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Two new related oodine genera in the Oriental Region, with remarks on the systematic position of the genera *Hololeius* and *Holosoma* (Coleoptera, Carabidae)

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Abstract

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Two new genera of Oodini LaFerté-Sénectère, 1851 are described: *Bamaroodes* **gen. n.** (type species: *Hololeius cyaneus* Facchini, 2011) for *Bamaroodes cyaneus* (Facchini, 2011), **comb. n.**, here placed in tribe Oodini and removed from Chlaeniini Brullé, 1834; and *Thaioodes* **gen. n.** (type species: *Thaioodes piceus* **sp. n.**) for *Thaioodes piceus* **sp. n.** (type locality: Khon Kaen, Thailand). The new genera are closely related and belong to the same lineage as evidenced by the following combination of characters: body shape semi-elongate; discal setiferous pore lacking in interval 3 of elytra; mesocoxa without lateral seta; tarsomere 5 setose ventrally; joints of the claws of tarsomere 5 parallel, situated closely to each other. The two genera are readily distinguished from one another by a number of distinct characters.

Further, the tribal position of two other genera is reconsidered. The monospecific *Hololeius* LaFerté-Sénectère, 1851 is redescribed and its current placement within Chlaeniini is confirmed, though it might be distantly related to the two new genera. Analysis of character states in species of *Holosoma* Semenov, 1889 leads me to transfer the genus from Oodini to Chlaeniini. Pictures of the taxa dealt with here are provided, including habitus, external characters, and genitalia. In addition, all the genera of the Oodini from the Oriental Region, including genera of Oriental Chlaeniini with oodine facies, are keyed for the first time.

Introduction

The Oriental fauna of Oodini has not been examined by taxonomists for a long time. Its representatives were reviewed by LaFerté-Sénectère in 1851, who assigned six Indian and one Javanese species to *Oodes* Bonelli, 1810. Today the same species are arranged in six different genera of the tribe (Lorenz 2005). A second work of importance regarding the discussed fauna is the posthumous revision of Chaudoir (1882, 1883) that, even though old and out of date, is still the only worldwide review of the tribe. Subsequently other works appeared on this topic, among the more important being those of Bates (1892), Andrewes (1923, 1940), and Louwerens (1951). The only study entirely devoted to the Oriental Oodini is that of

Andrewes (1940). This author described seven new species and keyed most of the known species from the Indian subcontinent and Southeast Asia. Andrewes treated all the species as belonging to *Oodes*. Today the same taxa are classified into the genera *Brachyodes* Jeannel, *Nanodiodes* Bousquet, *Oodes*, and *Pseudosphaerodes* Jeannel (Lorenz 2005).

Some works devoted to other biogeographic areas are of use for recognition of the Oriental fauna. Habu (1956, 1958) published two careful studies on the Japanese Oodini, which include a few taxa shared between the Palaearctic and Oriental Region. The same applies to the work of Darlington (1968) in regard to taxa from the Australasian and Oriental Region. Last, but not least, is the revision of the Nearctic Oodini by Bousquet (1996).

Table 1. List of the Oriental genera of Oodini, their species number and distribution.

Genera	Species	Distribution (incl. unpublished data)
<i>Anatrichis</i> LeConte, 1853	3	Indian subcontinent, Myanmar, Philippines
<i>Bamaroodes</i> B. Guéorguiev, gen. n.	1	Myanmar, Thailand
<i>Brachyodes</i> Jeannel, 1949	4	whole region
<i>Holcocoleus</i> Chaudoir in Oberthur, 1883	2	India (Tamil Nadu), Ceylon
" <i>Holosoma boettcheri</i> Jedlička, 1936"	1	Philippines
<i>Megaloodes</i> Lesne, 1896	1	SE Thailand, E Cambodia
<i>Miltodes</i> Andrewes, 1922	1	India, Thailand, Sumatra
<i>Nanodiodes</i> Bousquet, 1996	3	Ceylon, SE Asia, Indonesia, Philippines
<i>Oodes</i> Bonelli, 1810	16	whole region
<i>Oodinus</i> Motschulsky, 1864	1	Vietnam, Sumatra, Moluccas, Philippines
<i>Pseudosphaerodes</i> Jeannel, 1949	2	Myanmar, Philippines
<i>Simous</i> Chaudoir, 1882	9	whole region east of Bengal
<i>Systolocranius</i> Chaudoir, 1857	1	"Bengal": MNHUB; "Ind. or.": NMW
<i>Thaioodes</i> B. Guéorguiev, gen. n.	1	Thailand

This work is useful for the making of a modern classification of the group in any other region.

