone pillars and boulders. Between these pillars we found open vegetation and small bushes. Collecting time: 1 day. (Fig. 2)
3. Jinghong, Xishuangbanna, Sanchahe Nature Reserve, 48 km north of Jinghong, 760 m, 19–21 June 2006 (N 22.10.489, E 100.50.591). This Nature Reserve is a huge, mainly primary tropical rainforest. We visited the Wild Elephant Valley (Yexang-gu) situated at the border of the western and eastern parts of the Menyang Reserve. Collecting time: 2.5 days.
4. Dali, 10 km southwest, 2200 m, 25–27 June 2006 (N 25.39.030, E 100.10.038). Located at the foot of the Cangshan Mountains. Surroundings of the starting point of the cable-lift (see also loc. 5) were explored. The area is a mix of tea plantations with open vegetation, bushes, and forests of mainly coniferous trees. Collecting time: 2 days. (Fig. 3)
5. Dali, 10 km southwest, 2600 m, 26–27 June 2006 (N 25.28.025, E 100.08.753) at the end of the cable-lift. Mainly a coniferous forest. Collecting time: 1 day.
6. Dali, 10 km west, 2200 m, 27 June 2006, at the starting point of another chair-lift. The area has an open varied vegetation, bushes and trees, more or less disturbed by human influence. Collecting time: 1 day.
7. Butterfly Spring Valley, 30 km north of Dali, 2030 m, 28 June 2006 (N 25.50.624, E 100.05.856). A public park with a butterfly farm. Collecting time: 1 day.
8. Road Dali-Lijiang, 120 km south of Lijiang, a short stop on 29 June 2006, 2200 m (N 25.59.045, E 100.06.989). Open disturbed area. Collecting time: 1 hour.
9. Lijiang City, Black Dragon Pool Park, 2400 m, 30 June 2006 (N 26.49.940, E 100.14.062). A varied public park with ponds and many flowers along paths. Collecting time: 1 day.
10. Jade Dragon Snow Mountain (Yulongxueshan), 45 km north of Lijiang City, 3000 m, 1–3 July 2006 (N 27.03.828, E 100.14.588). A natural mountain area with alpine shrub and meadows between scattered areas of coniferous trees, near a Mountain Service Centre. Collecting time: 2.5 days.
11. Lijiang City, Black Dragon Draper Pool Park, 2400 m, 2 July 2006. A varied public park with small lakes and many flowers. Collecting time: 0.5 day.



**Figs 2–3.** 2. Stone Forest Reserve, 1700 m, Shilin, Yunnan, with typical karst formation. 3. Collecting area at locality 4 with tea plantations and open vegetation, bushes and forest of mainly coniferous trees. Photos by R. Vis.

## Results

### Species of interest

Some taxa, mentioned in Appendix I are reviewed here for reasons of taxonomy, distribution, or scarcity. The treatment of the species usually follows the arrangement adopted in the Guide to the butterflies of the Palearctic region (Bozano 1999; et seq.). The distribution is given for the relevant subspecies only.

## Hesperiidae

### *Halpe hauxwelli* Evans, 1937

Type locality: Thoungyin Valley, Assam, India

Distribution: Thailand, Myanmar, and S Yunnan, China

Notes: Huang et al. (2003: 136) recorded the species for the first time for the Chinese fauna based on a specimen collected in 1957 by Wang Shu-Yong in Xishuangbanna, S Yunnan. The species was also mentioned from that area in 2003 (Huang & Xue 2004). *Halpe hauxwelli* belongs to the Oriental fauna and seems to be restricted to forests with tropical characteristics. Up until now no records are known from other places in Yunnan. We found some specimens of this local and rare skipper at locality 3.

### *Potanthus ganda* Fruhstorfer, 1911

Type locality: Nias, Sumatra, Indonesia

Distribution: NE India (Assam), Vietnam, Thailand, China (Yunnan, Guangxi, Hainan), up to Indonesia (Bali)

Notes: The male genitalia of the specimens we collected were examined by Dr de Jong. According to Corbet & Pendlebury (1956) *P. ganda ganda* is a common Malayan species. Unlike the closely related *P. omaha* Edwards, *P. ganda* ascends hills and is con-

fined to primary forest. Huang (2004) reports the species from Ye-xiang-gu. We found some specimens in the same area (locality 3).

## Pieridae

### *Aporia bieti* (Oberthür, 1884)

Type locality: Kangding (Tatsienlu), Sichuan, China

Subspecies: *Aporia bieti gregoryi* Watkins, 1927

Type locality: N of Dali, W Yunnan, 2700–3300 m, China.

Distribution: China, N Yunnan (Lijiang, Zhongdian)

Note: In Yunnan we found this species in very low numbers only in a park of Lijiang city (locality 11).

### *Aporia martinetti* (Oberthür, 1884)

(Fig. 4)

Type locality: Kangding (Tatsienlu), Sichuan, China

Distribution: China (Sichuan, Yunnan)

Notes: The taxonomic status of this taxon is somewhat unclear since Röber in Seitz (1909) supposed *martinetti* to belong to the taxon *bieti*. Ziegler (2005) as well as Della Bruna et al. (2004) treat *martinetti* as a separate species based on differences of the habitus and genitalia. We can confirm these opinions. Especially the heavily venation (see also d'Abbrera (1990: 77) of the underside of the hindwings is a constant character. We found *martinetti* uncommonly in bushy meadows at locality 10.

### *Anthocharis bieti* (Oberthür, 1884)

Type locality: Kangding (Tatsienlu), W China

Distribution: China (including Tibet)

Variation: According to Ziegler (2005) the following subspecies are found in China:

ssp. *bieti* (Oberthür, 1884); Distribution: W China

ssp. *decorata* (Röber, 1907); Type locality: Kukunor, China

ssp. *detersa* (Verity, 1908); Type locality: Amdo, China

ssp. *mandschurica* (Bollow, 1930); Type locality: Manchuria, China

Notes: Hirschfeld & Back (2001) recorded *bieti* in Tibet until 4400 m. Huang (2001, 2003) does not report the species from NW Yunnan and SE Tibet. At locality 10 a male and a female of this local and rare butterfly were found, together with *Aporia martinetti* Oberthür, *Melitaea bellona* Leech, and *Caerulea coelestis* Alpheraky. Our specimens most likely belong to the nominotypical ssp. *bieti* and match very well the pictures given by Ziegler (2005).

### *Gonepteryx amintha* (Blanchard, 1871)

Type locality: Baoxing (Mou-Pin), Sichuan, China

Subspecies: *murayamae* Nekrutenko, 1973

Type locality: Weihsi, Sichuan, China

Distribution: China (Sichuan, Yunnan)

Notes: At locality 2 several specimens were observed visiting flowers of *Buddleia* bushes. Some *amintha* were also seen in the Western Hills (locality 1).

***Delias subnubila* Leech, 1893**

(Figs 5a, 5b)

Type locality: Baoxing (Mou-Pin)-Bazifang (Pu-tsu-fong), Sichuan, China

Distribution: China (Sichuan, SE Tibet, Yunnan)

Note: According to Della Bruna et al. (2004), an examination of the male genitalia (uncus) is needed to allow for the correct determination of the species because of confusion with the sympatric *Delias sanaca* (Moore, 1858) and *Delias berinda* (Moore, 1872). We dissected the genitalia and our single male turned out to be a real *subnubila*. It was taken at locality 10.

## Lycaenidae

***Heliophorus eventa* (Fruhstorfer, 1918)**

Type locality: W China

Distribution: China (S Gansu, W Sichuan, N Yunnan)

Notes: Among the various subspecies known from Yunnan (Huang 1999, 2001, 2003), d'Abbrera (1993), Wang & Fan (2002) we only recorded *eventa*.

Males show dark brown forewing uppersides with metallic green at the wingbase. Females differ in shape and markings of the marginal band at the underside of the hindwings.

We found males and females of *eventa* on low vegetation along cultivated areas, mostly on *Rubus* shrubs (localities 4–6). There the males have territories where they perch on projecting bush branches at about 1.50 m. They attack other males that pass by. Sometimes they visit flowers of Umbelliferae and Compositae to feed.

***Satyrium persimilis* Riley, 1939**

(Figs 9a, 9b)

Type locality: Yunnan, China

Distribution: China, Yunnan

Notes: Among material of *Satyrium eximia fixseni* Leech, 1893 from locality 6 one female specimen attracted our attention due to its smaller size, different forewing outer margin, i.e. rounded and less pointed at apex. After a dissection of the genitalia and a comparison with the genitalia of three *S. eximia fixseni* we observed conspicuous dif-

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**Figs 4–12, 14a–15b.** Pieridae, Nymphalinae, Lycaenidae, and Satyrinae of Yunnan. **4.** *Aporia martinetti* (Oberthür) verso, ♂, near Yulongxue, Shan Jade Dragon Snow Mountain, 3000 m. **5a, 5b.** *Delias subnubila* Leech, recto and verso, ♂, same locality. **6a, 6b.** *Melitaea bellona* Leech, recto and verso, ♂, same locality. **7a, 7b.** *Melitaea bellona* Leech, recto and verso, ♀, same locality. **8a, 8b.** *Neptis divisa* Oberthür, recto and verso, ♂, 10 km SW of Dali, 2200 m. **9a, 9b.** *Satyrium persimilis* Riley, recto and verso, ♀, 10 km W of Dali, 2200 m. **10a, 10b.** *Satyrium eximia fixseni* Leech, recto and verso, ♀, same locality. **11a, 11b.** *Caerulea coelestis* (Alphéraky), recto and verso, ♀, same locality as 4. **12.** *Caerulea coelestis* (Alphéraky), recto, ♂. Same locality as 4. **14a, 14b.** *Phengaris atroguttata* (Oberthür), recto and verso, ♂, same locality as 4. **15a, 15b.** *Lethe sidonis* (Hewitson), recto and verso, ♂, 1700m, Shilin, Stone Forest Reserve, 1700 m. Specimens shown at 75% natural size.



ferences of the signa in the bursa copulatrix, i.e. signa with two thorns in *eximia fixseni* and with one thorn in the unknown female under study. Our conclusion is that this female most probably is the first known female of *S. persimilis*. Up until now only the male type specimen seems to be known (Weidenhoffer et al. 2004: 36). This female will be described in a forthcoming paper.

***Satyrium eximia fixseni* Leech, 1893**

(Figs 10a, 10b)

Type locality: Wa-shan [Hanyan, S of Ya'an, W Sichuan], China

Distribution: China (W Sichuan, Central and N Yunnan)

Notes: At localities 4 and 6 some males and one female were collected. Both sexes have a straight forewing outer margin. The female has a large orange postdiscal patch on the forewing and the underside of both wings are more or less the same as in *persimilis* (see Vis & Coene 2008).

***Caerulea coelestis* (Alphéraky, 1897)**

(Figs 11a, 11b, 12)

Type locality: Kham, W Sichuan, China

Subspecies: *dubernardi* (Hemming, 1931)

Type locality: Tsekou, NW Yunnan

Distribution: China (NW Yunnan)

Notes: Schröder (2006) treats genus *Coerulea* Forster, 1938 and makes it clear that the taxa *coeligena* and *coelestis* cannot be separated by the development and number of spots alone. The genitalia of both species are rather similar. A combination of characters as discussed by Schröder (2006) seems more reliable. The male of *C. coelestis* is more brilliant blue, the black border at apex is very narrow, and the black spots on the forewing underside are large, elongated, and bordered by a very narrow white rim. The females are almost uniformly brownish on the wings uppersides with only a weak blue dusting basally. In *coeligena* females the blue is much more extensive. According to the above conclusions d'Abrera (1993: 482) figures both species. Li & Wang (1997: 50) figure the upper and underside of a male as *Caerulea coeligena*, but obviously this must be *C. coelestis*! Taking into account all these references, we conclude that we found a good population of *C. coelestis* at locality 10. Males and females were only seen on a relatively small area with sparse vegetation and bare soil.

***Phengaris atroguttata* (Oberthür, 1876)**

(Figs 14a, 14b)

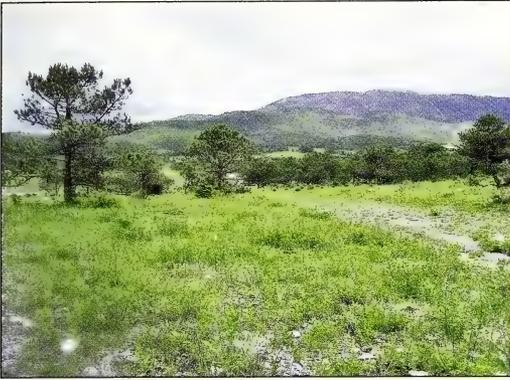
Type locality: unknown

Subspecies: *juenana* (Forster, 1940)

Type locality: Dali, N Yunnan, China

Distribution: China, NW Yunnan

Notes: According to Seitz (1909) the species should be common and widely distributed in West China. At locality 10 we only found one male specimen. The butterfly is much larger and more blue than the illustrated specimen from Siao Lou in d'Abrera (1993: 486) and in Jiu et al. (1995: 162). Huang (2003) reports one male and two females of *juenana* during his expedition to NW Yunnan in June and July 2002. This result does not suggest an abundant occurrence of the species!



**Fig. 13.** Habitat of *Caerulea coelestis* with sparse vegetation and areas with bare soil; near Yulongxue Shan, Jade Dragon Snow Mountain, 3000 m. Photo by R. Vis.

## Nymphalinae

### *Charaxes aristogiton* C. & R. Felder, 1867

Type locality: Unknown (described from Sikkim, Assam, and Burma [Myanmar])

Distribution: Sikkim, Assam to Myanmar, Thailand, Laos

Notes: Chou (1994) mentions the first record for China. Huang (2001, 2003) and Huang & Xue (2004) do not give information on this taxon at all. We collected one male basking in a sunny spot of a small path along a river at locality 3.

### *Melitaea bellona* Leech, 1892

(Figs 6a, 6b, 7a, 7b)

Type locality: Chou Pin Sa, China

Distribution: W China

Note: Some confusion may arise with the partly sympatric *Melitaea jezebel* Oberthür, 1888, but in *bellona* the orange postdiscal band on the upperside of the hindwing is filled with black dots. Also, the heavy black dots in the discal and postdiscal areas on the forewing upper- and underside are absent in *jezebel*. See also d'Abrera (1992: 303). A small population was found at locality 10.

### *Clossiana gong* (Oberthür, 1884)

Type locality: Kangding (Tatsienlu), Sichuan, China

Subspecies: *charis* (Oberthür, 1891)

Type locality: Yunnan, China

Distribution: China

Notes: According to Tuzov & Bozano (2006) the nominotypical subspecies is distributed in Sichuan, while ssp. *xizangensis* Huang, 2000 is represented in SE Tibet. In a number of specimens found at locality 10 the black basal suffusion of the upperside of the hindwing is less developed than in ssp. *xizangensis* while others show this suffusion as in ssp. *charis*.

We also collected specimens with silvery spots in the median band broader and less elongate than in ssp. *charis* while others have these spots as in ssp. *xizangensis*.

Concerning the ground colour of the uppersides most of our specimens are as in ssp. *xizangensis* as figured by Tuzov & Bozano (2006) while others are like ssp. *charis*.

Thus, the diagnostic characters quoted for ssp. *xizangensis* seem to be within the range of the variability of ssp. *charis*. We examined a large series of specimens and we hereby synonymize *Clossiana gong xizangensis* Huang, 2000, syn. n. with *Clossiana gong charis* (Oberthür, 1891).

At location 10 we found a large population of ssp. *charis* flying along with *Melitaea bellona* and visiting flowering plants. Both males and females were in very fresh condition.

***Neptis divisa* Oberthür, 1908**

(Figs 8a, 8b)

Type locality: Tse-kou, China

Distribution: China, N W Yunnan

Notes: This poorly known species was known only from its holotype (Eliot, 1969) for a long time.

Huang (2003) collected two males at Nidadan and a female at Sijitong. At locality 4 a few specimens were observed and collected. They were flying on a forest side while inspecting bushes along a path between tea plantations. Our specimens (males) are very fresh, suggesting that they had recently emerged. The species is figured in Chou (1994: 550) and d'Abrera (1993: 357). According to our records the distribution of *divisa* extends to Central Yunnan at altitudes of about 2000 m. The specimen figured here apparently has been attacked by a bird.

**Satyrinae**

***Lethe confusa* Aurivillius, 1897**

Type locality: India

Distribution: N India, Himalayas, Assam, Myanmar, Thailand, Malaya, China (Hainan, SE Tibet, Yunnan)

Notes: Huang (2003) and Huang & Xue (2004) report *L. confusa* from Lishadi, Nujiang Valley in NW Yunnan and from Wang-tian-shu, S Yunnan. We found some specimens of the nominotypical subspecies at locality 3. For a good picture we refer to Jiu et al. (1995: 115).

***Lethe europa* (Fabricius, 1775)**

Type locality: S India

Subspecies: *gada* Fruhstorfer, 1911

Type locality: Tonkin, Siam [Vietnam]

Distribution: N Vietnam and China (S Yunnan)

Notes: Subspecies *gada* is also known under the name *Lethe nilada f. gada* Fruhstorfer, 1911 from Tonkin, Siam [Vietnam], and even as a valid species as *Lethe gada* Dubois & Vitalis de Salvaza, 1919, from Tonkin. As far as we can interpret now *Lethe europa*

*f. gada* and *Lethe gada* are synonyms. Huang & Xue (2004) report this species under the name *Lethe europa gada* Fruhstorfer from Ye-xiang-gu in the southern part of the Meng-yang Nature Reserve, S Yunnan. In the same area (locality 3) we collected one specimen, which, in our opinion, also belongs to ssp. *gada*.

***Lethe sidonis* (Hewitson, 1863)**

(Figs 15a, 15b)

Type locality: Darjeeling, India

Distribution: Afghanistan, NW Himalayas to Bhutan, Sikkim, Assam, Myanmar, Vietnam, China (SE Tibet, NW and Central Yunnan).

Notes: Bozano (1999) mentions the distribution of this species only as S Tibet and Himalayas. Huang (2003), who collected 10 specimens during his expedition to Nujiang and Dulongjiang, NW Yunnan, mentioned the species under the genus name *Zophoessa*. We collected two specimens, one at locality 1 and the other at Shilin, locality 2.

***Lethe kansa* (Moore, 1857)**

(Figs 16a, 16b)

Subspecies: *vaga* Fruhstorfer, 1911

Type locality: Tenasserim, Myanmar

Distribution: S Myanmar, S Thailand, China (S Yunnan)

Notes: Talbot (1947) distinguishes *vaga* as a dry-season form and *kansa* as the wet-season form and as a consequence not as a valid subspecies. Huang & Xue (2004) mention the species from Ye-xiang-gu, S Yunnan. At locality 3 we collected two males. Our specimens are much darker than the illustrations of d'Abrera (1984: 419).

***Neope yama* (Moore, 1857)**

(Figs 17a, 17b)

Type locality: Bhutan, N India

Subspecies: *serica* (Leech, 1892)

Type locality: unknown

Distribution: N Vietnam, SW China

Notes: The taxonomic status of ssp. *serica* is unclear as Huang (2003: 96) treats *serica* as a separate species while Chou (1994: 351) reports it as *Neope yama* ssp. *serica*. Lee (1962: 145) described ssp. *kinpingensis* based on one male and one female from Yunnan. Huang (2003: 96) examined the holotype of *kinpingensis* Lee and treated it as synonymous with *serica* Leech, referring to the revision of Sugiyama (1994), but we could not consult the latter publication.

We only collected one male (locality 1) of ssp. *serica* and it matches very well with the figure given by Chou. The butterfly flew leisurely and low above the grass along a forest edge at about 2200 m in cloudy weather conditions.

***Callerebia polyphemus* (Oberthür, 1876)**

Type locality: Moupin (Baoping, W Sichuan) China

Distribution: S-E China, N Myanmar, India (Assam)

Notes: The taxonomic status of this species is still somewhat unclear. In China the following taxa are known according to Della Bruna et al. (2002).

- ssp. *confusa* Watkins, 1925; Type locality: Chang Yang (Yichang, Hubei), China
- ssp. *oberthueri* Watkins, 1925; Type locality: Wa-Shan (near Omei Shan), W Sichuan, China
- ssp. *polyphemus* (Oberthür, 1876); Distribution: Gansu, S Shaanxi, Sichuan, SE Tibet
- ssp. *ricketti* Watkins, 1925; Type locality: Kuatum (Kao-Tien, Fujian), China
- ssp. *suroia* Tytler, 1914; Type locality: Suroj (Manipur, Assam) NE India

Furthermore, a new species, *Callerebia ulfi* Huang, 2003 was described from Dulong Valley, NW Yunnan, based on internal and external characters and differing from *polyphemus*, *confusa*, *ricketti*, and *suroia*. Subspecies *oberthueri* is treated as synonym of ssp. *polyphemus* by Huang.

Huang (2003) in his systematic arrangement classifies *suroia* as a valid species while Della Bruna et al. (2002) consider *suroia* to be a subspecies of *polyphemus*. We follow Della Bruna et al. (2002) in their systematic arrangement of *polyphemus* and allied taxa.

We collected a number of specimens in the area of Dali (localities 4, 5 and 6). A dissection of the male genitalia of one male shows that our material belongs to ssp. *suroia*.

***Loxerebia sylvicola* (Oberthür, 1886)**

**(Figs 18a, 18b)**

Type locality: Chapa, 2 km S of Luding, W Sichuan, China

Subspecies: *gregory* Watkins, 1927

Type locality: Loma Valley, N Yunnan, China

Distribution: China (N Yunnan)

Notes: This species was present in one of the public parks of Lijiang City (locality 9). It was flying near half-shadowed bushes and near paths. An obvious aberrant specimen (Figs 19a, 19b) with premarginal elongated ocelli on both the upper- and underside of the wings was collected there.

***Loxerebia ypthimoides* (Oberthür, 1891)**

**(Figs 20a, 20b)**

Type locality: Tse-Kou, N Yunnan, China

Distribution: China (N Yunnan)

Note: This species is very local and only one worn specimen was collected at locality 9.

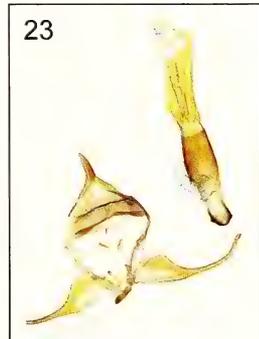
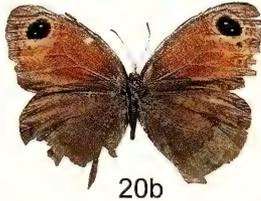
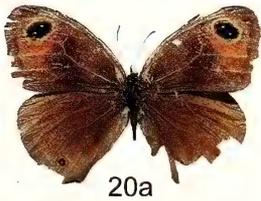
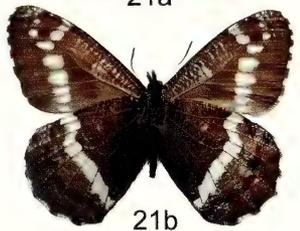
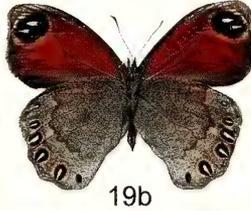
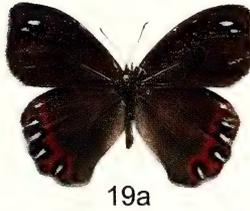
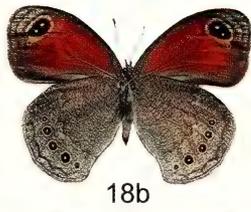
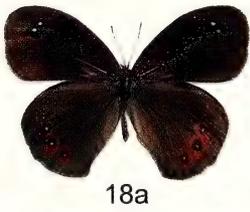
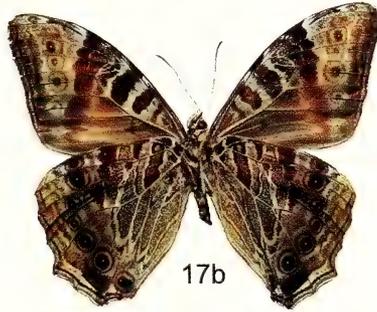
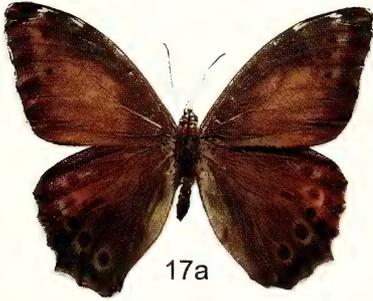
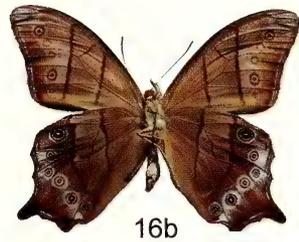
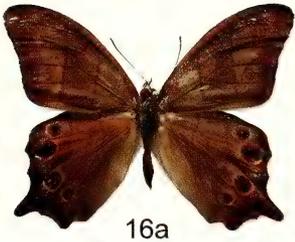
***Aulocera sybillina* Oberthür, 1890**

**(Figs 21a, 21b)**

Type locality: Kangding (Tatsienlu), Sichuan, China

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**Figs 16a–23.** Satyrinae of Yunnan. **16a, 16b.** *Lethe kansa* (Moore), recto and verso, ♂, about 48 km north of Jinghong, Sanchahe Nat. Reserve, 760 m. **17a, 17b.** *Neope yama* (Moore), recto and verso, ♂, Xi Shan, Western Hills, 2200 m. **18a, 18b.** *Loxerebia sylvicola* (Oberthür), recto and verso, ♂, Lijiang City, Black Dragon Pool Park, 2400 m. **19a, 19b.** *Loxerebia sylvicola* (Oberthür), aberrant form, recto and verso, ♂, same locality as 18. **20a, 20b.** *Loxerebia ypthimoides* (Oberthür), recto and verso, ♂, same locality as 18. **21a, 21b.** *Aulocera sybillina* Oberthür, recto and verso, ♂, near Yulongxue Shan, Jade Dragon Snow Mountain, 3000 m. **22a, 22b.** *Ypthima phania* (Oberthür), recto and verso, ♂, same locality as 21. **23.** *Ypthima phania* (Oberthür), ♂, male genitalia, same locality as 21. Specimens shown at 75 % natural size.



Distribution: Tibet and W China. There are also unclear records from Sikkim, Yatung, and Garhwal (Gross, 1958)

Subspecies: *yunnanicus* Gross, 1958

Type locality: Likiang [Lijiang], 4000 m, Yunnan, China

Notes: Chou (1994) figures *sibyllina* without subspecific name while d'Abrera (1992) figures a male from Che tou. Huang (2001) mentioned no records at all. Our male specimen belongs to ssp. *yunnanicus* and was collected at locality 10, where it was flying in open spots in a pine forest.

### *Ypthima phania* (Oberthür, 1891)

(Figs 22, 22a, 23)

Type locality: Yunnan, China

Distribution: China (Yunnan)

Notes: Shirozu & Shima (1979) treated *phania* as a species of the *sordida* group of *Ypthima* Hübner. They examined a male specimen from Likiang (Lijiang), collected on 7 July 1934 (coll. H. Höne) and determined by Förster (1948). And they agreed with this determination.

Huang (2001) only notes *phania* as belonging to the *motschulskyi*-group based on the analysis given by Shima (1988). Our specimens agree with the pictures given by Förster (1948) and those of Shirozu & Shima (1979). We found no illustrations of genitalia of *phania* in Förster, nor in Shirozu & Shima, or Huang (2001, 2003). We found our specimens at locality 10. We figure one male and its genitalia.

**Altitudinal observations.** In total we found 163 species of butterflies at localities 1–11 (see Appendix I). From low to high altitude the composition of the species changes gradually: species disappear and others come in. The distribution of the species from the lower to the higher altitudes is demonstrated on Fig. 24. In Appendix II these species are listed and it may be noted that some of them are recorded more than one time at different altitude classes, like *Zizina otis otis*, *Pseudozizeeria maha diluta*, *Parantica melaneus*, *Lobocla proximus*, and *Acraea issoria sordice*. Due to this 'double counting' the total number of species in the altitude classes of 2200–2400 m and 2600–3000 m differs from the numbers in Table 1.

The number of species per family-group taxon and their overlap over the altitude classes are demonstrated in Table 1.

Excluding the Acraeinae, with only one species, the Papilionidae, Riodininae, and Danainae particularly occupy a larger altitudinal range. At altitudes of 760 m and 2200–2400 m we found nearly the same numbers of species. In the latter altitude class, however, we spent more collecting days.

Many species (128) were found to be 'unique' to a particular altitude class. The number of unique species in each family-group taxon in relation to altitude is demonstrated in Table 2. Of these unique species 39.2% were found at the tropical locality 3. A relatively high percentage of the species (22.7%) were only observed between 2200–2400 m.

The number of species separated into family-group taxa in relation to the occupied altitude classes is demonstrated in Fig. 25. The Nymphalinae have an obvious peak

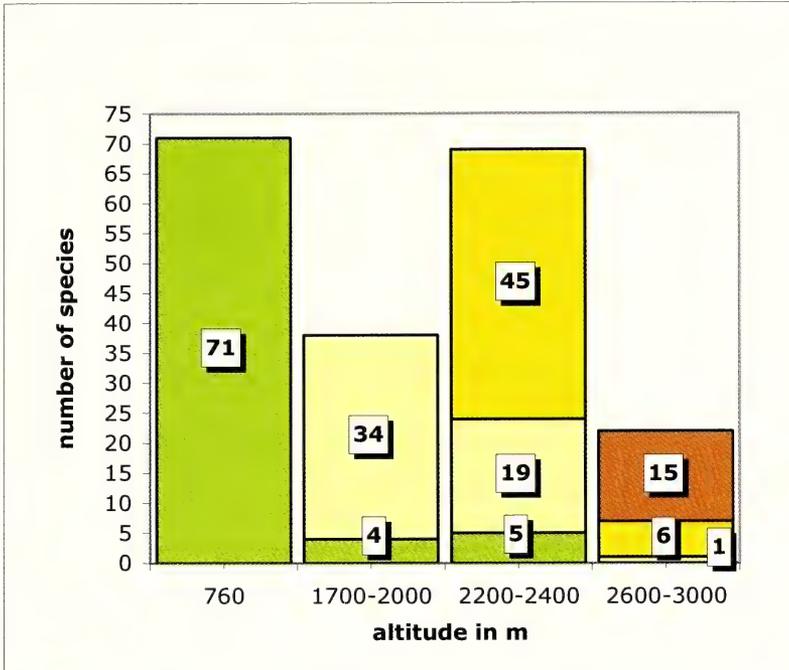


Fig. 24. Distribution of species in relation to altitude classes.

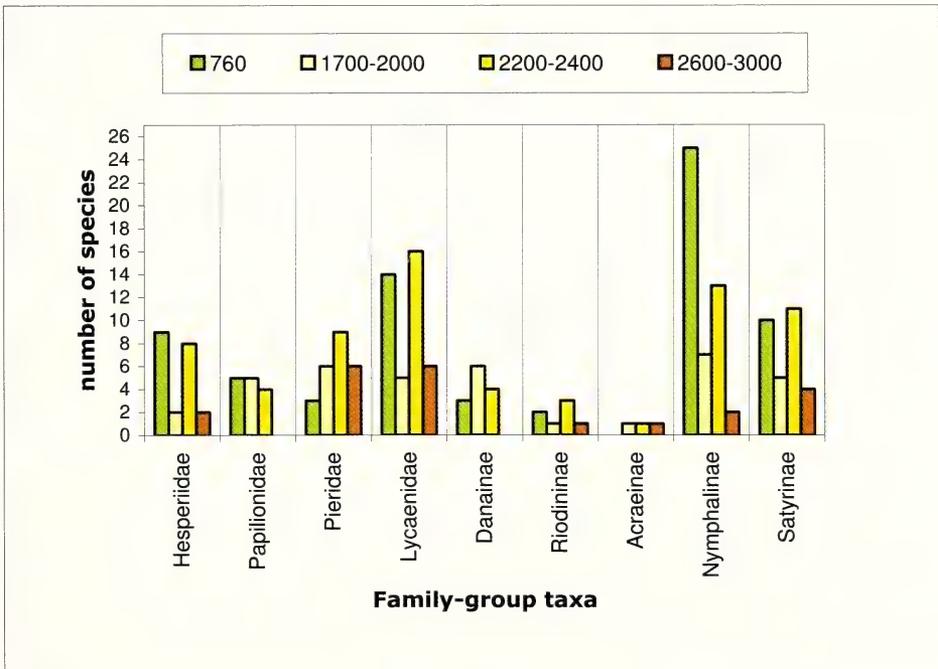


Fig. 25. Number of species by family-group taxon and altitude classes.

**Tab. 1.** Total number of species by altitude classes. Overlaps indicate the number of species observed in more than one altitude class. There is no percentage for Acraeinae because there is only one taxon.

altitude in m	760	1700–2000	2200–2400	2600–3000				
					<i>total</i>	<i>total spp. in group</i>	<i>overlap</i>	<i>% of species</i>
Hesperiidae	9	2	8	2	21	17	4	23.5
Papilionidae	5	5	4		14	10	4	40.0
Pieridae	3	6	9	6	24	20	4	25.0
Lycaeninae	14	5	16	6	41	32	9	28.1
Danainae	3	6	4		13	9	4	44.4
Riodininae	2	1	3	1	7	5	2	40.0
Acraeinae		1	1	1	3	1	2	–
Nymphalinae	25	7	13	2	47	44	3	6.8
Satyrinae	10	5	11	4	30	25	5	20.0
<i>Total</i>	71	38	69	22	200	163	37	22.7
<i>% species/altitude class</i>	43.6	23.0	42.3	13.5				

**Tab. 2.** Total number of species observed in only one altitude class, excluding Acraeinae.

altitude in m	760	1700–2000	2200–2400	2600–3000	<i>unique spp.</i>	<i>total spp. in group</i>	<i>% of species</i>
Hesperiidae	9	0	6	0	15	17	88.2
Papilionidae	4	1	1	0	6	10	60.0
Pieridae	2	2	5	6	15	20	75.0
Lycaeninae	11	2	8	3	24	32	75.0
Danainae	2	3	1	0	6	9	66.7
Riodininae	2	0	1	0	3	5	60.0
Acraeinae	0	0	0	0	0	1	0.0
Nymphalinae	25	4	10	2	41	44	93.2
Satyrinae	9	1	5	3	18	25	72.0
<i>Total</i>	64	13	37	14	128	163	78.5
<i>% of unique species/altitude class</i>	39.2	8.0	22.7	8.6	78.5		

at 760 m, but the Pieridae, Lycaeninae and Satyrinae were better represented between 2200–2400 m.

**Tab. 3.** Relative similarities of altitude classes with regard to the number of species. Bold: Number of species in altitude class; Normal: Taxa in common by altitude class; Italic: Similarity coefficient between two altitude classes.

altitude in m	760	1700–2000	2200–2400	2600–3000
760	<b>71</b>	4	5	0
1700–2000	<i>0.04</i>	<b>38</b>	19	1
2200–2400	<i>0.04</i>	<i>0.215</i>	<b>69</b>	6
2600–3000	<i>0</i>	<i>0.016</i>	<i>0.07</i>	<b>22</b>

**Tab. 4.** Numbers and percentage of Palaearctic species observed in relation to the total numbers of observed species.

	Total	Palaearctic	%
Hesperiidae	17	6	35.3
Papilionidae	10	9	90.0
Pieridae	20	18	90.0
Riodininae	5	4	80.0
Lycaeninae	32	16	50.0
Danainae	9	6	66.7
Acraeninae	1	1	100.0
Nymphalinae	44	20	45.5
Satyrinae	25	10	40.0
<i>Total species</i>	<i>163</i>	<i>90</i>	<i>55.2</i>
<i>Loc. 3 Palaearctic</i>	<i>-71</i>	<i>-30</i>	<i>42.2</i>
<i>Other locations</i>	<i>92</i>	<i>60</i>	<i>65.2</i>

**Xishuangbanna (Locality 3).** At this locality 71 species of butterflies and skippers were observed during 2.5 days of collecting only. This result suggests that the area is particularly rich in species. Thanks to the contribution of Huang & Xue (2004), who collected in late June and for the whole of July 2003 at three localities in Xishuangbanna, a list of 256 species is available. Along with other literature data in Lee (1962) and Wang & Fan (2002) 318 species have been reported from Xishuangbanna. Our contribution reflects only 22.3% of the known Rhopalocera fauna of the area, but nevertheless we can report several new species not mentioned in previous publications:

Papilionidae

- *Papilio protenor euprotenor* Frühstorfer, 1908
- *Atrophaneura latreillei genestieri* Oberthür, 1918

Nymphalinae

- *Athyma cama cama* Moore, 1858
- *Athyma kanwa phorkys* (Frühstorfer, 1912)

- *Athyma jina* Moore, 1857
- *Cheresonesia risa transiens* (Martin, 1903)
- *Polyura athamas athamas* (Drury, 1773)
- *Rohana parisatis staurakius* (Fruhstorfer, 1913)

#### Charaxinae

- *Charaxes aristogiton* C. & R. Felder, 1867

#### Satyrinae

- *Mycalesis mamerta mamerta* (Stoll, 1780)

**Similarity (Tab. 3).** The coefficients of similarity between the altitude classes are very low. The fauna within 1700–2000 m of elevation is most similar to that between 2200–2400 m, but this relation is not very convincing! The provisional conclusion is that more data are needed to suggest any similarity.

**Biogeography.** Throughout Central Asia the Palaearctic butterfly fauna interfaces with Oriental taxa. Sometimes the barrier is well defined, but mostly the boundaries are confusing. Boundaries vary from one locality to another due to geographical, climatic, ecological, and altitudinal factors. Bozano (1999) considers that in China, all species distributed north of latitude 34° N are Palaearctic. D’Abrera (1990) takes 30° N as a reference line. In transition areas like western and central China Palaearctic elements are accepted between 34° and 26° N (Bozano 1999). Yunnan belongs to such a transition area, where Palaearctic- and Oriental taxa fly together. Bozano (1999) points out that many genera found in this area do not have an obvious Palaearctic or Oriental identity (*Neope*, *Heliophorus*, *Callerebia*). An additional zoogeographical region, the Himalayan-Sino-Japanese region, was suggested by Palestrini et al. in Bozano et al. (1999).

Though the fauna in South Yunnan is predominantly Oriental, its Palaearctic elements cannot be neglected. A taxon is treated here as being Palaearctic if it has been observed in the Palaearctic Region. In that sense 42.2% of the species that we found at locality 3 also have a limited Palaearctic distribution. Most of these species have an Oriental distribution and only “touch” the Palaearctic Region. Two species are mainly Oriental-Ethiopian (*E. hecabe*, *H. bolina*) and another three (*H. bolina*, *G. sarpedon*, *L. plinius*) are mainly Oriental, but are also distributed in Australia. *Hypolimnas bolina* is curiously also known from Saudi Arabia and Madagascar. Only two species (*C. argiolus*, *P. maha*) are predominantly Palaearctic although they also come into the Oriental Region. In Appendix III we list the species with a Palaearctic/ Oriental interface at locality 3. Besides locality 3 (22°10’ N) all other localities treated here are between the latitudes of 24°49’ N and 27°03’ N. In these localities 65.2% of the taxa are generally accepted as belonging to the Palaearctic fauna as well (Table 4). Finally, the Palaearctic species - in the sense mentioned above - are indicated with a P in Appendix I. It may be noted, that many species of the Papilionidae, Pieridae, and Riodininae are Palaearctic (with connection into the Oriental). This means that the latitudes taken as boundaries for 100% of the Palaearctic taxa treated by Bozano and d’Abrera, are very acceptable, but that even at lower latitudes Palaearctic taxa can be observed.