Currently 44 oodine species from the Oriental Region are classified in 11 genera (*Holosoma* Semenov excluded). I add two more genera and two more species that will be discussed in detail in this work (Table 1). Undoubtedly, the status of some taxa needs verification, so this study should be considered a preliminary attempt to contribute to a better recognition of the taxa of Oodini in the region.

The main reason for doing this work is the finding of two unusual oodine-like specimens in MNHUB from Thailand, one of them found to be conspecific with *Hololeius cyaneus* Facchini, 2011. The samples had been collected with light traps by Dr Sastri Saowakontha and donated to MNHUB by Prof. Dr Hans-Jürgen Bremer, a specialist on Tenebrionidae. A careful study of the two specimens has revealed that each of them belongs to a separate genus, and that *H. cyaneus* is not congeneric with *H. ceylanicus* (Nietner, 1856), the type species of the genus. In addition, the study of specimens of *Holosoma* and a review of published descriptions revealed that this genus does not belong to the Oodini, and should be transferred to Chlaeniini.

Material and methods

This study is based upon the examination of type and non-type material of species from the following genera of Oodini: *Brachyodes* Jeannel, 1949; *Holcocoleus* Chaudoir in Oberthur, 1883; *Holosoma* Semenov, 1889; *Lonchosternus* LaFerté-Sénectère, 1851; *Miltodes* Andrewes, 1922; *Nanodiodes* Bousquet, 1996; *Oodes* Bonelli, 1810; *Oodinus* Motschulsky, 1864; *Protopidius* Basilewsky, 1949; *Simous* Chaudoir, 1882; *Systolocranius* Chaudoir, 1857; and two the new genera described below. The holotypes of the type species of genera *Brachyodes*, *Holcocoleus*, *Miltodes*, *Protopidius*, *Simous* and *Systolocranius* were studied. In addition, I have studied many taxa of Chlaeniini, representing samples of the Palearctic, Ori-

ental, and Afrotropical regions. The examined material was provided by EU natural history museums (BMNH, MNHN, MRAC, NBC, NMNHS, and NMW) and it was investigated in 2007-2013. Many references, among them Chaudoir (1882, 1883), Sloane (1910), Andrewes (1940), Jeannel (1949a), Basilewsky (1953), Darlington (1968), Erwin (1974), Spence (1983), Kirschenhofer (1995), and Bousquet (1996), were carefully studied.

The measurements and drawings of the dorsal view of the aedeagus were made using an Olympus SZ 60 stereoscopic microscope. The rest of the drawings were taken with a Carl Zeiss Jena Technival 2 stereoscopic microscope. The photographs were made with a Zeiss Stemi 2000 microscope equipped an AxioCam ERc 5s camera.

The measurements are made as previously described by the author (Guéorguiev 2013).

Abbreviations of the repositories of the specimens herein studied are:

BMNH	Natural History Museum, London, United Kingdom (Max Barclay, Beulah Garner)
IZAS	Institute of Zoology, Chinese Academy of Science, Beijing, China (Hongbin Liang)
MNHN	Muséum National d'Histoire Naturelle, Paris, France (Thierry Deuve, Azadeh Taghavian)
MNHUB	Museum für Naturkunde der Humboldt-Universität, Berlin, Germany (Manfred Uhlig, Bernd Jaeger)
MRAC	Musée Royal de l'Afrique Centrale, Tervuren, Belgium (Marc De Meyer)
NBC	Naturalis Biodiversity Center, Leiden, The Netherlands (Ben Bruggé)
NMNHS	National Museum of Natural History, Sofia, Bulgaria (Borislav Guéorguiev)
NMW	Naturhistorisches Museum Wien, Vienna, Austria (Harald Schillhammer)
CFa	Coll. Sergio Facchini, Piacenza, Italy

The distribution map was made using the online mapping software SimpleMappr (©David P. Shorthouse).