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Appendix I. Lepidoptera species observed in Yunnan, China from 16 June until 3 July 2006. 'P' refers to Palaearctic species. Continuation.

altitude in m	760	1700-2000	1700-2000	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2600-3000	2600-3000
localities	3	2	7	1	4	6	8	9	11	5	10	
<b>Papilionidae</b>												
<i>Graphium sarpedon</i> (Linnaeus, 1758)	3	0										
<i>Papilio bianor ganesa</i> Doubleday, 1842	4		0	0								
<i>Papilio paris</i> Linnaeus, 1758	5	0										
<i>Papilio polytes</i> Linnaeus, 1758	6	0										
<i>Papilio protenor euprotenor</i> Fruhstorfer, 1908	7	0	0									
<i>Papilio xuthus</i> Linnaeus, 1767	8	0	0	0	0	0	0					
<i>Papilio syfanius</i> Oberthür, 1890	9							0				
<i>Troides aeacus</i> (C. & R. Felder, 1860)	10	0										
number of species	5	4	1	2	1	1	1	1	1			
<b>Pieridae (20 species)</b>												
<i>Anthocharis bieti</i> (Oberthür, 1884)	1											0
<i>Aporia bieti gregoryi</i> Watkins, 1927	2								0			
<i>Aporia larraldei nutans</i> (Oberthür, 1892)	3									0		
<i>Aporia martinetti</i> (Oberthür, 1884)	4											0
<i>Catopsilia pomona</i> (Fabricius, 1775)	5	0										
<i>Colias erate sinensis</i> Verity, 1911	6		0	0	0	0			0			
<i>Colias fieldi</i> Menetrier, 1855	7				0							
<i>Delias subnubila</i> Leech, 1893	8											0
<i>Dercas lycorias</i> (Doubleday, 1842)	9			0	0							
<i>Eurema blanda silhetana</i> (Wallace, 1867)	10		0									
<i>Eurema brigitta rubella</i> (Wallace, 1867)	11		0									
<i>Eurema hecabe</i> (Linnaeus, 1758)	12	0	0	0	0	0						
<i>Eurema laeta sikkima</i> (Moore, 1906)	13		0		0							







Appendix I. Lepidoptera species observed in Yunnan, China from 16 June until 3 July 2006. 'P' refers to Palaearctic species. Continuation.

altitude in m	760	1700-2000	1700-2000	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2600-3000	2600-3000
localities	3	2	7	1	4	6	8	9	11	5	10	
<b>Nymphalinae</b>												
<i>Athyma nefita asita</i> Moore, 1858	5	0										
<i>Athyma kanwa phorkys</i> (Fruhstorfer, 1912)	6	0										
P <i>Boloria gong charis</i> (Oberthür, 1891)	7											0
P <i>Calinaga buphonas</i> Oberthür, 1920	8			0	0							
<i>Cethosia biblis</i> (Drury, 1773)	9	0										
<i>Cethosia cyane euanthes</i> Fruhstorfer, 1912	10	0										
<i>Charaxes bernardus hierax</i> (C. & R. Felder, 1867)	11	0										
<i>Charaxes aristogiton</i> Felder 1867	12	0										
<i>Chersonesia risa transies</i> (Martin, 1903)	13	0										
P <i>Chilidrena childreni</i> Gray, 1831	14			0								
<i>Cupha erymanthis</i> (Drury, 1773)	15	0										
<i>Doleschallia bisalide continentalis</i> Fruhstorfer, 1899	16	0										
<i>Hypolimnas bolina jacintha</i> Drury, 1773	17	0										
<i>Junonia almana</i> (Linnaeus, 1758)	18	0										
P <i>Junonia iphita</i> (Cramer, 1779)	19	0										
P <i>Junonia lemontias</i> (Linnaeus, 1758)	20	0										
P <i>Junonia orithya</i> (Linnaeus, 1758)	21	0			0							
P <i>Kallima inachus chinensis</i> Swinhoe 1893	22		0									
P <i>Kaniska canace</i> Linnaeus, 1763	23				0							
<i>Lexias pardalis jadeitina</i> (Fruhstorfer, 1913)	24	0										
P <i>Limenitis homeyeri meridionalis</i> Hall, 1930	25				0							
P <i>Melitaea bellona</i> Leech, 1893	26											0
P <i>Melitaea yuenty</i> Oberthür, 1888	27							0				





Appendix I. Lepidoptera species observed in Yunnan, China from 16 June until 3 July 2006. 'P' refers to Palaearctic species. Continuation.

altitude in m	760	1700-2000	1700-2000	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2200-2400	2600-3000	2600-3000
localities	3	2	7	1	4	6	3	8	9	11	5	10
number of species	10	5		4	6	3	0	0	3	1	2	2
summary												
Hesperiidae	9	1	1	2	8	3	3	1	3		1	1
Papilionidae	5	4	1	2	1	1	1	1	1			
Pieridae	3	6	1	2	7	4	4	1	1	3	2	4
Lycaeninae	14	4	3	1	10	7	2	2	3	5	2	4
Danainae	3	3	4	1	3				1			
Riodininae	2	1		1	3					1	1	
Acraeinae		1		1	1	1					1	
Nymphalinae	25	6	1	4	10	1	3		3			2
Satyrinae	10	5		4	6	3			3	1	2	2
Totals	71	31	11	18	49	20	3	15	10	9	13	

## Appendices

Appendix II. Lepidoptera species observed in several altitude classes. See also Tab. I.

from 760 m into	2000	2400	3000
<i>Celastrina argiolus nymteana</i> (de Niceville, 1884)		X	
<i>Eurema hecabe</i> (Linnaeus, 1758)	X		
<i>Leptotes plinius</i> (Fabricius, 1793)		X	
<i>Neptis soma shania</i> Evans, 1924	X		
<i>Papilio protenor euprotenor</i> Fruhstorfer, 1908	X		
<i>Parantica melaneus</i> (Cramer, 1775)	X	X	
<i>Pseudozizeeria maha diluta</i> (Felder, 1865)	X	X	
<i>Ypthima baldus luoi</i> Huang, 1999		X	
Totals	5	5	0
from 2000 m into	2400	3000	
<i>Acraea issoria sordice</i> (Fruhstorfer, 1914)	X	X	
<i>Carterocephalus alcinooides</i> Lee, 1962		X	
<i>Colias erate sinensis</i> Verity, 1911		X	
<i>Dodona dirga</i> (Kollar & Redtenbach, 1844)		X	
<i>Euploea core amymone</i> (Godart, 1819)		X	
<i>Eurema brigitta rubella</i> (Wallace, 1867)		X	
<i>Eurema hecabe</i> (Linnaeus, 1758)		X	
<i>Eurema laeta sikkima</i> (Moore, 1906)		X	
<i>Everes lacturnus</i> (Godart, 1824)		X	
<i>Gonepteryx amintha murayamae</i> Nekrutenko, 1973		X	
<i>Graphium cloanthus</i> (Westwood, 1841)		X	
<i>Junonia orithya</i> (Linnaeus, 1758)		X	
<i>Lethe sidonis</i> (Hewitson, 1863)		X	
<i>Lobocla proximus</i> (Leech, 1891)		X	

Appendix II. Lepidoptera species observed in several altitude classes. See also Tab. 1. Continuation.

from 2000 m into	2400	3000
<i>Neptis hylas</i> Linnaeus, 1758	X	
<i>Papilio bianor ganesa</i> Doubleday, 1842	X	
<i>Papilio xuthus</i> Linnaeus, 1767	X	
<i>Parantica melaneus</i> (Cramer, 1775)	X	
<i>Pseudozizeeria maha diluta</i> (Felder, 1865)	X	
<i>Rapala nissa nissa</i> (Kollar, 1844)	X	
<i>Tirumala limniace</i> (Cramer, 1775)	X	
<i>Ypthima dromon</i> Oberthur, 1871	X	
<i>Ypthima ciris</i> Leech, 1891	X	
<i>Ypthima tiami nuae</i> Huang, 2001	X	
<i>Zizina otis</i> (Fabricius, 1787)	X	X
Totals	25	3
from 2400 m into		3000
<i>Acraea issoria sordice</i> (Fruhstorfer, 1914)		X
<i>Callerebia polyphemus suroia</i> Tytler, 1914		X
<i>Dodona dipoea</i> Hewitson, 1865		X
<i>Heliophorus eventa</i> Fruhstorfer, 1918		X
<i>Lobocla proximus</i> (Leech, 1891)		X
<i>Ochlodes subhyalina</i> (Bremer & Grey, 1853)		X
<i>Tongeia ion</i> (Leech, 1891)		X
<i>Zizina otis</i> (Fabricius, 1787)		X
Total		8

## Appendices

**Appendix III.** Lepidoptera species observed at locality 3 with their distribution characteristics.

	mainly Palaeartic	mainly Oriental	mainly Oriental- Ethiopian	mainly Oriental- Australian
<i>Atrophaneura latreillei genestieri</i> Oberthür, 1918		X		
<i>Celastrina argiolus</i> Linnaeus, 1758	X			
<i>Cethosia biblis</i> Drury, 1773		X		
<i>Charaxes bernardus hierax</i> C. & R. Felder, 1867)		X		
<i>Cupha erymanthis</i> (Drury, 1773)		X		
<i>Doleschallia bisaltide continentalis</i> Fruhstorfer, 1899		X		
<i>Euploea mulciber</i> (Cramer, 1777)		X		
<i>Eurema hecabe</i> (Linnaeus, 1758)			X	
<i>Graphium sarpedon</i> (Linnaeus, 1758)				X
<i>Hypolimnas bolina jacintha</i> Drury, 1773			X	X
<i>Junonia iphita</i> Cramer, 1779		X		
<i>Junonia lemonias</i> (Linnaeus, 1758)		X		
<i>Leptotes plinius</i> (Fabricius, 1793)				X
<i>Lethe confusa</i> Aurivillius, 1898		X		
<i>Lethe europa gada</i> Fruhstorfer, 1911		X		
<i>Melanitis leda</i> (Linnaeus, 1758)		X		
<i>Mycalesis mineus subfasciata</i> (Moore, 1882)		X		
<i>Papilio paris</i> (Linnaeus, 1758)		X		
<i>Papilio protenor euprotenor</i> Fruhstorfer, 1908		X		
<i>Parantica melaneus</i> (Cramer, 1775)		X		
<i>Polyura athamas</i> (Drury, 1773)		X		
<i>Pseudozizeeria maha diluta</i> (Felder, 1865)	X	X		
<i>Troides aeacus</i> (C. & R. Felder, 1860)		X		
<i>Ypthima baldus luoi</i> Huang, 1999		X		
<i>Zemeros flegyas</i> (Cramer, 1780)		X		
Totals	2	20	2	3

## *Pyrgus andromedae* (Wallengren, 1853) (Hesperiidae) in the Romanian Carpathians

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**Abstract.** The presence of *Pyrgus andromedae* (Wallengren, 1853) (Hesperiidae) is confirmed for the Romanian Carpathians, where it occurs sympatrically with *Pyrgus cacaliae* (Rambur, 1839). The records presented here represent the second area of occurrence in the Carpathian chain. Male and female imagos are illustrated and the genitalia of both sexes are figured in comparison with *P. cacaliae*. The current and potential distribution, habitat preferences, and conservation status of *P. andromedae* are discussed.

**Résumé.** La présence de *Pyrgus andromedae* (Wallengren, 1853) (Hesperiidae) est confirmée dans les Carpathes roumaines, où elle est sympatrique avec *Pyrgus cacaliae* (Rambur, 1839). Ces données représentent la deuxième région de présence dans la chaîne carpatique. Les adultes mâles et femelles sont illustrés et l'appareil génital des deux sexes est illustré en comparaison avec *P. cacaliae*. La distribution connue et potentielle, les préférences d'habitat et le statut de conservation de *P. andromedae* en Roumanie sont commentés.

**Rezumat.** Prezența speciei *Pyrgus andromedae* (Wallengren, 1853) (Hesperiidae) este confirmată în Carpații românești, unde este simpatrică cu *Pyrgus cacaliae* (Rambur, 1839). Aceste date reprezintă a doua regiune în care specia este semnalată în lanțul carpatic. Sunt ilustrați adulții ambelor sexe, precum și armătura genitală masculă și femelă a acestora în comparație cu *P. cacaliae*. Sunt discutate distribuția actuală și cea potențială în Carpați, preferințele față de habitat și statutul de conservare la nivelul țării.

### Introduction

Although Romania harbours a relatively high butterfly diversity (Rákósy 2003, Schmitt & Rákósy 2007, Cuvelier & Dincă 2007, Dincă & Vila 2008), there are still large regions insufficiently studied from a lepidopterological point of view. The latest version of the Romanian Lepidoptera Catalogue (Rákósy et al. 2003) lists 202 butterfly species, but some of them represent doubtful records for several reasons, such as lack of recent data, nonexistent material or improperly documented publications.

An example of such a species is *Pyrgus andromedae* (Wallengren, 1853), which was not included in the Romanian Lepidoptera Catalogue published by Popescu-Gorj (1987) and is considered as data deficient in the latest version of the catalogue (Rákósy et al. 2003). *Pyrgus andromedae* has only one old published record from Romania (one specimen collected on August 4<sup>th</sup> in the Bucegi Mountains) (Czekelius 1917) without adult or genitalia illustrations. Also, Rákósy et al. (2003), based on a personal communication, mention a specimen collected in 1978 by E. Schneider in the Piatra Craiului Mountains. Both records are commented as requiring confirmation by Rákósy et al. (2003). Moreover, *Pyrgus cacaliae* (Rambur, 1839), a species rather similar in appear-

ance and habitat preferences to *P. andromedae*, is also present in Romania (Bucegi and Făgăraş Mountains) and misidentifications could be possible.

The species is not mentioned as being present in Romania in any of the recent major studies dealing with the distribution of European butterflies (Karsholt & Razowski 1996, Kudrna 2002). *Pyrgus andromedae* has an arcto-alpine distribution apparently restricted to Europe and is reported as local from the Pyrenees, Alps, Balkans, and parts of Scandinavia (Tolman & Lewington 1997, Kudrna 2002, Lafranchis 2004, Slamka 2004) while in Russia it is cited from the Kola Peninsula (Chibiny Mountains) and the Polar Ural (Tuzov et al. 1997, Gorbunov 2001, Tshikolovets 2003). From the Carpathians it has been reported only from southern Ukraine (Tshikolovets 2003, 2005, Slamka 2004, Popov 2005), where *P. cacaliae* seems not to be present.

## Material and methods

Specimens of *P. andromedae* were collected during several field trips to the Meridional Carpathians during 1984–2007. This material is preserved in L. Székely's and S. Kovács & Z. Kovács' personal collections. Genitalia were processed as follows: maceration in 10% potassium hydroxide, dissection and cleaning under the stereomicroscope, and storage in tubes with glycerin.

The terminology used for the description of the male and female genitalia follows De Jong (1972).

## Results and discussion

### *Pyrgus andromedae*

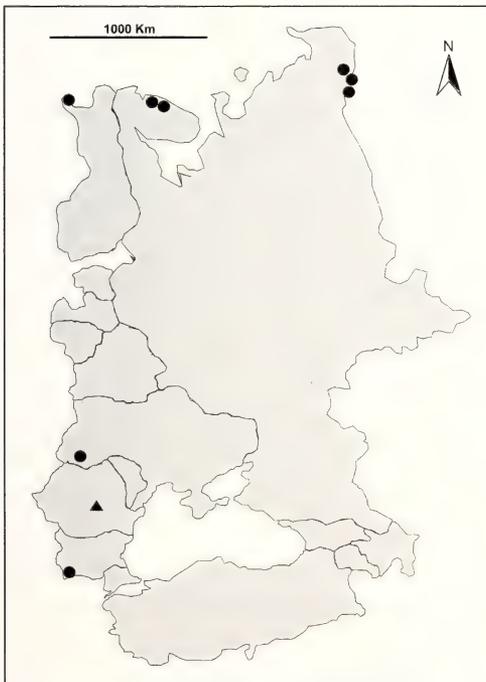
**Material.** Romania: 1♂, Bucegi Mountains, Jepii Mari, 2000 m, 25.vi.1994, leg. Székely; 1♀, Bucegi Mountains, Caraiman, 2100 m, 18.vii.2004, leg. Székely; 1♀, Bucegi Mountains, Cota 2000, 2000 m, 24.vi.2007, leg. Székely; 3♂, 3♀, Bucegi Mountains, Vânturiş, 1800–1900 m, 22.vi.1993, leg. S. Kovács & Z. Kovács; 1♀ Bucegi Mountains, Caraiman, 2100 m, 27.vi.2003, leg. S. Kovács & Z. Kovács; 1♀ Bucegi Mountains, Babele, 2150 m, 24/26.vii.1984, leg. S. Kovács & Z. Kovács.

The species was collected in the alpine area of the Bucegi Mountains (Meridional Carpathians) where it is sympatric with *P. cacaliae* (Fig. 1). The collecting sites range from the southern parts of the Bucegi Mountains (Vânturiş) to the northern peaks (Caraiman and Babele). The linear distance between the southernmost and northernmost sites is about 10 km. Given the position of the collecting sites, it is likely that the species has a continuous distribution in the whole alpine plateau of the Bucegi Mountains. Surprisingly, since the record of Czekelius (1917), the species has never been reported again in the Bucegi Mountains, although this is one of the best studied massifs in the Romanian Carpathians (Popescu-Gorj 1948, 1963, 1995; Székely 1994, 1996).

Our data confirm the presence of *P. andromedae* in Romania and show that the species flies together with *P. cacaliae* in the Bucegi Mountains. Moreover, these data represent



**Fig. 1.** Distribution of *Pyrgus andromedae* and *Pyrgus cacaliae* in Romania (black and white dot: *P. andromedae* and *P. cacaliae* (Bucegi Mts.); black dot: *P. cacaliae* (Făgăraș Mts.); ?: unconfirmed record of *P. andromedae* (Piatra Craiului Mts.)).



the second region of occurrence for *P. andromedae* in the Carpathian chain, where it was known only from southern Ukraine, near the border with Romania (area of Yaremcha to Hoverla Massif) (Tshikolovets 2003, 2005, Slamka 2004). The distance between the two areas is more than 300 km (Fig. 2). As a matter of fact, the entire eastern distribution of *P. andromedae* is poorly known: two areas in the Carpathians (including the present report), one site in Bulgaria (northern Pirin Mountains) (Kolev 2002) and two regions in Russia (Kola Peninsula and Polar Ural) (Tuzov et al. 1997, Gorbunov 2001, Tshikolovets 2003) (Fig. 2).

**Fig. 2.** Distribution of *Pyrgus andromedae* in Eastern Europe (black dots: records outside Romania; triangle: Romanian population).



**Fig. 3.** Dorsal (left) and ventral (right) view of *Pyrgus andromedae* male, Bucegi Mts., Jepii Mari, 2000 m, 25.vi.1994, prep. genit 561/Dincă. Photo L. Székely.

### Identification of *Pyrgus andromedae*

*Pyrgus andromedae* and *P. cacaliae* are rather similar morphologically, but they can be reliably distinguished based both on wing and genital characters.

### External characters

The most reliable element of the wing pattern lies at the base of the hind wing underside where *P. andromedae* presents three white spots, while *P. cacaliae* has only two (the middle one is absent). *P. andromedae* also bears a more or less shallow, yet always present, elongated discal white spot on the hind wings upper side, which is absent in *P. cacaliae* (Figs 3, 4). These two diagnostic characters apply equally to both male and female specimens.

### Genitalia characters

**Male genitalia.** The dorsal part of the cuiller (under the base of the style) of *P. andromedae* bears very small and fine teeth, almost invisible, while a series of more obvious sclerified teeth are present in *P. cacaliae*. In *P. andromedae*, the angle where the ventral and dorsal lines of the cuiller meet is about 90 degrees, giving this region a pointed aspect (Figs 5, 6), a feature also mentioned by Warren (1926).

The number and size of setae in the terminal part of the style was found to be slightly variable (gradually increasing in length towards the tip of the style). The setae, rather difficult to count, are more than 12 for *P. andromedae* and more than 18 for *P. cacaliae* from Romania (Figs 7, 8). This is contrary to the findings of Higgins (1975) and Gorbunov (2001) who mention 6 and 6–8 setae for *P. andromedae*, while Fernández-Rubio (1991) mentions 4–6 setae for Spanish specimens. To further test the constancy of this character, we prepared the genitalia of two male specimens of *P. andromedae* from north-eastern Spain (Vall d'Aran) and found that the style bears more than 12 setae, as in the Romanian specimens.



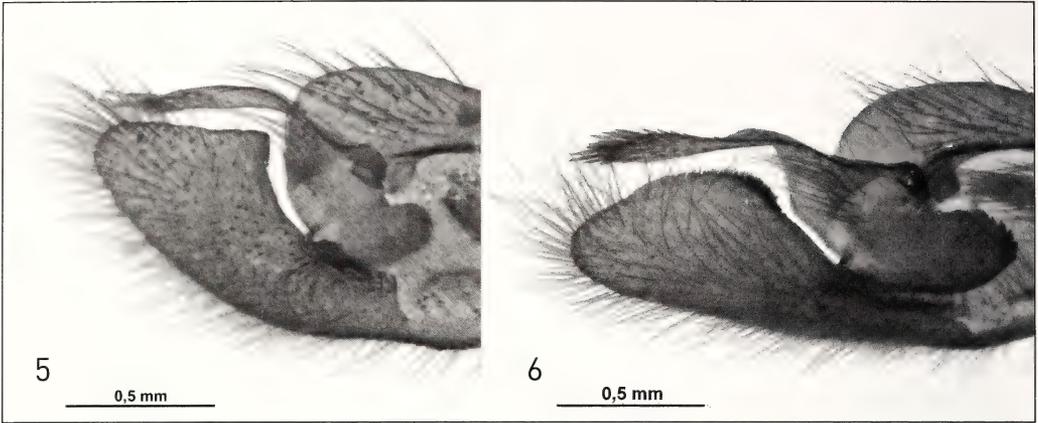
**Fig. 4.** Dorsal (left) and ventral (right) view of *Pyrgus andromedae* female, Bucegi Mts., Vânturiș, 1800–1900 m, 22.vi.1993. Photo Z. Kovács.

**Female genitalia.** In *P. andromedae*, the sclerified structures of the eighth abdominal segment lack striations, while in *P. cacaliae* these structures have several obvious and symmetrically disposed striations. The space below the genital plate is shorter and wider in *P. andromedae* in comparison to the longer and narrower space in *P. cacaliae* (Figs 9, 10).

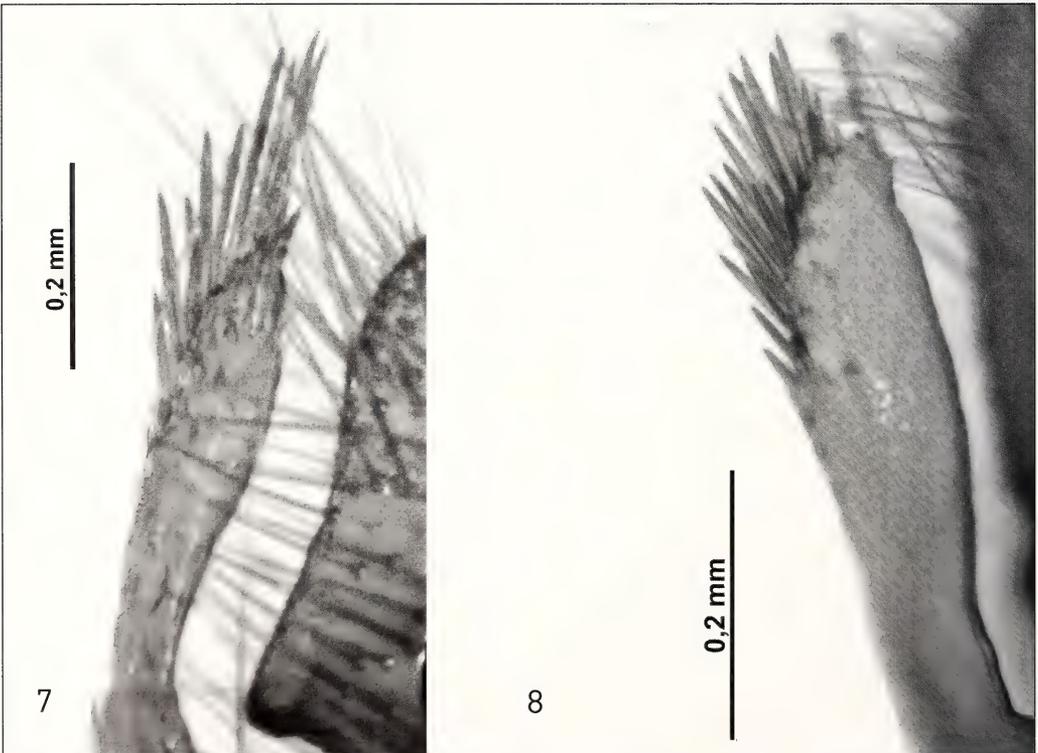
### **Habitat, biology, and conservation of *Pyrgus andromedae* in the Romanian Carpathians**

The habitat of *P. andromedae* in the Bucegi Mountains consists of subalpine and alpine meadows at altitudes between 1700–2200 m, according to the available material (Fig. 11). This habitat is shared with *P. cacaliae*, which in Romania is known to be restricted to alpine meadows from the Bucegi and Făgăraș Mountains (Meridional Carpathians) (Fig. 1).

The Bucegi Mountains probably offer the most suitable habitat conditions for *P. andromedae* in Romania as the alpine plateaus of these mountains are the largest in the country and shelter the highest concentration of typically alpine and arcto-alpine Lepidoptera, such as: alpine elements – *Pyrgus cacaliae*, *Boloria pales* (Denis & Schiffermüller, 1775), *Erebia epiphron* (Knoch, 1783), *Erebia pronoe* (Esper, 1780), *Erebia gorge* (Hübner, 1804), *Glacies noricana* (Wagner, 1898), *Glacies canaliculata* (Hochenwarth, 1785), *Apamea zeta* (Treitschke, 1825), and arcto-alpine elements – *Erebia pandrose* (Borkhausen, 1788), *Apamea maillardi* (Geyer, 1834), *Grammia quenseli* (Paykull, 1793), *Glacies coracina* (Esper, 1805), etc. Several of these taxa are not known from other parts of the Romanian Carpathians. The biology of the *P. andromedae* populations in the Bucegi Mountains is unknown. While some general works mention *Potentilla* sp., *Alchemilla glomerulans* Buser (Rosaceae), and *Malva* sp. (Malvaceae) as larval host plants (Henriksen & Kreutzer 1982; Fernández-Rubio 1991; Tolman & Lewington 1997; Tshikolovets 2003; Slamka 2004), Wagner (2003) indicates that, at least in the Alps, the larval food plant for *P. andromedae* is *Dryas octopetala* L. (Rosaceae) and not

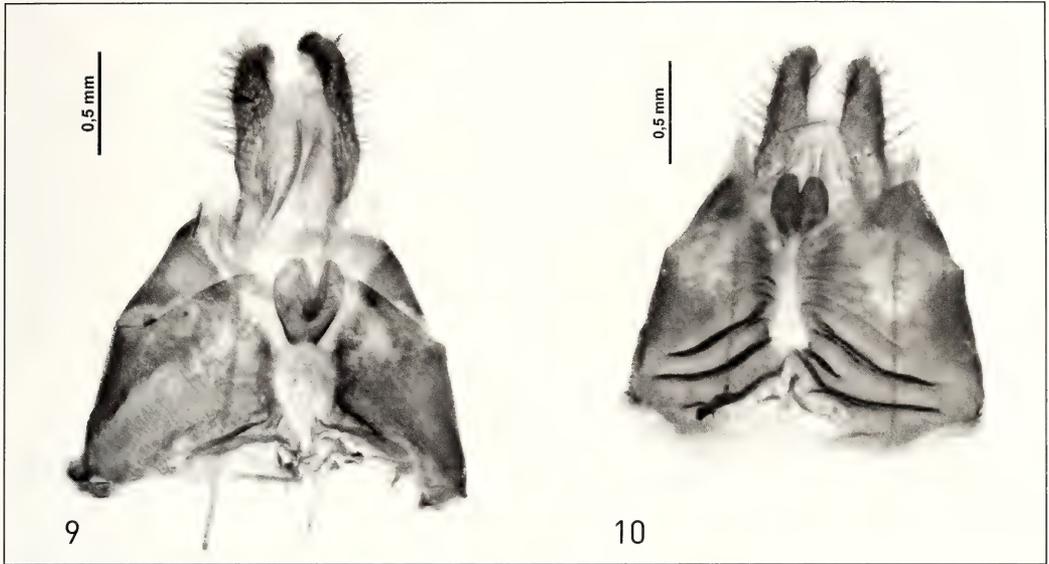


**Figs 5–6.** Lateral view of male valva. **5.** *Pyrgus andromedae*, Bucegi Mts., Jepii Mari, 2000 m, 25.vi.1994, prep. genit. 561/Dincă. **6.** *Pyrgus cacaliae*, Făgăraș Mts., south of Bâlea Lac, 1900 m, 22.vii.2004, prep. genit. 585/Dincă.



**Figs 7–8.** Style detail. **7.** *Pyrgus andromedae*, Bucegi Mts., Jepii Mari, 2000 m, 25.vi.1994, prep. genit. 561/Dincă. **8.** *Pyrgus cacaliae*, Făgăraș Mts., Bâlea Lac, 2040 m, 22.vii.2004, prep. genit. 563/Dincă.

*Potentilla* sp., which is used by *P. cacaliae*. Grös (1998) highlights the close relationship between *P. andromedae* and *Dryas octopetala* in the Austrian Alps and south-eastern Bavaria. In the area of Salzburg and Berchtesgaden, the butterfly may sometimes



**Figs 9–10.** Ventral view of the female genitalia. **9.** *Pyrgus andromedae*, Bucegi Mts., Cota 2000, 2000 m, 24.vi.2007, prep. genit. 564/Dincă. **10.** *Pyrgus cacaliae*, Bucegi Mts., Jepii Mici, 1800–2000 m, 11.viii.1984, prep. genit. 565/Dincă

be found at atypical heights of 600–800 m above sea level, following the distribution of *Dryas octopetala*, which locally reaches these low altitudes (Gros pers. comm.). Eliasson et al. (2005) also mention *Dryas octopetala* for Scandinavia.

The Bucegi Mountains and many other parts of the Romanian Carpathians shelter several species of *Alchemilla*, *Malva*, and *Potentilla*, as well as *Dryas octopetala* (Oprea 2005) and therefore *P. andromedae* might be more widespread in the country. The Piatra Craiului Massif, where one unconfirmed record already exists (Rákósy et al. 2003), is particularly promising, as well as the area of the Făgăraș Mountains (Fig. 1) where *P. cacaliae* is already known to occur in similar habitats to those of the Bucegi Mountains (Rákósy et al. 1994, Dincă pers. obs.). Finally, the subalpine-alpine areas near the border with Ukraine might also shelter populations of *P. andromedae* as Ukrainian populations (Hoverla Massif) are situated less than 30 km away from the Romanian border.

Based on the available material, *P. andromedae* flies in June–July in the Bucegi Mountains. Although conclusions cannot be drawn in the absence of monitoring activities, our data suggest that the imago might be active about two weeks earlier than *P. cacaliae* (which flies between the end of June until August), with an overlap of their flight times in July. These dates are roughly similar to the ones reported by Fernández-Rubio (1991) for Spain, Henriksen & Kreutzer (1982), Eliasson et al. (2005) for Scandinavia, and Warren (1926), De Jong (1972), and Tolman & Lewington (1997) for Europe.

In the Red Data Book of European Butterflies (Van Swaay & Warren 1999) *P. andromedae* is not listed as threatened in Europe, but it is considered a species of conservation concern due to its European endemic status. In Romania, the species is considered as “data deficient” and is commented as requiring confirmation (Rákósy 2003, Rákósy et



**Fig. 11.** Habitat of *Pyrgus andromedae* in the Bucegi Mountains (2000 m). Photo: V. Dincă.

al. 2003) for the country. In the light of our new data, the conservation status of this species can be addressed. Large parts of the Bucegi Mountains are included in a Natural Park where the species should be relatively safe as long as the alpine meadows are preserved in good condition. The main disturbing factor in such areas is overgrazing by sheep. On the other hand, moderate grazing might not greatly affect *P. andromedae*, as it has been observed that in the Hohe Tauern (Salzburg) the species seems to lay eggs preferably on ground leaves of *Dryas octopetala* in very short alpine vegetation (Gros pers. comm.). Therefore, we propose a red list status of “near threatened” at a national level and we recommend a monitoring of the populations in the Bucegi Mountains.

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## Systematic notes on *Dasorgyia* Staudinger, 1881, *Dicallomera* Butler, 1881, and *Lachana* Moore, 1888 (Lymantriidae)

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**Abstract.** The little-known lymantriid moth *Dicallomera pumila* (Staudinger, 1881), comb. n. is reported from the South Ural Mountains, a first record for Russia. Based on this finding, the taxonomy of the high alpine Central Asian lymantriids formerly treated in *Dasorgyia* Staudinger, 1881 and *Gynaephora* Hübner, 1819 is discussed. Based on adult morphology, *Dasorgyia* Staudinger, 1881 syn. n. is synonymized with *Dicallomera* Butler, 1881. Three species are transferred from *Gynaephora* to *Lachana* Moore, 1888 as *Lachana selenophora* (Staudinger, 1887) comb. n., *L. sincera* (Kozhantshikov, 1950) comb. n., and *L. alpherakii* (Grum-Grzhimailo, 1891) comb. n. A new species, *Lachana kulu* sp. n. is described from Northern India. Lectotypes are designated for *Dasorgyia pumila* Staudinger, 1881, *Dasychira selenophora* Staudinger, 1887, *Dasychira alpherakii* Grum-Grzhimailo, 1891, *Dasorgyia grumi* Staudinger, 1901, and *Dasorgyia alpherakii* f. *staudingeri* Bang-Haas, 1938.

### Introduction

While investigating the lepidopteran fauna of the southeastern extremity of the Irendyk mountain ridge in the Southern Urals (Russia, Bashkortostan), an unusual diminutive mature larva of a lymantriid was collected. I succeeded to a male moth from this larva, and to identify it as *Dasorgyia pumila* Staudinger, 1881 (Figs 1–2b) by comparison with the type series preserved at the Museum für Naturkunde der Humboldt Universität zu Berlin (Germany). The species was known until then only from the type series consisting of two reared pairs from Zaisan Lake (Kazakhstan). Originally this species was described in genus *Dasychira* by Staudinger (1881). However, at the end of original description Staudinger proposed the new genus *Dasorgyia* for *pumila* (by monotypy), characterising it by the small size of the moths, shortened wings of the females and their high mountain steppe habitat preference, though he noted some affinities in general habitus with *Dicallomera fascelina* (Linnaeus, 1758). Later, Staudinger (1901: 114) included five species in *Dasorgyia* Staudinger, 1881: *D. pumila* Staudinger and four other species occurring in the high alpine zone of Central Asia: *D. selenophora* (Staudinger, 1887), *D. alpherakii* (Grum-Grzhimailo, 1891), *D. semenovi* (Grum-Grzhimailo, 1891), and *D. grumi* Staudinger, 1901. Kozhantshikov (1948, 1950) transferred the whole genus *Dasorgyia* Staudinger, 1881 (s. l.) into *Gynaephora* Hübner, 1819 on the basis of the single pair of spurs on the hindtibia and the brachypterous females. Since then *Gynaephora* sensu Kozhantshikov has never been reviewed in spite of its evident heterogeneity. However, the species treated earlier in *Dasorgyia* were later separated into subgenus *Dasorgyia* within *Gynaephora* (Černí & Spitzer 1981; Spitzer 1984; Tschistjakov 2003) on the basis of the smaller size of the adults and some other morphological and ecological characteristics. After investigating larval external features (Fig. 2b) and adult characters (Fig. 20) of *pumila* I found some characters that were obviously unknown to previous authors and that point to a different taxonomic treatment, which is the content of this paper.

## Abbreviations

BMNH	Natural History Museum, London
LSSU	Laboratory of Animal Systematics and Faunistics, Samara State University, Samara
MHUB	Museum für Naturkunde der Humboldt Universität zu Berlin
MWM	Entomologisches Museum of Thomas J. Witt, Munich
MTD	Museum für Tierkunde Dresden
ZFMK	Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn
ZISP	Zoological Institute of Russian Academy of Sciences, St. Petersburg

## Results

### *Dicallomera* Butler, 1881 [February]

Type species: *Phalaena Bombyx fascelina* Linnaeus, 1758.

= *Dasorgyia* Staudinger, 1881 [October–December], syn. n. Type species: *Dasychira pumila* Staudinger, 1881.

References: Linnaeus 1758: 503 (*Phalaena*); Staudinger 1887: 97; Staudinger 1901: 115; Strand 1910: 112; Bryk 1949: 11; Ebert 1968: 182; Daniel 1952: 74; 1969: 271; Bustillo & Garnica 1980: 79 (*Dasychira*); Bryk 1934: 11; Kozhantshikov 1950: 227; (*Olene*); Butler 1881: 12; Ferguson 1978: 17; Bacallado et al. 1981: 8; Holloway 1982: 44; Holloway 1999: 34; Lukhtanov & Khruliova 1989: 41; Tschistjakov 2003: 612 (*Dicallomera*).

**Redescription.** Medium sized lymantriids with stout body, wingspan 26–45 mm in males and up to 55 mm in females. Fore- and hindwings elongate, triangular. Antennae strongly bipectinate in male and filiform in females. Eye rounded, large. Labial palpus hairy, short, antrorse; tufts of hairs on first 1–2 abdominal segments present; hind tibia with two pairs of spurs. Venation as in orgyiine ground plan. Forewing with R-cell wide and short; R3+R4 stalked and, as R5, originating from top of R-cell; M1 originating from top of discal cell; M2 and M3 originating from lower top of discal cell; A1 absent. Hindwing with closed basal cell; Sc and R joined or anostomosed; R+M1 on stalk; M3+Cu1 on short or long stalk. Male genitalia characters discussed and illustrated in Kozhantshikov (1950), Bacallado et al. (1981), Tschistjakov (2003), and also in species account for *D. pumila* below. The male genitalia of *Dicallomera* differ from those of genus *Gynaephora* in the rounded shape of the uncus, the extended, angulate valva, and the stout and curved phallus (Tab. 1).