Taxonomy

CHLAENIINI Brullé, 1834

Tribal diagnosis. Mandibular scrobe without seta near anterior margin of excavation, mesocoxal cavities conjunct (mesepimeron does not reach middle coxal cavity), metepisternum separated from metepimeron by distinct suture, and parameres without setae, with left paramere “conchoid”, therefore a member taxon of Conchifera Jeannel, 1941 (Jeannel 1949b: 1047); head with one pair of supraorbital setae, its capsule “normal”, i.e. without annular constriction behind eyes and with ultimate maxillary palpomere elongate and well-centered with respect to penultimate palpomere, pronotum usually without anterolateral setae, anterior coxal cavities biperforate, elytron with internal plica, metepisternum laterally coadunate with elytral epipleuron, middle femur posterior margin without longer setae, metacoxa lacking posterior seta, and median lobe of aedeagus in lateral view long and considerably bent, with basal bulb decreased, indicate a member taxon of Callistidae Jeannel, 1941 (Jeannel 1949b: 1051); tegument largely punctate and pubescent, antennomere 3 densely pubescent or at least with a few short, scattered setae (in addition to apical setae), elytron with intervals 7 and 8 not fused and not forming ridge posteriorly, stria 7 distinct to apex, stria 8 not deeper than other striae, and interval 9 normal (not transformed), wider or narrower, are other features peculiar to tribe.

Hololeius LaFerté-Sénéctère, 1851

Type species. *Chlaenius nitidulus* Dejean, 1826

Diagnosis. Small to medium-sized specimens (11–13 mm) for Oriental chlaeniines, with the following characters: habitus semi-elongate; color mostly olivaceous; integument punctate and pubescent, pubescence denser on sides of elytra and on sides of abdomen, less developed, scattered or lacking on rest of body; head with conspicuously large eyes and minute tempora; penultimate segment of labial palpomere without setae; antennomeres 1–3 lighter than other antennomeres, scape and pedicel glabrous, antennomere 3 with a few fine and scattered setae; pronotum subquadrate, without protruded angles, with basal margin laterally oblique towards posterior angle; elytra more densely pubescent and punctate laterally and apically, with only a few hairs basally and on disc; striae 1–7 of elytra punctiform; striae 5–7 obliterated anteriorly; stria 8 linear, somewhat more impressed than other striae; mesocoxa with two long setae, one lateral seta and one posteromedial seta; sterna 4–5 with pair of long ambulatory setae, sternum 3 without such setae; last abdominal sternum with two pores in male, four pores in female; male protarsomeres 1–3 longer than wide and with protarsomere 1 longer than each of following two protarsomeres separately; tarsomere 5 of all legs setose ventrally.

Taxonomic position. LaFerté-Sénéctère (1851: 274) proposed *Hololeius* for *Chlaenius nitidulus* Dejean, 1826,

due to: 1, pronotum at the base narrower than the base of elytra; 2, lack of pubescence; 3, antennomere 3 not longer than subsequent antennomeres. He placed the genus in tribe Oodini LaFerté-Sénéctère, 1851, concluding: “C’est-à-dire qu’à l’exception de la largeur du corselet, cet insecte réunit tout les caractères à l’aide desquels nous avons séparé les Oodites des Chlaenides.” In terms of the present knowledge, I can state that the first and third characters are true, but not the second one. When examined it was found that *H. ceylanicus* has the integument partially and diffusely punctate and pubescent, both dorsally and ventrally. This state is opposed to one of the basic features of the Oodini, namely the lack of pubescence and lack of extensive punctuation of the integument (Bousquet 1996: 448). Hence, the three characters LaFerté-Sénéctère mentioned are typical of Chlaeniini. The length and ratio of antennomere 3 to the following antennomeres is not of tribal significance.

Hololeius is usually placed in the beginning of the genera of Chlaeniini (Lorenz 1998, 2005), presumably because of some odd features that it possesses. Actually, the genus combines characters distinctive for either one or the other tribe and the importance of each is discussed below (see ‘Affinities’ under *Bamaroodes* gen. n., ‘Discussion’).