**Remarks.** Kozhantshikov (1950) did not examine the type specimens or conspecific specimens of *Dasorgyia pumila*. However, this has not prevented him to remark on the morphology of the species as follows (p. 245: “This species is unknown to me in life... it is required to note that the structure of the legs of this species was reported [by Staudinger (1881)] inaccurately, and the single pair of spurs that is characteristic of all species of *Gynaephora* Hbn. was not noted”). As a result of this misleading argumentation, Kozhantshikov and subsequent authors (Ferguson 1978; Černí & Spitzer 1981; Spitzer 1984) treated *Dasorgyia pumila* in *Gynaephora*. A detailed study of our material showed that the hindtibia of *pumila* has the two pairs of spurs (Fig. 21) that characterise genus *Dicallomera*, but not *Gynaephora*. Based on our examination of the male genitalia and external appearance of *pumila* I am transferring *Dasorgyia pumila*

Staudinger, 1881 from *Gynaephora* to *Dicallomera*, establishing the new combination *Dicallomera pumila* (Staudinger, 1881) **comb. n.** As a result, *Dasorgyia* Staudinger **syn. n.**, with type species *Dasorgyia pumila* Staudinger, 1881, has to be considered a junior subjective synonym of *Dicallomera* Butler.

The two species, *D. pumila* and *D. fascelina* have many characters in common with, for example, the absence of toothed fasciae and transparent fields on the wings, the pale brown ground colour of the forewing with an admixture of black scales, the labial palpi hairy, short, pointing forward, the large eyes, the presence of tufts of hairs on the first two abdominal segments, the hind tibia with two pairs of spurs, the male genitalia with the valva extended and angulate, the uncus rounded, the gnathos ring-like, the juxta wide and platelike, and the phallus somewhat curved, and the last instar larva with five black and white dorsal hair brushes, with a hair-pencil on the anal segment (Fig. 2a).

*Dicallomera* currently includes the following species: *Dicallomera fascelina* (Linnaeus) with subspecies *D. f. obscura* Zetterstedt, 1840, *D. f. caucasica* Scheljuzhko, 1919, *D. f. karafutonis* Matsumura, 1933, *D. f. moto* Bryk, 1949, *D. f. fischeri* Daniel, 1952, *D. f. salangi* Ebert, 1968, and *D. f. danieli* de Freina, 1979, *D. nivalis* (Staudinger, 1887) with subspecies: *D. n. obscurata* (Staudinger, 1900), *D. angelus* (Tschetverikov, 1904), *D. kaszabi* (Daniel, 1969), *D. kusnezovi* Lukhtanov et Khruliova, 1989, *D. olga* (Oberthür, 1881), and *D. pumila* (Staudinger). The taxa treated as subspecies of *D. fascelina* still need careful revision, preferably using molecular methods because external and genitalia characters are strongly variable (Lukhtanov & Khruliova 1989).

The species of the genus occur in the Palaearctic Region, including the mountains of Central Asia and the Far East.

### *Dicallomera pumila* (Staudinger, 1881) **comb. n.**

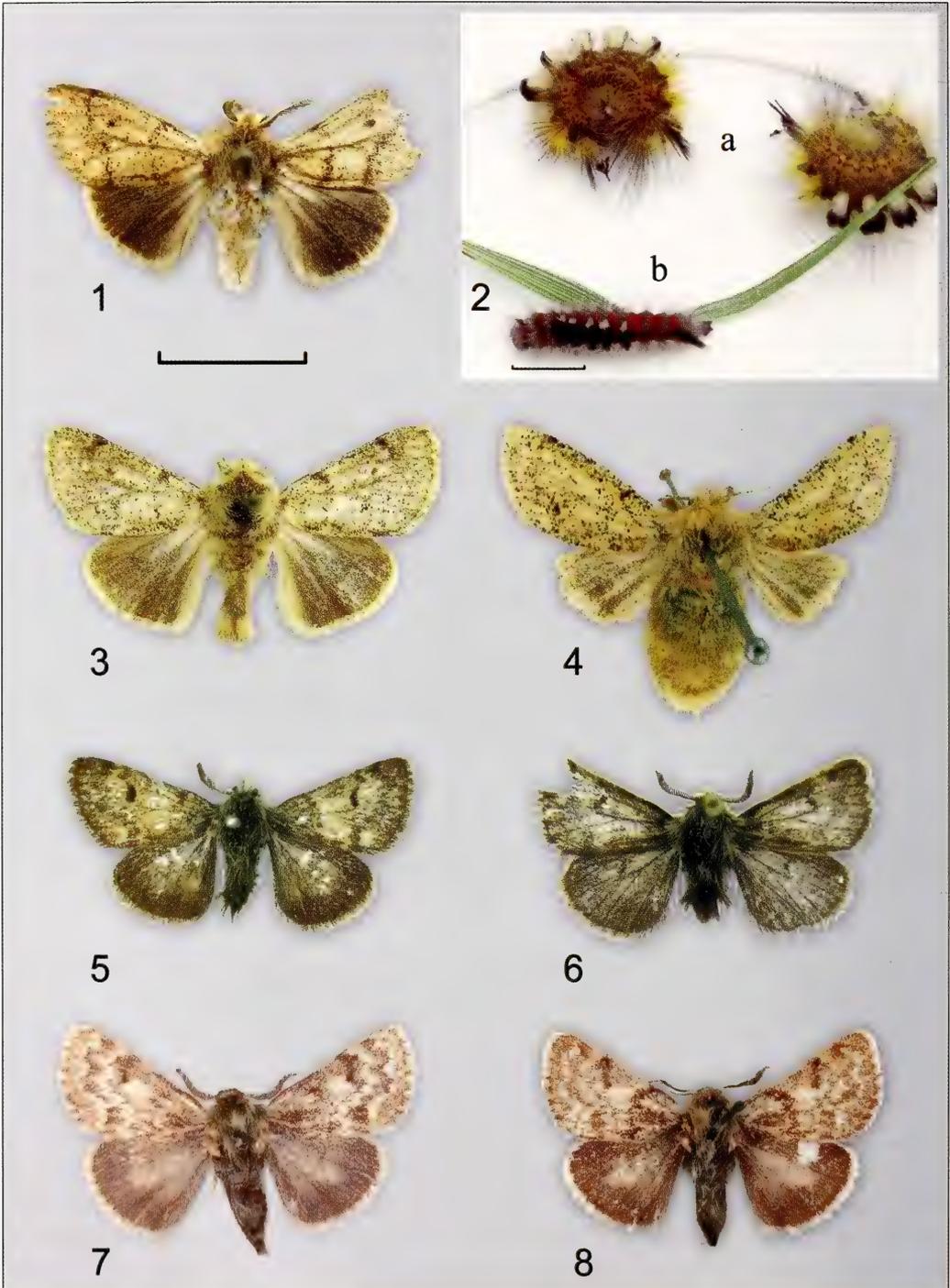
(Figs 1–4, 20–21, 34)

*Dasychira pumila* Staudinger, 1881: 405. Type locality: [Kazakhstan] Saisan.

References: Staudinger 1901: 114; Strand 1910:120; Bryk 1934: 83 (*Dasorgyia*); Kozhantshikov 1950: 244; Ferguson 1978: 17 (*Gynaephora*); Spitzer 1984: 183 (*Gynaephora* (*Dasorgyia*)).

Material. Lectotype (hereby designated): ♂ *Dasychira pumila* Staudinger, 1881 'Origin[al]' <rose rectangle with printed>, 'Zaisan | Hbhr [Haberhauer]' <brown rectangle with inscription by black ink>, '161' <white rectangle with printed>, LECTOTYPUS. | ♂ *Dasychira pumila* Staudinger, 1881 | T. Trofimova design. 2008' <red rectangle with printed>, MHUB. – Paralectotypes: 1♂, 2♀, same data (MHUB). – Additional material. 1♂ Kazakhstan, Akmola Prov., Kokshetau Mts., Terrissakan R., ex larva 23.viii.1958, leg. M. I. Falkovitch (ZISP); 1♂ Russia, Bashkortostan, Southern Urals Mts., Irendyk Ridge, N 52°29', E 58°25', ex larva 2.viii.2003, leg. T. Trofimova (LSSU).

**Redescription** (Figs 1–4). Male. Medium sized lymantriid. Wingspan 26 mm, length of forewing 11 mm. Wings widely triangular. Venation and pattern of fore- and hindwings generally as in *Dicallomera fascelina*. Forewings pale greyish brown irrorated with black scales, fringe pale brown. Basal and medial fasciae of forewing indistinct and consisting of scattered black scales. Discal spot dark, not prominent. Hindwings blackish-brown, lighter in basal part. Fringe yellowish grey. Abdomen coloured as thorax and forewings, brown. Body stout, length 12 mm. Thorax and abdomen with small tufts of scales. Hindtibia with two pairs of spurs. Palps hairy, short, antrorse; eyes large. Antennae bipectinate.



**Figs 1–8.** *Dicallomera* and *Lachana* spp.. **1.** Male of *D. pumila*, Southern Urals Mts. (LSSU). **2a.** Mature larvae of *D. fascelina*. **2b.** Mature larva of *D. pumila*. **3.** Male lectotype of *D. pumila* (MHUB). **4.** Female paralectotype of *D. pumila* (MHUB). **5.** *L. ladakensis*, male, holotype (BMNH). **6.** *L. ladakensis*, Kashmir, Zogi-La-Pass (MWM). **7.** *L. sincera*, male, holotype (ZISP). **8.** *L. sincera*, male, Pamir, Angoudar, Pr-Chorog, 3200 m (ZISP).

**Male genitalia** (Fig. 20). Tegumen narrow. Uncus symmetrical, consisting of lateral processes, rounded, with small depression apically. Gnathos ring-like, wide, apically divided. Valvae simple, ovate-triangular, basally more sclerotised. Juxta flattened, rhomb-shaped. Vinculum narrow. Saccus rounded, weakly developed. Phallus stout, cylindrical, with weak curvature, distally slightly expanded, vesica without cornuti.

**Female** (Fig. 4). Larger than male. Wingspan 27 mm. Brachypterous: forewing 11 mm, 2/3 length of body, slightly narrower than in male, with coloration and pattern as in male, can be questionably used for flying. Hindwing 1/5 smaller and lighter than that of male. Abdomen very robust, colored as forewing. Antenna filiform. Female genitalia not examined.

**Larva** (Fig. 2b). Mature larva reaching 34 mm. Head, legs and prolegs ash grey. Body dark red with dorsolateral ash grey bands. Five well differentiated dorsal hair tufts black with white setae on flanks. Anteriorly, black hair pencils on first thoracic segment very short rudimentary, posterior dorsal black hair pencil on eighth abdominal segment present. Pupal skin not conserved.

**Life history.** Food plants unknown. A mature larva was collected walking on 13 July 2003 on a stem of *Koeleria cristata* (L.) Pers. (Poaceae), on a mountain slope of southern exposition at an altitude of 707 m and with a mozaic of petrophytic dry steppe and mesoxerophytic steppe. The basic vegetable cover present there by: *Stipa zaleskii* Wilensky, *S. capillata* L., *Festuca valesiaca* Gaud., *Helictotrichon desertorum* Nevski., *Calamagrostis epigeos* (L.) Roth., *Phleum phleoides* (L.) Karst. (all Poaceae), *Crinitaria villosa* Grossh., *Artemisia dracunculus* L., *A. austriaca* Jacq., *Centaurea ruthenica* Lam. (all Asteraceae), *Veronica incana* L. (Scrophulariaceae), *Potentilla humifusa* Willd. ex Schlecht., *Filipendula hexapetala* Gilib., *Spiraea hypericifolia* L. (all Rosaceae), *Caragana frutex* (L.) C. Koch (Papilionaceae), *Thymus marshallianus* Willd. (Lamiaceae), *Onosma simplicissima* L. (Boraginaceae), *Gypsophyla altissima* L. (Caryophyllaceae) and others plants. On 14 July 2003 the larva spined a cocoon and on 2 August 2003 a male adult emerged.

**Distribution** (Fig. 34). Central Asia – Zaisan (Eastern Kazakhstan), Kokshetau Mts. (Northern Kazakhstan), Southern Ural Mts., 52°29'N, 58°25'E (Russia). The species could be widely distributed on petrophytic dry steppes of Western Siberia and Kazakhstan, but surprisingly it is not known from similar localities in neighboring regions so far.

**Taxonomic notes.** *Dasorgyia* was described by Staudinger by monotypy. Later on it was considered to be a subgenus within *Gynaephora* and to include three species (*G. selenophora* (Staudinger), *G. sincera* Kozhantshikov, *G. alpherakii* (Grum-Grzhimailo)) with similar ecological peculiarities and occurring in the cryophyte steppe zone of the highlands of Central Asia. Bionomic details are known only for the Tian-Shanic and Pamiro-Alaian species *G. selenophora* (Černi & Spitzer 1981). Our comparative study of external characters and genitalia structures has revealed that these three Central Asian mountain lymantriids do not possess characters that would make them congeneric with *Dicallomera pumila*. They have a different number of spurs on the hindtibia, another type of wing pattern, completely apterous (not brachypterous) females, and differences in the shape of the valva, phallus, and uncus. Thus, all species placed ear-



**Figs 9–19.** *Lachana* spp. **9.** *L. selenophora*, male, lectotype (MHUB). **10.** Female of *L. selenophora*, Kirgizen–Zaailiski Alatau, (MWM). **11.** Male of *L. selenophora*, Kirgizen–Zaailiski Alatau, (MWM). **12.** Male of *L. selenophora*, Kirgizen–Zaailiski Alatau, (MWM). **13.** *L. alpherakii*, male, lectotype (ZISP). **14.** *L. alpherakii*, male, Tibet, (ZFMK). **15.** *Dasychira semenovi*, male, holotype (ZISP). **16.** *Dasorgyia grumi*, male, lectotype (MHUB). **17.** *Trichosoma haublerti*, male, holotype (BMNH). **18.** *Dasorgyia alpherakii* f. *staudingeri*, male, lectotype (MHUB). **19.** *L. kulu* sp. n. male, holotype (ZISP).

lier in *Dasorgyia* are in need of revision. All available material of these species was investigated. As a result of my examination, I found that they all possess a unique combination of external characters and genitalia structures that also makes them non-congeneric with *Gynaephora* s. str., with type species *Gynaephora selenitica* (Esper, 1789). Consequently, I propose to separate this group of lymantriids into another genus. The oldest suitable name to accommodate them is the little-known *Lachana* Moore, 1888, with type species *Lachana ladakensis* Moore, 1888, from the high mountains of Ladak (Northern India, Kashmir) (by monotypy). It is obvious that this species is congeneric with the three species under consideration. Using characters of wing venation and genitalia structure they are moved to genus *Lachana* as follows: *L. selenophora* (Staudinger, 1887) comb. n., *L. sincera* (Kozhantshikov, 1950) comb. n., and *L. alpherakii* (Grum-Grzhimailo, 1891) comb. n. A new species, *Lachana kulu* sp. n. is also described below.

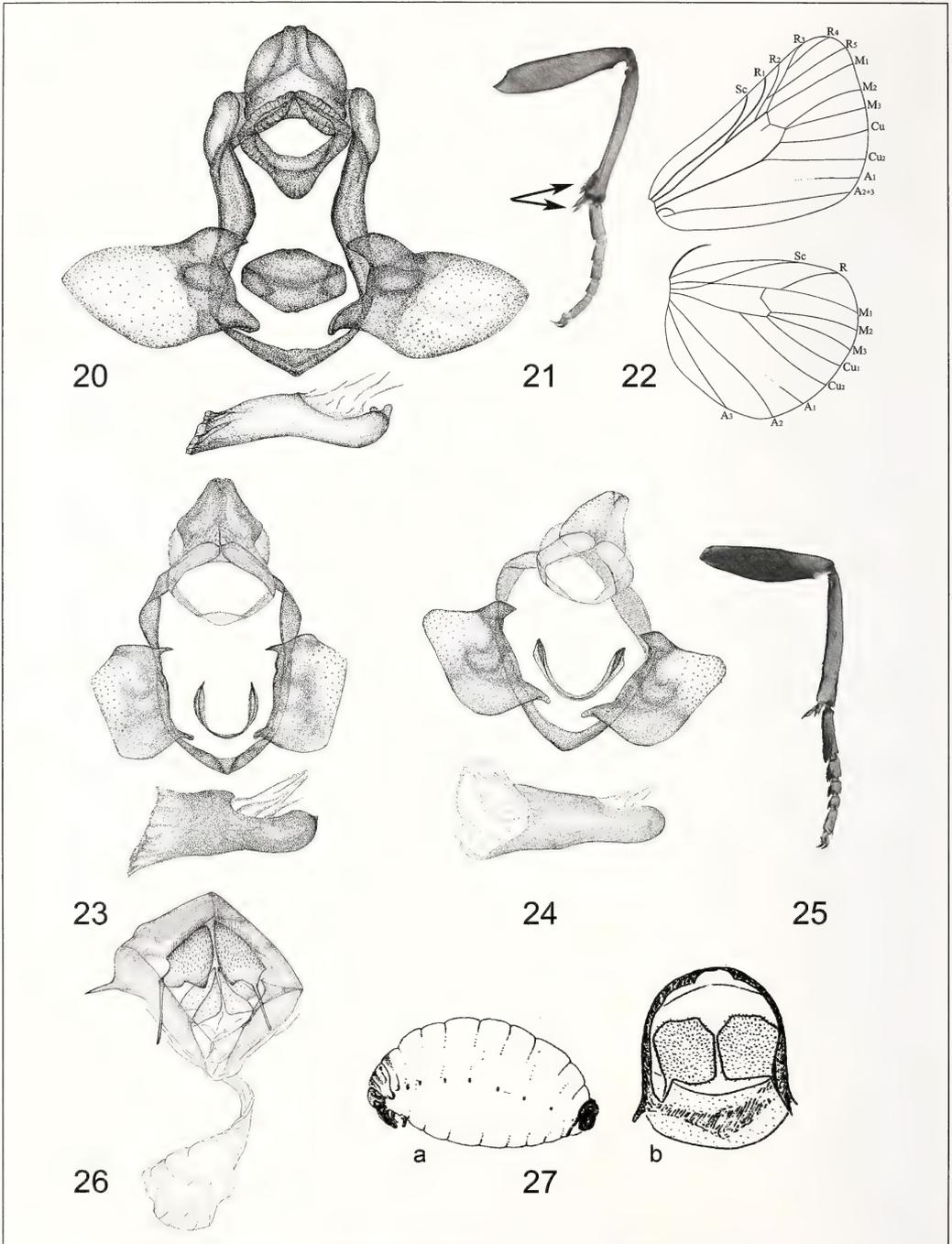
**Remarks.** *Dasorgyia pumila* was described based on a type series of two couples preserved at MHUB. One male is designated here as lectotype in order to clarify the taxonomy of the species. The only two known female specimens of *pumila* are in the MHUB. They were bred ex larvae and Staudinger (1881) supposed that their shorter wings were the result of unsuccessful breeding. In our opinion, these females are slightly brachypterous, but this remains to be proven.

### *Lachana* Moore, 1888

(Figs 5–19, 22–33, 35, 36)

Type species: *Lachana ladakensis* Moore, 1888.

**Description** (Figs 5–19, 22, 33). Little to medium sized lymantriids, wingspan 22–28 mm in males. Body stout. Antennae bipectinate or strongly bipectinate (in males of *alpherakii* and *kulu* sp.n.). Eye rounded, not very large. Labial palpus hairy, short, descending. Proboscis reduced. Head, body, and legs strongly hairy with admixture of scales. Hindtibia with one pair of spurs of different lengths (Fig. 25). Claws with wide base and acute ventral lobe. Fore- and hindwings widely triangular. Venation as in orgyiine ground plan. Forewing with R-cell wide and short; M1 originates from top of discal cell; M2 and M3 originate from top of discal cell; A1 absent. Hindwing venation similar to that of genus *Dicallomera* Butler, 1881. Forewing and hindwing with strongly modified pattern with indistinct or obvious slightly zigzag fasciae and with dark lunular spots on discal vein. Hindwing with dark basal and outer marginal areas and indistinct lunular spots on discal vein. Moths Later on it was considered to be a subgenus within *Gynaephora* and to include three species (*G. selenophora* (Staudinger), *G. sincera* Kozhantshikov, *G. alpherakii* (Grum-Grzhimailo)) with similar ecological peculiarities and occurring in the cryophyte steppe zone of the highlands of Central Asia. strongly dimorphic with apterous females. Female of type species unknown. Description based on females of *L. selenophora* (Fig. 10). Female wingless and similar to some species of genus *Orgyia* Ochs., 1810, which even have no wing rudiments. Head developed, legs rudimental. Antenna short, very slightly pectinate. Body covered with short pale yellow hairs. Male genitalia (Figs 19, 20, 24–29). Uncus triangular, apically pointed, consisting of joined lateral processes, ventrally flexed, uncus separated by seam from tegumen;



**Figs 20–27.** Different features of *Dicallomera* and *Lachana*. **Fig. 20.** Genitalia male of lectotype *Dicallomera pumila*, phallus below. **Fig. 21** Hindtibia of *Dicallomera pumila*. **Fig. 22.** Wing venation of genus *Lachana*; **Fig. 23.** Genitalia of *Lachana ladakensis* male, Kashmir, Zogi-La-Ppass. (MWM), phallus below. **Fig. 24.** Genitalia of lectotype *L. selenophora*, phallus below. **Fig. 25.** Hindtibia of *L. selenophora*. **Fig. 26.** Female genitalia *L. selenophora*, Uzbekistan, Ferghanskaya region, Alai. Mts. (MWM). **Fig. 27a.** Female of *Gynaephora qinghaensis* **b.** Female genitalia *G. qinghaensis* Chou & Ying (both from Chou & Ying 1979).

tegumen and vinculum narrow; gnathos ring-like; valvae squarish and relatively short, without lobes, with strong sclerotization basally and with weak sclerotization in distal part; juxta arcuate, slender; phallus slightly curved, distally expanded, vesica simple without cornuti.

**Female genitalia** (Fig. 26). Papillae anales triangular, with well developed pseudopapillae basally; anterior and posterior apophyses developed, anterior apophyses two times as long as posterior apophyses; antrum and ductus without sclerotization; ductus very slender, somewhat more shorter than corpus bursae; latter flimsy, rounded, without signa.

**Diagnosis.** *Lachana* differs from *Gynaephora* by the following characters: (1) distinctly smaller size, with wingspan up to 28 mm; (2) forewing M1 originating from top of discal cell, with latter rather wide; M2 and M3 originating from top of discal cell, in hindwings M3 with Cu1 originating from top of discal cell, but not on stem as in *Gynaephora*; (3) male juxta arcuate, slender, valva squarish and relatively short; (4) habitat at higher altitudes. Apterous females are known only for *selenophora* and *alpherakii*. However, this character would be an important additional characteristic of the genus if females of the other species are found to be apterous.

**Distribution** (Figs 35, 36). The genus is limited to high mountains (3000 m and above) of Middle Asia (Tian-Shan and Pamiro-Alai) and Central Asia (Tibet, Ladak, the Himalayas).

**Remarks.** The males are day-fliers. The host-plants are little known. The genus includes five species.

### *Lachana ladakensis* Moore, 1888

(Figs 5, 6, 23)

*Lachana ladakensis* Moore, 1888: 398. Type locality: [India] Ladak.

**References:** Strand, 1910:111; Kozhantshikov, 1950: 232.

**Material.** Holotype ♂ *Lachana ladakensis* Moore, 1888, with labels: 'Ladak | 83-26 | 491.', 'Type' (BMNH). – Additional material. 2♂ **India:** Kaschmir, Zogi-La-Pass, 4200 m, 21.vii.1980, leg W. Thomas (MWM); 1♂ **India:** Jammu & Kaschmir, Kaschmir, Fatu-La-Pass, 3700 m, 7.–8.vii.1980, leg W. Thomas (MWM); 1♂ Ladak (ZFMK).

**Redescription** (Figs 5, 6). Male. Wingspan 24 mm. Head, thorax, and abdomen densely pilose, with long silky brown and brownish grey hairs. Legs brown, slightly pilose. Antennae bipectinate. Eyes ovate. Forewings triangular, brown ochreous with dark brown bands; basal area sepia-brown, covered with dark brown scales and outlined by dark band from sepia-brown medial area, expanded dorsally. Brown costal area shaded by dark scales; discal veins covered with dark brown scales forming lunular spot. External band dark brown with angles on M1 and M2+M3; marginal area dark brown. Hindwings widely triangular, dark brown with indistinct dark marginal band, and with lighter medial area; dark scales distinct on discal vein; fringe brownish ochreous.

**Male genitalia** (Fig. 23). Uncus cone-shaped with wide basis; height of uncus as long as valva; gnathos consisting of ribbon, ring-like sclerite divided apically and narrowed distally; valva characteristic: rectangular, two times wider than long, dorso-caudal superior edge and ventro-caudal edge bevelled, caudal edge straight, basal part and interior half more strongly sclerotised, dorso-caudal angle weakly sclerotised, almost

membranous; juxta arcuate, slender; tegumen and vinculum narrow; saccus expressed slightly; phallus rather wide, almost straight, distally expanded.

**Distribution and life history** (Fig. 35). The distribution of this species is limited to Northern India (Kaschmir) in the Ladak mountain range. The life history and immature stages are unknown.

**Remarks.** I did not have the possibility to study the genitalia of the type specimen preserved in the BMNH. Therefore, my description and figure are based on specimens collected at the type locality and kept in MWM.

***Lachana selenophora* (Staudinger, 1887) comb.n. (Figs 9–12, 24–26)**

*Dasychira selenophora* Staudinger, 1887: 96. Type locality: [Uzbekistan], Margelan.

**References:** Grum-Grzhimailo 1890: 556; Kirby 1892: 485 (*Dasychira*); Staudinger 1901: 114; Strand 1910:120; Bryk 1934: 83 (*Dasorgyia*); Kozhantshikov 1948: 151; 1950: 245; Ferguson 1978: 17 (*Gynaephora*); Černý & Spitzer 1982: 41–44; Spitzer 1984: 180–183 (*Gynaephora* (*Dasorgyia*)).

**Material.** Lectotype (here designated) with the following labels: 'selenophora | Stgr.' <white rectangle, hand-written in black ink>, 'Margelan | [18]84 Maur[er]' <brown rectangle, hand-written in black ink >, 'Origin' <rose square, printed> 'LECTOTYPUS | *Dasychira selenophora* | Staudinger, 1887 | T. Trofimova design. 2008' <red rectangle, printed>, MHUB. – Paralectotype: 1♂ same data (MHUB). – Additional material. 1♂ [Kyrgyzstan] Artcha-Bakhi, m[ountain]. Alai sept. 20.vi.1908, leg. A. Avinoff (ZISP); 1♂ b. Chagdir, (ZISP); 1♂ Aleksandrovsky range, Shakshi, 16. vii.1910 (ZISP); 1♂ Alai ridge, nothern slope, Nary-Kazyk, 3600 m, 25.vii.1952, leg. Bundel (ZISP); 1♂ Alai Mont., 1905, Korb [leg.] (ZFMK); 1♂ Artcha-Baschi, 21.vi. [19]08 (ZFMK); USSR, 7♂ 4♀ Kyrgyzstan, mer. occ., Oshskaya region, Alai, Alaiskyi hrebet, Kadamzhai lake, Aksu river, 1000 m, 21.–22.v.1980, Černý (MWM); 2♂ Asia Centralis, USSR Kyrgyzstan, Mt. Tian-Schan, Alaartscha, 3900 m, 7. vii.1981, K.+L. Krusek leg. (MWM); 146♂, 21♀ Kirgizen–Zaailiski Alatau, river Bolshoi Almatinca, Kosmosstanzija, 3200 m, 5.–25.vii.1992, leg.Murzin (MWM); 1♂, 2♀ Kyrgyzstan, Tian-Schan-Geb., Songkol-See, 3200 m, vii. 1995, V. Luchtanov leg. (MWM); 2♂ Kyrgyzstan, Talasskij khrebet, Kara-Buura-Schlucht, 3200 m, 30.vii.1999, leg. O.Novikov (MWM); 1♂, 2♀ Uzbekistan, Ferganskaya region, Alai Mts, 300–3300 m, Aksu valley, Jordon, 22.–24. vi. 1982, Černý leg. (MWM); 1♂ Alai ridge, central southern slope, Kok-Su river, (ZISP); ); 1♂ Mts. Alaensis, centr cl. meridional, Kok-Su pr. fl. Kosh-Tjuss, 3600 m, 6.viii.1964, leg. Bundel (ZISP); 1♂ Mts Alaensis, centr. cl. Meridional, Kok-Su pr. fl. Kosh-Tjuss, 3300 m, 29.vii.1964, leg. Bundel (ZISP); 2♂ Kosh-Dube, 3200 m, 7.viii.1964, leg. Bundel (ZISP); 1♂ Afghanistan, Kot. Parandey, 3500 m, 2.viii.1972, leg. Dr. Reshöft (MWM); 1♀ Afghanistan, Nord-Salang, 2700 m, 26.vi.1976, leg. Dr. Reshöft (MWM).

**Redescription** (Fig. 9). Male. Wingspan 24–28 mm. Externally close to *Lachana ladakensis*, but larger and more greyish. Forewing contrasting pale grey with dark brown bands; basal area grey, covered with dark brown scales restricted by dense dark brown band expanded dorsally; internal area dark, discal cell grey, discal veins covered with dark brown scales forming lunular spot, external band in zigzag and merging with marginal area. Hindwing widely triangular, dark brown with wide, dark marginal band expanding on Cu2 and interlocking with dark discal spot; fringe greyish brown.

**Male genitalia** (Fig. 24). Uncus cone-shaped; gnathos ribbon ring-like; valva characteristically trapezium-shaped, 1.5 times wider than long, dorso-caudal angle tapered, ventro-caudal angle rounded, caudal edge straight oblique, basal part and interior half more strongly sclerotized, dorso-caudal angle weakly sclerotized; juxta arcuate, slender; saccus slightly expressed; phallus rather straight, distally expanded.

**Female** (Figs 10, 26). As discussed in generic account of *Lachana*.

**Remarks.** This is a very variable species (Figs 9, 11, 12) in size – wingspan 24–28 mm in males – and in forewing coloration. Males occur in two forms, one with a dark brown forewing with confluent bands and the second with a yellowish grey forewing with three

distinct dark bands and with a lighter hindwing. The genital structures also vary in the degree of tapering of the dorso-caudal angle of the valva, but proportions are always constant.

*Lachana selenophora* was described from 2 males: "Von dieser neuen Art erhielt zwei anscheinend gezogene ♂ von Herrn Maurer aus Margelan.", now kept in MHUB. One of them is here designated as the lectotype of the species.

**Distribution and life history** (Fig. 35). High mountains from 1000 to 3600 m in Middle Asia (Tian-Shan and Pamiro-Alai, Hindukush).

Černý and Spitzer (1981) described the life cycle of *Lachana selenophora* in the high mountains of Pamiro-Alai and pointed out some bionomic peculiarities: the species inhabits high-mountain ecosystems of the cryophytic steppe zone. Larvae resemble those of Arctiidae – they are black, dark rusty on the thoracic segments with no distinct dorsal brushes or hair-pencils. The males are common day-fliers from the second half of June to early August. Females are wingless and do not leave the cocoon like as in *Orgyia dubia* (Tauscher, 1806). The larva feeds on *Dactylis* (Poaceae).

***Lachana sincera* (Kozhantshikov, 1950) comb. n. (Figs 7, 8, 28)**

*Gynaephora sincera* Kozhantshikov, 1950: 248. Type locality: Tajikistan, Pamir, river Mats.

References: Spitzer 1984: 180–183 (*Gynaephora* (*Dasorgyia*)).

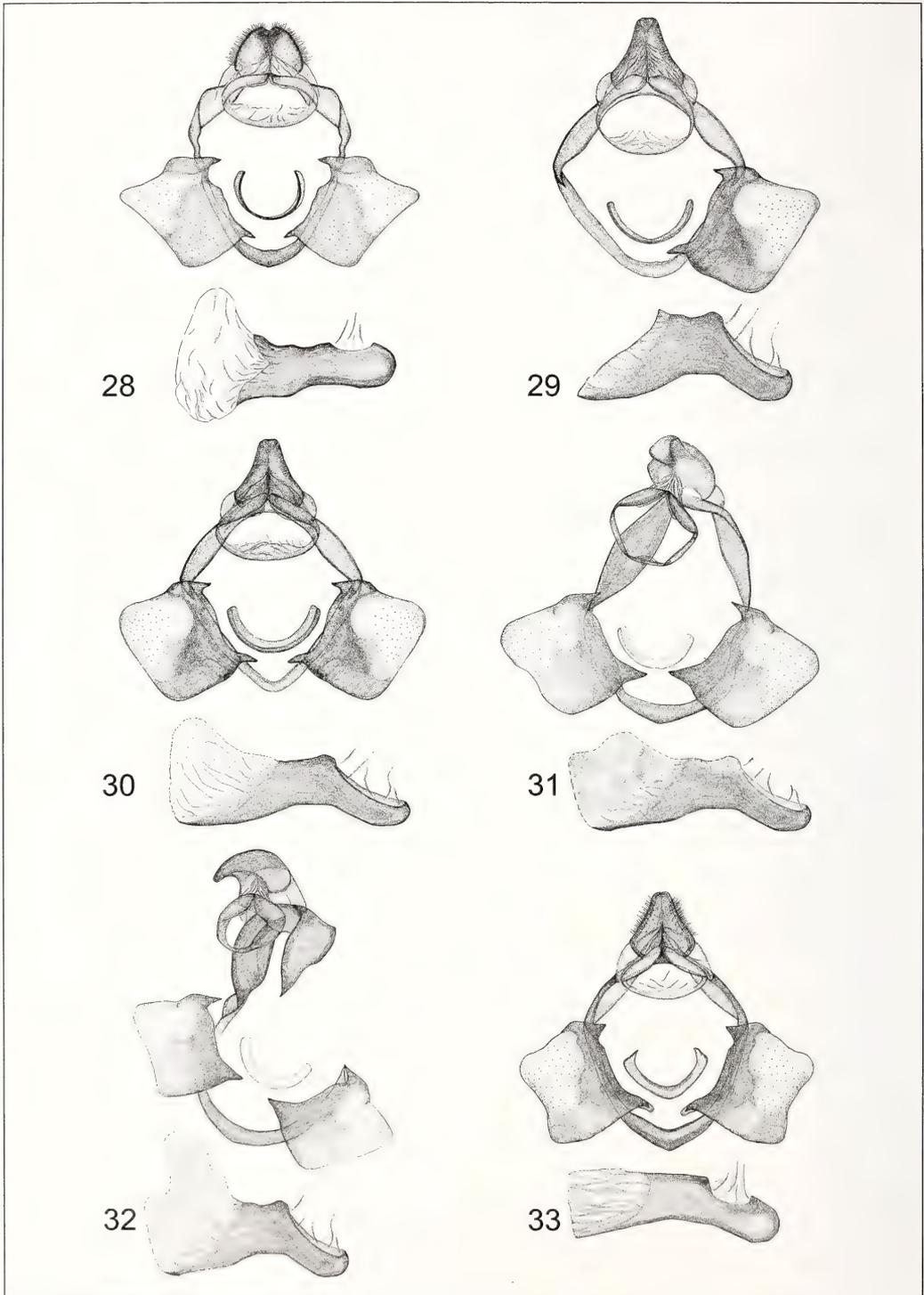
Material. Holotype ♂ with labels: 'p. Маџ [river Mats, Pamir] | 3600 м | 29 vi. 1909. А. Я.', 'coll. O. John', 'Gynaephora typus | sincera | Kozh.' (ZISP); – Additional material. 2♂ [Tajikistan] Pamir, Angoudar, Pr-Chorog, 3200 m, 19. vii.1961, Bundel leg. (ZISP).

**Redescription** (Figs 7, 8). Male. Wingspan 24 mm. Head, thorax, and abdomen densely pilose: long silky brown hairs with admixture of pale greyish and red hairs. Pattern of wings similar to that of *L. ladakensis* and *L. selenophora* but differing in showing clear zigzag bands. Forewing mostly light beige, in basal area brown, mixed with whitish-grey scales, internal brown band narrowly zigzag, outer brown bands zigzag in lower half curved by angle to internal bands, medial area beige but lighter on discal cell, discal spot formed by brown scales on discal veins and reaching costal edge of wing, marginal area pale brown. Hindwing dark brown with indistinct dark marginal band and slightly lighter medial area, discal veins weakly outlined by dark scales; fringe pale greyish with dark spots.

**Male genitalia** (Fig. 28). Uncus rounded, triangular, smaller than in previous species and following; gnathos ribbon, ring-like and rather narrow; valva trapezium-shaped, two times wider than long, dorso-caudal angle distinctly tapered, ventro-caudal angle almost right, rounded, caudal edge cut off obliquely, valva sclerotized as in *selenophora*; juxta arcuate, very slender; saccus expressed; phallus robust, rather straight, distally expanded.

**Female**. Unknown.

**Distribution and life history** (Fig. 35). This species is found in the high mountains of Middle Asia (Pamir). The life history and immature stages are unknown.



**Figs 28–33.** Male genitalia of *Dicallomera* and *Lachana* types (phallus below). **28.** *L. sincera*. **29.** *L. alpherakii*. **30.** *Dasychira semenovi*. **31.** *Dasorgyia grumi* (juxta destroyed). **32.** *Dasorgyia alpherakii* f. *staudingeri* (juxta destroyed). **33.** *Lachana kulu* sp. n.

***Lachana alpherakii* (Grum-Grzhimailo, 1891) comb. n. (Figs 13–18, 27, 29–32, 36)**

*Dasychira alpherakii* Grum-Grzhimailo, 1891 25: 464. Type locality: [Qinghai, China], Sinin-Schan.

= *Dasychira semenovi* Grum-Grzhimailo, 1891: 464. Type locality: [China], Sinin-Schan.

= *Dasorgyia grumi* Staudinger, 1901: 115. Type locality: [China], Kuku-Noor.

= *Trichosona haulberti* Oberthür, 1911: 337. Type locality: [China], Ta-tsién-Lou.

= *Dasorgyia alpherakii* f. *staudingeri* Bang-Haas, 1938: 179. Type locality: [China], Kan-Tschou, Naschi Pass.

References: Kirby, 1892: 485; Staudinger 1901: 114 (*Dasorgyia*); Strand 1910: 120; Bryk, 1934: 83; Bang-Haas 1938: 179; Kozhantshikov 1950: 246 (*Gynaephora*); Ferguson 1978: 17; Chou Io & Ying Chiang-Chu 1979: 23; Zhao Xhongling 2003: 134; Spitzer 1984: 180–183 (*Gynaephora* (*Dasorgyia*)).