Hololeius ceylanicus (Nietner, 1856)

Figs 1–11

Chlaenius nitidulus Dejean, 1826: 341 [nec Schrank, 1781]

Chlaenius ceylanicus Nietner, 1856: 385

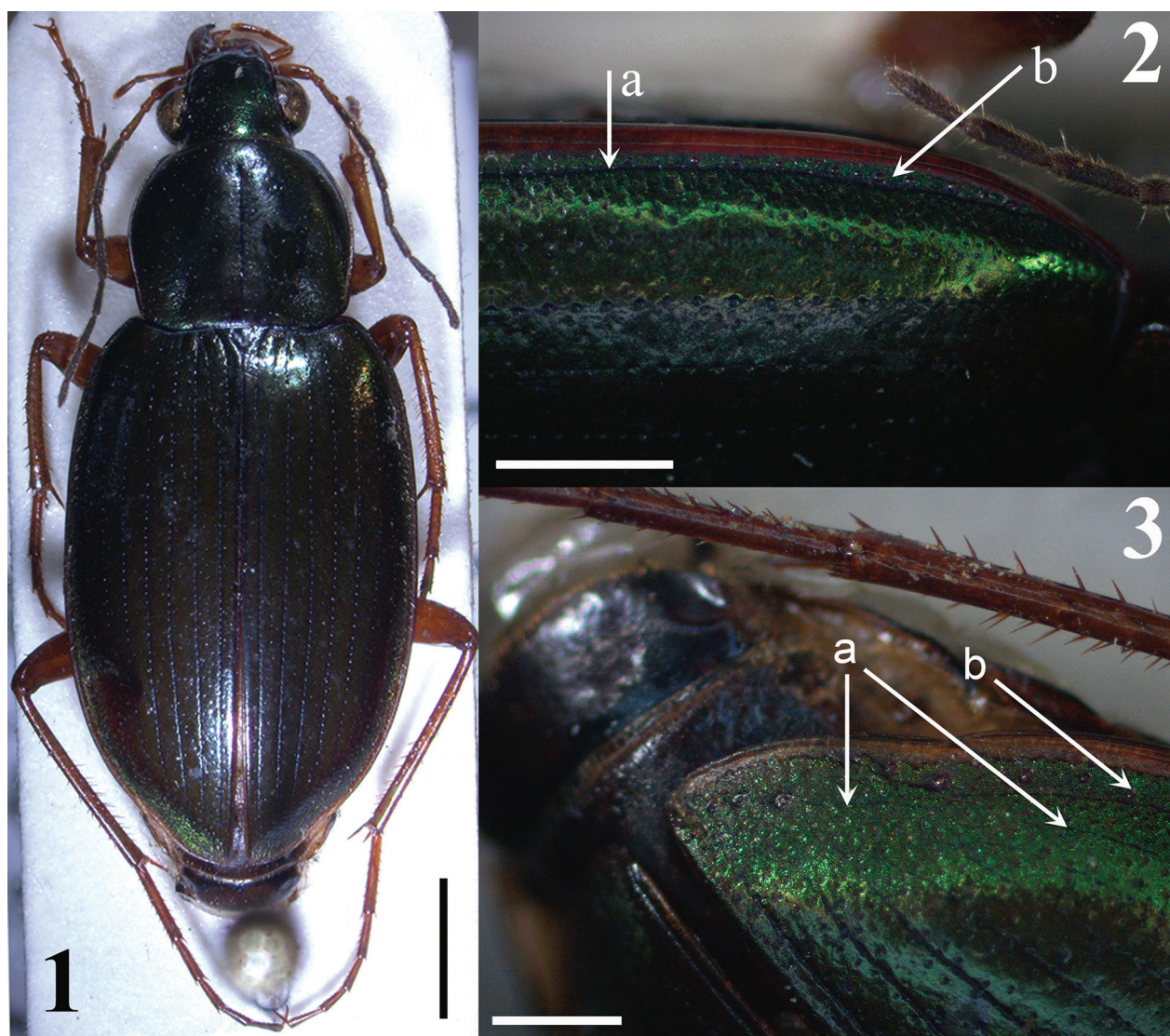
Hololius (sic!) *punctulatus* Chaudoir, 1857: 10

Poecilus ornatus Tryon, 1890: 109.

Material examined. 1♂, 1♀, Indonesia, Bali, south shore of Danau Buyan Lake, 1250 m, 11.VII.1991, Balke & Hendrich leg. (NMNHS).

Diagnosis. Same as the generic diagnosis.

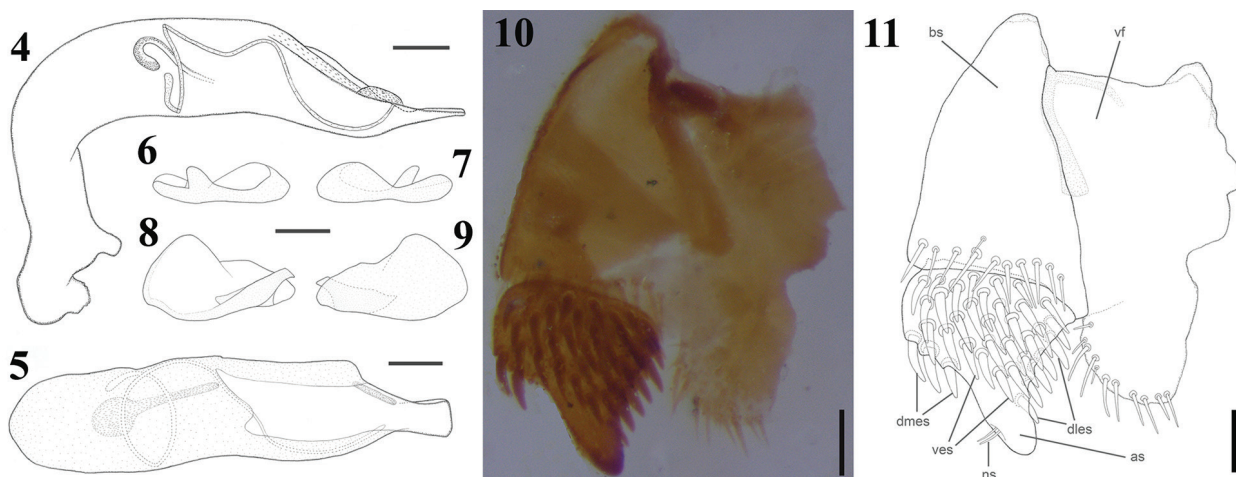
Redescription. *Habitus.* Semi-elongate (Fig. 1). *Color.* Uniformly olive-green on most of dorsal surface, elytra light green to coppery at apex; venter black; elytral epipleura reddish; palpi, legs, antennomeres 1–3 and base of 4 red-yellow. *Microsculpture.* Reduced on most of surface, isodiametric on interval 9 and on medial intervals posteriorly, transverse on proepisternum. *Punctuation and pubescence.* Head finely and densely punctate dorsally, slightly rugose at sides and posteriorly; pronotum and elytra with punctures coarser and more scattered than punctures on head; pronotum more densely punctate laterally and basally, less densely punctate apically, with a few hairs on disc; elytra more densely pubescent and punctate laterally and apically, with only a few hairs basally and on disc; prosternum, mesepisternum, metasternum, and metepisternum glabrous medially, sparsely to moderately punctate and pubescent laterally; abdominal sterna 1–2 sparsely punctate and pubescent, sterna 3–6 sparsely punctate and pubescent medially, more densely punctate and pubescent laterally.



Figures 1–3. *Hololeius ceylanicus* (Niether, 1856) from Danau Buyan Lake, Bali, Indonesia, female. **1.** Habitus; **2–3.** Elytra (**2.** left anterolateral view; a – stria 8; b – interval 9; **3.** left posterolateral view; a – stria 7; b – interval 9). Scale bars = 2 mm (Fig. 1); = 1 mm (Figs 2–3).