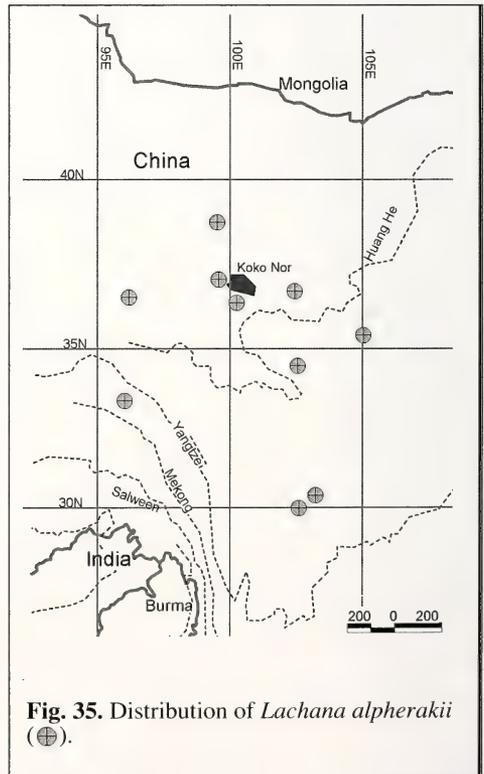
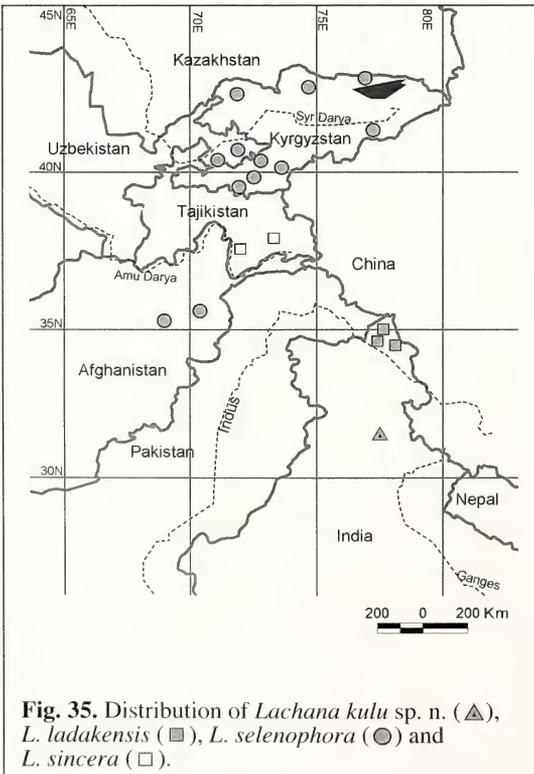
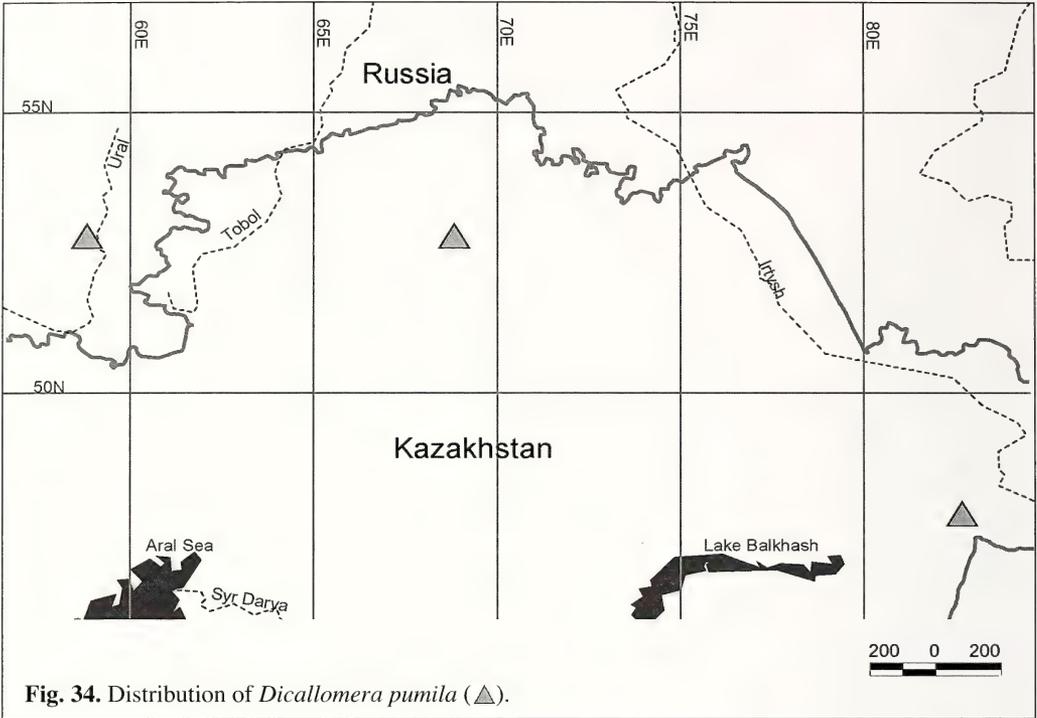
Material. Lectotype (here designated) with the following labels: 'Das. alpherakii ♂ Gr.-Gr.' <white rectangle, hand-written in black ink>, 'Sinin. alp.' <white rectangle, hand-written in black ink>, 'alpherakii' <white rectangle, hand-written in black pencil>, 'Кол. б. Вел. Кн. I Николая Михайловича' [collection of Grand Duke Nikolay Mikhailovich] <white rectangle, printed> 'Origin' <blue rectangle, printed>, 'LECTOTYPUS / *Dasychira* / *alpherakii* / Grum-Grzhimailo, 1891 / T. Trofimova design. 2008' <red rectangle, printed>, ZISP – Paralectotype: ♂ with label 'Kuku-Noor' (ZISP). – Additional material. 1♂ China, Qinghai, Ouest Qinghai Nan-Shan, Road Caka Tianjun, km 338–339, 4000–4300 m, 16.–19.vii.1993, J. Verhulst leg. (MWM); 1♂ Kukunor Geb., Burchan Buddha Nomohun Pass, 4000 m, July (MWM); 2♂ Kansu sept. occ., Kan-tschou, Richthofen. mont. sept. Naschi Pass, 3000 m, July (MWM); 3♂ with same data, but in ZFMK; 15♂ 37) Auf Wiesen im Buschland bei Jecundo. 97 ö 33nß, 4300 m (Tibet), 11.viii.1935 H. Höne (ZFMK); 1♂ Weynanpou, Sining Gebit, Kansu sept, 4000 m, Mitte July (ZFMK); 1♂ Kuku-Noor (ZFMK); 1♂ Kansu occ., Langow (ZFMK); 1♂ Kansu sept. Kanchow (ZFMK); 1♂ Kansu sept., Liangchow (ZFMK); 2♂ Kukunor Geb. (ZFMK), 1♂ «Pamir» [locality questionable] (ZFMK).

**Redescription** (Figs 13–18). Male. Wingspan 27 mm. Head, thorax, and abdomen covered with long silky hairs, mostly intense dark brown with yellowish. Legs dark brown, pilose, with rather long hairs. Antenna bipectinate with long setose branches twice as long as those of previous species. Wings of type specimens yellow with dark brown bands; basal area of forewing yellow lightly mixed with brown scales, internal bands dark brown, indistinct, medial area brown with large yellow spot in discal cell and distinct second yellow spot under discal cell, discal veins covered with dark brown scales as lunular spot, costa dark brown with scattered yellow scales, outer band zigzag on M1 and M3, curved by angle to internal band; submarginal band merged with marginal area. Hindwing yellow with dark brown marginal band, latter either narrow with clear border or broad; some specimens with completely dark hindwing; fringe yellow with dark scales.

**Male genitalia** (Fig. 29). Uncus cone-shaped, slender, uncinata, as long as valva; gnathos ring-like, narrow in lower part; valva with diagnostic shape: squarish with caudal right angle, 1.2 times broader than long; juxta arcuate, slightly wider than that of previous species; tegumen almost twice as wide as vinculum; saccus not expressed; phallus robust, down-turned, distally with deeply bevelled edge.

**Female** (Fig. 27 a, b). I did not examine the female of *Lachana alpherakii* because there are none in the collections investigated. However, the wingless female of *L. alpherakii* has been illustrated in "Fauna Sinica" (Zhao 2003) externally resembling the female of *L. selenophora*. In addition, the female genitalia have been illustrated by Chou & Ying (1979) under the name *Gynaephora qinghaensis* Chou & Ying, 1979, which, based on the original description and illustrations, is probably a junior synonym of *L. alpherakii*.

**Distribution and life history** (Fig. 36). High mountains (recorded from 3000 to 4500 m) of Central Asia (Tibet, China). The host-plant recorded by Zheng et al. (2004) was *Elaeagnus angustifolia* L. (Elaeagnaceae).



**Remarks.** *Lachana alpherakii* is a very variable species (Figs 13–18, 29–32) with a wingspan of 22–27 mm. Males occur in several forms as shown by the many described synonyms (see below).

New species of the complex under consideration were described from China by Chou & Ying (1979) as: *Gynaephora qinghaensis*, *G. aureata*, *G. ruoergensis*, and *G. minora*. These species are similar to *L. alpherakii* as noted in original descriptions and they were described from localities inhabited by *alpherakii*. The keys to define these species is based on the comparative sizes and shapes of the valvae and phallus, which are figured by Chou & Ying (1979). However, these species have the very characteristic shape of the phallus typical for *L. alpherakii*. The figured shape of the valva is unclear because the basal part is shown schematically. Nevertheless, it resembles that of *L. alpherakii* for which the valva is rather irregular in shape. Unfortunately, it was impossible to study the type materials of Chou & Ying in spite of special requests. These types are probably deposited in the Institute of Biology of Xining, Qinghai (China). Surprisingly these little known taxa from Tibet are not included in “Fauna Sinica” (Zhao 2003) while *alpherakii* is included. The short and schematic English diagnoses and strong phenotypic variability of *L. alpherakii* cannot allow us to discuss the taxonomic status of this Chinese material further.

#### *Dasychira semenovi* Grum-Grzhimailo, 1891

(Figs 15, 30)

**Material.** Holotype ♂ with labels: ‘Sinin. alp.’ <white rectangle, hand-written in black ink>, ‘Orig.’ <blue rectangle, printed>, ‘Кол. б. Вел. Кн. | Николая Михайловича’ [collection of Grand Duke Nikolay Mikhailovich] <white rectangle, printed>, ZISP.

**Remarks.** Holotype with wingspan of 28 mm; forewing dark, less yellow than in the type of *alpherakii*; hindwing dark brown, fringe yellow. The species name was treated by Bang-Haas (1938) as a colour form of *alpherakii*. Later, Kozhantshikov (1950) synonymized this name with *Gynaephora alpherakii*.

#### *Dasorgyia grumi* Staudinger, 1901

(Figs 16, 31)

**Material.** Lectotype (hereby designated): ♂ with the following labels: ‘Das. Selenophora Stgr. | ♂, 1894 | det. Thebel’ <white rectangle, hand-written in black ink>, ‘Alpherakii v.? | grumi Stgr.’ <white square, hand-written in black ink>, ‘Kuku-noor, | [18]94, Rückb[eil]’ <brown rectangle, hand-written in black ink>, ‘Origin’ <rose square, printed>, ‘Photo done by | A. Schintlmeister | # 2741’ <yellow rectangle, printed>, ‘LECTOTYPUS. | *Dasorgyia grumi* | Staudinger, 1901 | T. Trofimova design. 2008’ <red rectangle, printed>, MHUB. – Paralectotypes: 2♂ with same data (MHUB).

**Remarks.** The wing pattern is as in *semenovi*. The male genitalia (Fig. 31) of the lectotype are in Euparal. The species name was treated by Bang-Haas (1938) as a colour form (*alpherakii* f. *grumi* Staudinger, 1901). Kozhantshikov (1950) synonymized the name with *Gynaephora alpherakii*.

#### *Trichosoma haulberti* Oberthür, 1911

(Fig. 17)

**Material.** Holotype ♂ with labels: ‘Type’ <white oval with red frame, printed>, ‘*Trichosoma | haulberti* ♂ | Obthr.’ <white rectangle, hand-written in black ink>, ‘Frontière orientale | du Thibet | Chasseurs indigenes | du P. Néjean, | 1905’ <white rectangle, printed>, ‘Ex Oberthür Coll. | Brit. Mus. 1927-3’ <white rectangle, printed> (BMNH).

**Remarks.** The male genitalia have not been examined. Oberthür (1911) introduced this name without any description, only the type locality and a good illustration of a male, which makes the description valid. On the basis of this illustration *haulberti* Oberthür was synonymized by Kozhantshikov (1950) with *L. alpherakii*.

***Dasorgyia alpherakii* f. *staudingeri* Bang-Haas, 1938****(Figs 18, 32)**

**Material.** Lectotype (here designated) ♂ *Dasorgyia alpherakii* f. *staudingeri* O. Bang-Haas, 1938, with labels: 'Kansu sept.occ. | Kan-tschou, | Richthofen. mont.sept. | Naschi Pass, | 3000 m, July' <white rectangle, printed>, '*Dasorgyia* | *alpherakii* | f. *staudingeri* | Type OBH' <white rectangle, hand-written in black ink>, 'Type | O.B.-Haas' <red rectangle, printed>, '*Dasorgyia alpherakii* f. *staudingeri* ♂ | O. Bang-Haas' <white slip of paper, printed> 'LECTOTYPUS. '*Dasorgyia* | *alpherakii* f. *staudingeri* | Bang-Haas, 1938 | T. Trofimova design. 2008' (MHUB). – Paralectotypes: 5♂ with the same data but marked by Bang-Haas with labels 'Cotype' (MTD) and 1♂ with the same data (ZFMK).

**Remarks.** The male genitalia of the lectotype are in Euparal (Fig. 32). This taxon was described as the dark colour form of *alpherakii*. Kozhantshikov (1950) synonymized it with *Gynaephora alpherakii*. The type specimens are relatively small (wingspan: 22 mm) and are characterized by the dark colour of the forewings and a reduction of the bands to indistinct spots from lightly yellow scales (Fig. 18). The hindwing is mostly dark and the fringe dark yellowish. This form is known from the type series only. Details of the genitalia structure do not differ significantly from those of *L. alpherakii*. Probably this is a good subspecies, but the lack of additional material does not allow to confirm this with certainty.

***Lachana kulu* sp. n.****(Figs 19, 33)**

**Material.** Holotype ♂: 'Kulu [Kullu Valley] | Elwes' <white square with black frame, hand-written in black ink>, 'HOLOTYPUS' | '*Lachana kulu* sp.n. ♂.' | det. T. Trofimova' <red rectangle, printed> (ZISP). 'PARATYPUS' | '*Lachana kulu*, Trofimova ♂' | T. Trofimova det. 2008' <red rectangle, printed>, ZISP. – Paratype ♂, same data (ZISP).

**Description** (Fig. 19). Male. Wingspan 25 mm. Head, thorax, abdomen, and legs covered with long silky brown and grey hairs. Antennae bipectinate with long setose branches as in *Lachana alpherakii*. Labial palpus hairy, short, descending. Eyes ovate. Forewing triangular, with grey ground colour, without bands, scales needle-shaped with toothed edge, raised, veins well visible, with indistinct groups of white scales between discal cell and costal edge, outer half of cell, and under cell also, with dark grey scales on discal veins. Hindwing widely triangular, marginal half grey, round discal spot with white scales; fringe lightly coloured and consisting of white and grey scales.

**Male genitalia** (Fig. 33). Uncus cone-shaped, slender, narrow apically; gnathos ring-like, narrowed distally; valva almost squarish, 1.5 times wider than long, ventro-caudal angle expressed, ventral edge longer than dorsal, caudal edge depressed; juxta widely V-shaped, ribbon-like; saccus rather expressed; phallus robust, rather straight, with apex oblique; vesica without cornuti.

**Female.** Unknown.

**Distribution and life history** (Fig. 35). Kullu Valley of Southern Himalayas, Himachal Pradesh, India. Nothing is known about the life history and immature stages.

**Diagnosis.** The new species is closely related to *L. alpherakii*, externally somewhat resembling its form *staudingeri* B.-H. in wing pattern. It clearly differs from other species of the genus by the following characters: grey color of wings with light fringe; valva with depressed caudal edge and expressed ventro-caudal angle.

**Etymology.** The species name is derived from that of the type locality.

**Remarks.** The species was collected by the famous traveller and naturalist Henry John Elwes, probably during his journey to India and Nepal in 1913.

**Tab. 1.** Differential characters of *Dicallomera*, *Gynaephora*, and *Lachana*.

Characters	<i>Lachana</i>	<i>Gynaephora</i>	<i>Dicallomera</i>
<b>External features</b>			
Venation hindwings	Sc and R joined, M3 and Cu1 originating from top of discal cell.	Sc and R joined, M3 and Cu1 on stalk at 1/4 of M3+Cu1 (Kozhantshikov 1948, 1950; Tschistjakov 2003).	Sc and R joined or anastomosed, M3+Cu1 on short stalk or long stalk (at 1/2 of M3+Cu1 as in <i>pumila</i> ).
Hindtibia	with one pairs of spurs	with one pairs of spurs (Kozhantshikov 1948, 1950; Ferguson 1978)	with two pairs of spurs (Tschistjakov 2003)
<b>Male genitalia</b>			
Uncus	triangular or cone-shaped, apically pointed, ventrally flexed.	short, almost triangular, rather inflated at base with medial depression dorsally (Kozhantshikov 1948, 1950; Ferguson 1978; Tschistjakov 2003)	wide, rounded, with small depression apically (Bacallado et al. 1981; Tschistjakov 2003)
Valva	squarish and short, as wide or wider than long	short and broad (Kozhantshikov 1948, 1950; Ferguson 1978; Tschistjakov 2003)	extending angulate (Bacallado et al. 1981; Lukhtanov et al. 1989; Tschistjakov 2003)
Juxta	arcuate, slender	platelike (Kozhantshikov 1948, 1950; Ferguson 1978)	large and platelike (Bacallado et al. 1981; Tschistjakov 2003)
Phallus	robust	slender, almost straight (Kozhantshikov 1948, 1950; Ferguson 1978; Tschistjakov 2003)	stout and curved (Bacallado et al. 1981; Tschistjakov 2003)
<b>Larva</b>			
Larva	Arctiid-like – on thoracic segments with no distinct dorsal brushes and hair-pencils (Černý & Spitzer 1981; Spitzer 1984) (known for <i>alpherakii</i> and <i>selenophora</i> only)	with five dorsal hair brushes with hair-pencil on anal segments (Kozhantshikov 1948, 1950; Ferguson 1978)	with same characters as <i>Gynaephora selenitica</i> (Esper, 1789) (Ferguson 1978)
<b>Female</b>			
Sexual dimorphism	female wingless (known for <i>alpherakii</i> and <i>selenophora</i> only)	females with fully developed wings (Ferguson 1978)	females with narrower wings or brachypterous (Tschistjakov 2003)

## Discussion

*Dicallomera*, *Gynaephora*, and *Lachana* form a close group of genera characterized by the following similarities in the adult: forewing venation, stout body, uncus symmetrical and consisting of fused lateral processes, ring-like gnathos, simple valva without processes and lobes, and phallus without cornuti. *Lachana* differs from the related genera more clearly as discussed above. *Dicallomera* is characterized by the relatively uniform genital structures. In Table 1 I suggest some morphological characters to distinguish these three genera. The characters of *Lachana* are given in conformity with the diagnosis provided above. The characters of *Gynaephora* and *Dicallomera* are from authors who discussed these genera and their diagnoses are based on the type species: *Gynaephora selenitica* and *Dicallomera fascelina*. For *Dicallomera* I also include some additional remarks based on my examination of the type specimens of *Dicallomera angelus*, *D. kusnezovi*, and *D. pumila*. Some specimens of other members of *Dicallomera* were also examined. Note that all characters mentioned in the table will have to be confirmed or revised because no type specimens have been examined for *Gynaephora* and *Dicallomera*.

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## Is *Euchloe falloui* Allard, 1867 (Pieridae) the butterfly with the longest diapause?

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**Abstract.** This paper presents the longest known incidence of pupal diapause in butterflies. *Euchloe falloui* Allard (Pieridae) from the Negev desert in Israel, is reported to remain up to fifteen years in the pupal stage. Other new observations on extended pupal diapause in desert butterflies are communicated for comparison.