Head. Frons with punctiform impressions and one pair of setiferous punctures. Labrum with six setae along anterior margin. Clypeus with a pair of setae. Labial palpomere glabrous. Mentum tooth truncate apically, bordered posteriorly. **Pronotum.** Subrectangular, without protruded angles, with anterior margin slightly shorter than posterior margin, posterior margin laterally oblique towards posterior angle; margins finely bordered laterally and lateroapically, border obliterated on anterior margin medially, basal margin not bordered; anterolateral setae lacking, posterolateral setae present; two laterobasal impressions faint, sublinear. **Elytra.** Striae 1–7 fine, punctiform (Figs 1–3); striae 5–7 obliterated basally (Fig. 2); stria 7 perceptible to apex (Fig. 3); stria 8 linear, not or hardly deeper than other striae, well-impressed along most of its length, depressed only apically (Figs 2–3); parascutellar striola fine, punctiform like striae 1–7, located between suture and stria 1. Intervals 7 and 8 separate to apex (Fig. 3); interval 9 distinct nearly to apex (Figs 2–3). Parascutellar pore present; dis-

cal setiferous pores lacking. **Ventral surface (thorax and abdomen).** Intercoxal process of prosternum unbordered, glabrous and impunctate. Mesosternum profoundly concave. Metepisternum laterally coadunate with elytral epipleuron. Sternum 3 without ambulatory setae, sterna 4–5 with pair of long ambulatory setae; apical sternum with two setae in male, four in female. **Legs.** Relatively long and slender. Mesocoxa with two setae, one lateral and one posteromedial. Metacoxa with anterior pore; metafemur with a few short setae on dorsal surface. Tarsomere 5 setose ventrally. **Male genitalia.** Median lobe of aedeagus large, strongly curved laterally, with complex internal structure (Figs 4–5); basal part small, narrow, with small bulb and concave orifice in lateral aspect, curved rectangularly towards massive and broadened medial part, from there toward apical lamella gradually narrowed, and then slightly raised distally (Fig. 4); median lobe long, straight, slightly asymmetrical in dorsal aspect, with left side obtusely angled and more concave before apex and right side



Figures 4–11. *Hololeius ceylanicus* (Niether, 1856) from Danau Buyan Lake, Bali, Indonesia. **4–9.** Male genitalia (**4.** median lobe of aedeagus, left lateral view; **5.** median lobe of aedeagus, dorsal view; **6–7.** right paramere, internal and external face; **8–9.** left paramere, internal and external face); **10–11.** Left ovipositor, ventral view (**10.** photograph; **11.** line drawing; as – apical stylomere; bs – basal stylomere; dles – dorsolateral ensiform setae; dmes – dorsomedial ensiform setae; ns – nematiform setae; ves – ventral ensiform setae; vf – valvifer). Scale bars = 0.3 mm (Figs 4–9); = 0.1 mm (Figs 10–11).

undulating, slightly concave in middle and before apex, apical lamella narrow proximally and widened distally (Fig. 5); inner sac with three well-chitinized, differently shaped structures: proximal paddle-like sclerite, long medial threadlike filament and small distal sclerite on the right side easily visible in dorsal aspect (Figs 4–5); parameres different in shape, right paramere elongate, thick, saddle-like, with short and oblique process internally (Figs 6–7), left paramere conchoid, with a thick, strongly chitinized and oblique process internally (Figs 8–9). *Female genitalia.* Ovipositor consists of valvifer and stylomere (Figs 10–11); distal margin of valvifer with 11–12 setae of varying lengths; basal stylomere conical, 1.5 times longer than apical stylomere, its ventral surface with 10 long and thin setae directed toward apical stylomere; apical stylomere subtriangular, with rounded blade, as wide as basal stylomere, provided with 36 long and well-chitinized ensiform setae (3 dorsomedial, 6 dorsolateral and 27 ventral) and with two thick nematiform setae, slightly shorter than ensiform setae.

Distribution. Palaearctic Region (Japan, East China), Oriental Region (Ceylon, India, South China, Taiwan, Philippines, Malaysia, Indonesia), Australian Region (New Guinea, northeast and southeast Australia).

Holosoma Semenov, 1889

= *Parahololius* Heller, 1923: 66 (type species *Parahololius weigoldi* Heller, 1923)

= *Parololius* Semenov, 1927: 232 [unjustified emendation of *Parahololius*, not in prevailing usage]

Type species. *Holosoma opacum* Semenov, 1889

Historical remarks. Semenov (1889: 388) proposed the generic name *Holosoma* for *H. opacum* from South

Gansu, China. The author placed the genus in “subtribum Oodidarum, prope genera *Oodes* Bon. et *Simous* Chaud, collocandum” (ibid.: 389). This tribal placement has been subsequently accepted (Jakobson 1906: 310–311). In 1923, Heller (1923: 66) described the genus *Parahololius* Heller, 1923, for *P. weigoldi* Heller, 1923, from Sichuan, China. He placed this genus in Chlaeniini, near to *Hololeius*. Shortly afterwards, Semenov (1927: 232) proposed [not Basilevsky 1953, as Kirschenhofer 1995: 77 stated] the synonymy of *Parahololius* and *Holosoma* and emended the former name to *Parololius* [according to the Article 32.2.3 of ICZN 1999, the change of the original name to *Parololius* is an “unjustified emendation”]. Jedlička (1931: 21–22) described *H. rambouseki* Jedlička, 1931 from Sichuan, China. Andrewes (1935) described *Chlaenius hedini* Andrewes, 1935, from North Gansu and Southeast Sichuan, China. He noted, “It does not appear to be nearly allied to any other Asiatic species.” [of *Chlaenius* Bonelli, 1810]. Jedlička (1936: 51) described *Holosoma boettcheri* Jedlička, 1936, from the Philippines, which is the only known extra-Palaearctic record for the genus. Subsequent authors dealing with the genus, except for Lorenz (2005), have omitted this species. I have seen the holotype of *Holosoma boettcheri* in BMNH and found that it belongs to a different group of Oodini. Later, Basilevsky (1953: 153) included *Holosoma* to the tribe Simoini Basilevsky, 1953, of subfamily Oodinae (sensu Jeannel, 1949a). Kirschenhofer (1995) reviewed the known species (excl. *Chlaenius hedini* and *H. boettcheri*), adding three more species and retaining the tribal affiliation of the genus. Later, he synonymized one of his added taxa with *H. hedini* (Kirschenhofer 1998). Recently, Ito (2003, 2012) added five more species and one subspecies to the genus and keyed all species known at that time. He retained the position of the genus within the Oodini.

Taxonomic position. The discussion here is based on all the generic and species descriptions (Semenov 1889, Heller 1923, Jedlička 1931, Andrewes 1935, Kirschenhofer 1995, Ito 2003, 2012) and on the detailed examination of two specimens. It considers only the characters that are significant for the tribal position of *Holosoma*. Excluding *H. boettcheri*, I am aware that the group is homogeneous and the main structural features are uniform among the species.

- 1) *Pronotum posterior margin as wide as basal margin of elytra, thus habitus seems semi-oval rather than elongate.* Atypical of Chlaeniini (but occurs in a few species, such as the Nearctic *Chlaenius tomentosus* (Say, 1823); remark by R. Davidson). Typical of Oodini, except for the new genera. This condition is probably a derived trend within the genus because it occurs in most, but not all, species.
- 2) *Body dorsally with metallic lustre (greenish, turquoise, bluish, violet to black-blue) on dorsal surface.* Habitual to Chlaeniini, since many species from this tribe are metallic colored. In the Oodini, a metallic hue is present only in *Bamaroodes* gen. n., most species of *Simous* and a few taxa of *Stenocrepis* Chaudoir, 1857.
- 3) *Integument sparsely pubescent dorsally and ventrally.* The character is distinctive of Chlaeniini, but it is unknown in the Oodini. In the species of *Holosoma*, the dorsal surface of the head, antennomere 3 (excl. apical setae), pronotum, intervals 8–9 of elytra, prosternum, mesepisternum, mesocoxa, mesofemur, metasternum, metepisternum, and abdomen all have rather fine and scattered punctures (see also Kirschenhofer 1995, Ito 2003). Most of the punctures are provided with short, yellowish hairs, usually well visible under higher magnification. Sparse pubescence is also present on the medial elytral intervals posteriorly, though it is much more sporadic than on the intervals 8–9.
- 4) *Labrum with six setae along anterior margin.* This feature is typical of Chlaeniini. Although it is present in most Oodini, several groups have different setation of the labrum.
- 5) *Clypeus with a pair of setae.* The condition is usual for Chlaeniini. Although it occurs in most Oodini, several groups lack clypeal setae.
- 6) *Penultimate labial palpomere with 2–4 spines at front margin.* Indicative of Chlaeniini (occurs in the most of the species). This feature is unknown in the Oodini. Jedlička (1931: 22) has noted that the penultimate labial palpomere in *H. rambouseki* lack setae, but this fact needs verification.
- 7) *Terminal labial palpomere with a few fine and short setae on lateral margin* (see also Ito 2012: 303). Occurs in some Chlaeniini. Unknown in the Oodini.
- 8) *Elytral stria 8 shallower than, or as deep as striae 1–7.* Typical of Chlaeniini, except for *Hololeius*. All