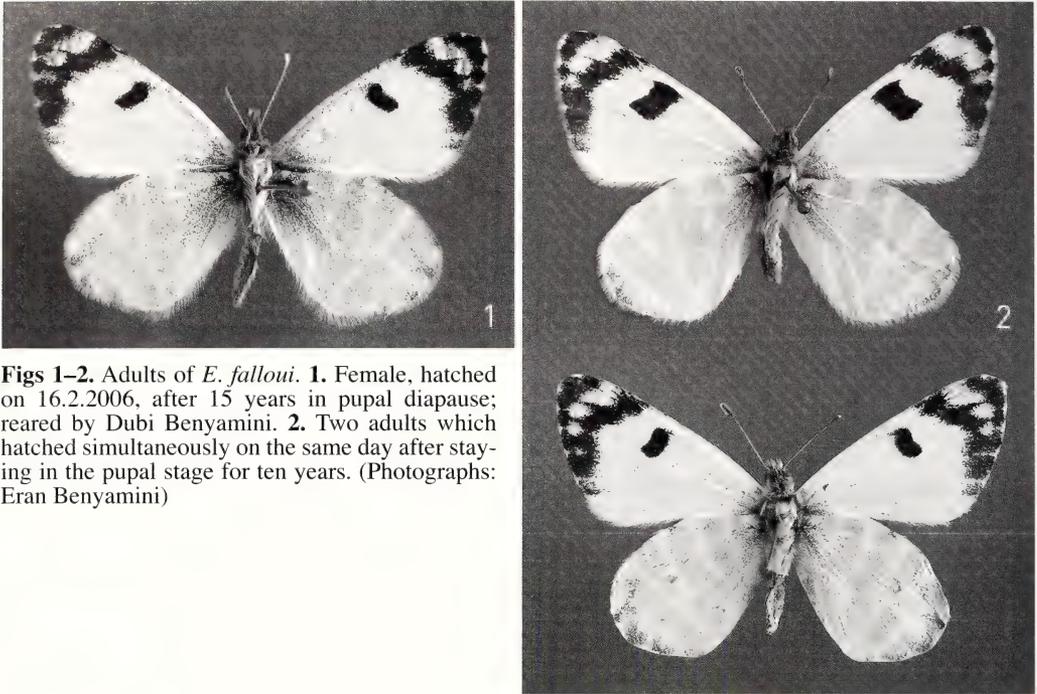
### Long term pupal diapause of *Euchloe falloui*

*Euchloe falloui* Allard, 1867 is a typical spring desert pierid flying in one to three annual broods pending local availability of its Brassicaceae host-plants. It is distributed across the Sahara from Morocco to the Sinai Peninsula, NW Arabian Peninsula, South Israel and South Jordan (Tennent 1996; Larsen 1990; Pittaway 1985; Benyamini 2002).

In spring 1983 I bred a field collected larva from East Sinai. This last instar larva was feeding on a large *Schouwia thebaica* Webb. (a desert annual Brassicaceae plant). In 1991 when this live pupa had still not hatched I decided to move to a larger scale experiment. A caged fertile female from the Negev desert laid tens of eggs on *Moricandia nitens* (Viv.) Dur. et Barr. (a desert perennial Brassicaceae). Subsequently, sixty pupae started the run for this “world championship”. After ten years only seven pupae (11%) survived; two hatched simultaneously on the same day after about 3650 days in diapause, two were deep-frozen for further analysis, two hatched after thirteen years and the last one, a female, which pupated on 01.v.1991, hatched successfully on 16.ii.2006, i.e. nearly fifteen years after entering diapause. No artificial wetting was used to expedite the eclosion. This single specimen survived some 5430 days in the pupal stage relying on its own internal energy sources for survival throughout this extended period. *Euchloe falloui* generally diapause, but the length of long term diapause varies from one to fifteen years.

### Other pupal diapause “champions” in arid habitats

In permanent desert butterfly species in Israel, pupal diapause is a common strategy in Papilionidae, Pieridae, and Lycaenidae, because without rain there are no or minimal host-plants available and the long term diapause is a clear survival must. The results of my rearing experienced with Middle East butterflies place the Pieridae in first place: after *Euchloe falloui* (15 years) come *E. crameri aegyptiaca* Verity (9 years), *E. belemia* Esper (7 years), *Elphinstonia charlonia* Donzel and *Zegris eupheme uarda* Hemming (5 years each), *Euchloe ausonia* Hübner (3 years), and *Anthocharis cardamines phoenissa* von Kalchberg (2 years – a single record of Christodoulos Makris from Lemesos, Cyprus). Papilionidae comes next with records of up to five years: *Papilio saharae*



**Figs 1–2.** Adults of *E. falloui*. **1.** Female, hatched on 16.2.2006, after 15 years in pupal diapause; reared by Dubi Benyamini. **2.** Two adults which hatched simultaneously on the same day after staying in the pupal stage for ten years. (Photographs: Eran Benyamini)

Oberthür (5 years), *P. alexanor* Esper (4 years – Nakamura & Ae (1977) reported three years only), *Archon apollinus* Herbst (2 or even 3 years), and *P. machaon syriacus* Verity (2 years - only in the Negev Mts.). The following Lycaenids are reported here for the first time to have long term pupal diapause: *Pseudophilotes abencerragus nabataeus* Graves (4 years), *Iolana alfierii* Wiltshire (3 years), *Tomares nesimachus* Oberthür (3 years), and *Pseudophilotes jordanicus* Benyamini (one live pupa retained since June 2006 is now entering its third year of diapause).

A similar situation exists in North America where a pierid species has the longest known diapause: *Anthocharis cethura pima* Edwards emerged after nine years (Todd Staut, pers. comm.) while *Papilio zelicaon* Lucas and *Papilio coloro* Wright (*P. polyxenes coloro*) are known to diapause for up to six years (Art Shapiro, pers. comm.; Powell 1987). In Chile I found a two-year diapause in *Battus polydamas archidamas* Boisduval (Papilionidae) which possibly suggests that an as yet unknown local desert pierid there has developed longer pupal diapause. *Hypsochila wagenknechti sulphurodice* Ureta an Atacama Desert species or *Tatochila mercedis macrodice* Staudinger a Tarapaca (Northern Chile) species are possible candidates. There is no question that many other Asian and African desert species will be found to have similar behaviour.

## Discussion

Long term pupal diapause is documented at least since the end of the nineteenth century (Dyar 1891; Riley 1892) but has started to receive scientific attention since the early

1970's. While the Yucca Moth (*Prodoxus inversus*, Prodoxidae) was well documented to have up to 30 years diapause in the pupal stage (Powell 1987, 1989, 2001) thus far no species of butterfly came even close to it. To add to the results mentioned above I plan to publish my findings in detail (Benyamini & Benyamini, unpubl.) in trying to link the expected length of diapause with internal (physiological) and external (climatic) conditions. Preliminary conclusions suggest that two main factors dictate the solution: 1) Planned/ programmed risk sharing function, 2) Opportunistic function. Each one is using internal sensors and accumulated “knowledge” or software as we call it nowadays.

### Acknowledgements

I would like to express my gratitude to Mr Todd Stout of Salt Lake City, Utah, USA and Christodoulos Makris, Lemesos, Cyprus for sharing their long term diapause data. Prof. A. M. Shapiro of UC Davis advised on North American Papilionidae long term diapause. Avishai Benyamini assisted with developing the long term diapause hatching function. Eran Benyamini photographed *Euchloe falloui* world champions. Mr Issy Shaked, Herzelia, Israel kept the cage of long term diapausing pupae while I lived for three years in Chile (1992–1995). Mr Eddie John edited the manuscript to this final shape. My friend and colleague of Middle East butterfly research Dr Torben Larsen who invented a new verb/noun “to dubi” or “doing a dubi”, meaning to stay in diapause in pupal stage for many years (Larsen 2008); i.e. *E. falloui* is known to dubi ... possibly better than to anybody else in the world.

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***Dichrorampha typhlodes* (Meyrick, 1931), syn. n.  
of *Dichrorampha acuminatana* (Lienig & Zeller, 1846)  
(Tortricidae)**

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**Abstract.** *Dichrorampha typhlodes* (Meyrick, 1931) is recognized as a junior synonym of *D. acuminatana* ([Lienig] & Zeller, 1846) on the basis of the external morphology and the genitalia of the lectotype.

### Introduction

About 80 years ago Meyrick (1931) described a new species of *Hemimene* Hübner, 1825 (= *Dichrorampha* Guenée, 1845) based on material collected by Dr Iwan Buresch from Bulgaria three years previously. He named the species *H. typhlodes* and in his opinion it was “near *plumbagana* and *cinerosana*”. The original description of the species is based on the external morphology of two male specimens (syntypes) recorded as “Bulgaria, Euxinograd, near Varna, May (Dr. Buresch); 2 ex. (Coll. King Boris of Bulgaria).” (Meyrick 1931: 143). I was able to find one of these in the collection of the National Natural History Museum in Sofia, Bulgaria. Although Meyrick did not mention any specimen as holotype, the specimen in the Museum collection was mistakenly labelled as “Holotype”. Unfortunately, the second specimen was not found in the collection of the Museum in Sofia, nor in the depot of the Institute of Zoology (Bulgarian Academy of Sciences). Another possible location for the second syntype is the Natural History Museum, London as Meyrick’s collection is preserved in London, but the specimen was not found there. According to Mr K. Tuck (Natural History Museum, London, pers. comm.) Meyrick would often (but not always) annotate his lists with a “+” to indicate specimens he had retained for his own collection. In the ledgers none of the specimens received from King Boris has such a symbol. Most likely the syntypes were sent to Meyrick for identification and then sent back to King Boris. The location of the second syntype remains unknown.

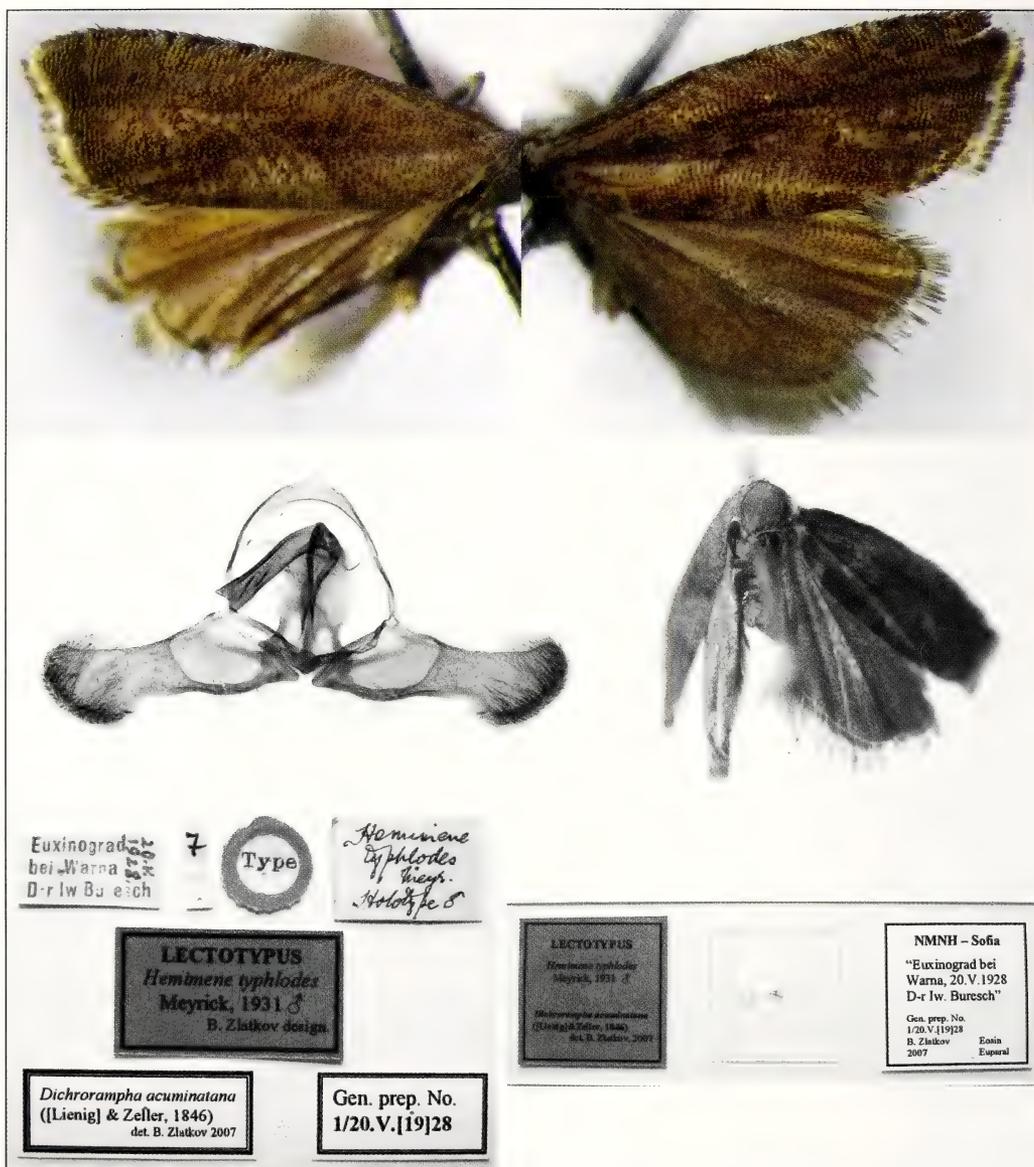
Prior to this study the genitalia of *D. typhlodes* were unknown (Danilevsky & Kuznetzov 1968; Razowski 2003) and its taxonomic status was unclear.

After careful examination of the external morphology and the genitalia of the Sofia Museum specimen I established that *D. typhlodes* (Meyrick, 1931), syn. n., is a junior subjective synonym of *D. acuminatana* (Lienig & Zeller, 1846). And I designate this specimen as lectotype.

### The lectotype

(Figs 1–5)

The lectotype belongs to a form with reduced colouration (Fig. 1). The dorsal patch of the forewing is indistinct and the subterminal black dots are reduced (two very weak



Figs 1–5. Lectotype of *Dichrorampha typhlodes* (Meyrick, 1931). 1. Wings. 2. Genitalia. 3. General view. 4. Labels. 5. Genitalia slide.

on the left wing and none on the right wing). Probably this is the reason why Meyrick could not recognize the specimen as *acuminatana*.

The specimen is not spread (Fig. 3). The wingspan is about 13 mm. The head is missing. When the genitalia (Fig. 2) were dissected the whole abdomen was removed. Its proximal part was glued back to the thorax with gum arabic, while the remaining part was embedded in Euparal together with the genitalia. The genitalia were stained in an alcoholic solution of Eosin.

The lectotype has seven labels (Fig. 4): ‘Euxinograd | bei Warna | D-r Iw Bu[r]esch | 20.V. | 1928’ [number and date sideways], ‘7’, ‘Type’ [round label with red border], ‘Hemimene | typhlodes | Meyr. | Holotype ♂’ [and on the back of the label:] ‘Labelled | by | W. H. T. Tams’, ‘LECTOTYPUS | *Hemimene typhlodes* | Meyrick, 1931 ♂ | B. Zlatkov design.’ [red label], ‘*Dichrorampha acuminatana* | ([Lienig] & Zeller, 1846) | det. B. Zlatkov 2007’, ‘Gen. prep. No. | 1/20.V.[19]28’.

The genitalia slide (Fig. 5) contains the dissected segments and the genitalia and has two labels: ‘LECTOTYPUS | *Hemimene typhlodes* | Meyrick, 1931 ♂ | *Dichrorampha acuminatana* | ([Lienig] & Zeller, 1846) | det. B. Zlatkov 2007’ [red label], ‘NMNH-Sofia | “Euxinograd bei | Warna, 20.V.1928 | D-r Iw. Buresch” | Gen. prep. No. | 1/20.V.[19]28 | B. Zlatkov Eosin | 2007 Euparal’.

### Acknowledgements

I would like to thank Dr S. Beshkov (National Natural History Museum, Sofia) who assisted me in searching the Tortricidae collection of the Museum, Dr Z. Kovács (Romania) who kindly provided the original description of *H. typhlodes*, and Mr K. Tuck (Natural History Museum, London) who provided detailed information on the missing syntype.

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- Book reviews. **31** (1): 24, 64, 76; **31** (2): 178, 226.

## Index of taxonomical changes

- alpherakii* Grum-Grzhimailo, 1891 (*Dasychira*), **LT**; **comb. n.**; now: *Lachana* – Trofimova 2008 (15.xi.): **31** (2): 285
- atraxi* **sp. n.** (*Spiniductellus*) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 211
- Dasorgyia* Staudinger, 1881 [October–December] (Lymantriidae), **syn. n.** to *Dicallomera* Butler, 1881 [February] – Trofimova 2008 (15.xi.): **31** (2): 274
- desertus* **sp. n.** (*Spiniphallellus*) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 202
- discrepitella* (Rebel, 1901) (*Ethmia*), **LT** – Skovkoon 2008 (15.xi.): **31** (2): 216
- efflexa* Xiao & Li, 2006 (*Montetinea*), **comb. n.**; now: *Crypsithyris* – Gaedike 2008 (15.v.) **31** (1): 77
- engadinensis* Müller-Rutz, 1920 (*Pammene*), **syn. n.** of *Pammene agnotana* Rebel, 1914 – Schmid 2008 (15.xi.): **31** (2): 224
- flavonigrum* **sp. n.** (*Spiniductellus*) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 211
- fuscescens* **sp. n.** (*Spiniphallellus*) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 208
- grumi* Staudinger, 1901 (*Dasorgyia*), **LT** – Trofimova 2008 (15.xi.): **31** (2): 287
- kulu* **sp. n.** (*Lachana*) – Trofimova 2008 (15.xi.): **31** (2): 288
- massaicae* **sp. n.** (*Anthophila*) – Agassiz 2008 (15.xi.): **31** (2): 227
- pumila* Staudinger, 1881 (*Dasychira*), **comb. n.**; now: *Dicallomera* – Trofimova 2008 (15.xi.): **31** (2): 275
- selenophora* Staudinger, 1887 (*Dasychira*), **LT**; **comb. n.**; now: *Lachana* – Trofimova 2008 (15.xi.): **31** (2): 282
- siculum* **sp. n.** (*Caryocolum*) – Bella 2008 (15.v.) **31** (1): 69
- sincera* Kozhantshikov, 1950 (*Gynaephora*), **comb. n.**, now: *Lachana* – Trofimova 2008 (15.xi.): **31** (2): 283
- Spiniductellus* **gen. n.** (Gelechiidae) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 220
- Spiniphallellus* **gen. n.** (Gelechiidae) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 201
- staudingeri* Bang-Haas, 1938 (f. of *Lachana alpherakii* Grum-Grzhimailo, 1891), **LT** – Trofimova 2008 (15.xi.): **31** (2): 288
- stonisi* **sp. n.** (*Spiniphallellus*) – Bidzilya & Karsholt 2008 (15.xi.): **31** (2): 206
- tugai* **sp. n.** (*Agdistis*) – Altermatt 2008 (15.v.) **31** (1): 65
- typhlodes* Meyrick, 1931 (*Hemimene*), **LT**; **syn. n.** of *Dichrorampha acuminatana* (Lienig & Zeller, 1846) – Zlatkov 2008 (15.xi.): **31** (2): 297
- witti* **sp. n.** (*Phocoderma*) – Solovyev 2008 (15.v.) **31** (1): 59
- xizangensis* Huang, 2000 (ssp. of *Clossiana gong* (Oberthür, 1884), **syn. n.** of *Clossiana gongcharis* (Oberthür, 1891) – Coene & Vis 2008 (15.xi.): **31** (2): 240

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