taxa of Oodini I have studied have stria 8 more or less grooved along its extent and deeper than other striae.

- 9) *Discal setiferous punctures situated in elytral intervals 3 and 5, or in intervals 3, 5 and 7.* There is no data for this condition in Chlaeniini, but it is also atypical of Oodini. Like point 1, it can be an apotypic trend within the genus since it occurs in several, but not in all species of *Holosoma*. For example, *H. hedini*, *H. heros* Kirschenhofer, 1995, and the specimens from Wenxian possess setiferous punctures in intervals 3, 5 and 7. *H. namikoe* Ito, 2012, has such punctures only in intervals 3 and 5, and *H. rambouseki* solely in interval 3. Discal punctures are lacking in *H. opacum*, *H. nigratum* Ito, 2003, *H. imurai*, *H. speciosum* Ito, 2003, and *H. misaoae* Ito, 2012. This character has not been described for *H. weigoldi*.
- 10) *Elytral intervals 7 and 8 separate (e.g., not fused) posteriorly, thus stria 7 perceptible to apex.* Typical of Chlaeniini. Unusual for Oodini, except for *Bamaroodes* gen. n.
- 11) *Elytral interval 8 not forming ridge laterally.* Typical of Chlaeniini. Unusual for Oodini, except for *Bamaroodes* gen. n.
- 12) *Tarsomere 5 of all legs setose ventrally.* Typical of Chlaeniini. Unusual for Oodini, except for the two new genera and a few species of *Systolocranius*. Among the species of *Holosoma*, the number of the setae varies from two to six on each side of tarsomere 5.
- 13) *Quinone-like smell defensive secretion.* This is one of three groups of compounds used for defence in the Chlaeniini. It is not found in Oodini. Ito (2003: 95) noted that the defensive chemical in *Holosoma* is “also the same as that of the genus *Chlaenius*”. I noticed this pungent smell many times when was taking the specimens from Wenxian out of the test-tube and handling them. The odor is identical or similar to that existing in the European species of *Chlaeniellus* Reitter, 1908 (Bousquet 1987). Moore (1979: 198–199) regarded the quinones as one of the most elaborate defensive strategies in the ground beetles.

Thirteen character states are considered. Number 9 is not counted due to deficient data about its presence among other taxa. Six character states, i.e., 2, 3, 6, 7, 8, 13, are typical for Chlaeniini and are unknown to Oodini. Characters 10, 11 and 12 are also typical of the Chlaeniini and have a few exceptions in the Oodini. Similarly, characters 4 and 5 are always indicative of Chlaeniini. Most genera and species of Oodini also share these two conditions, but there are some important exceptions. Character 1 is the only one characteristic of Oodini and not typical of Chlaeniini.

In conclusion, *Holosoma* lacks oodine characters but does share important traits with the chlaeniines. It is therefore removed to a new tribal placement incertae sedis within Chlaeniini. The precise affinity of the genus within the tribe remains unresolved.

***Holosoma* sp.**

Fig. 12

Material examined. 1♂, 1♀, China, Gansu, Wenxian, Shangde Hendan, 848 m, 27.VI.2012, Liang Hongbin leg. (NMNHS).

Notes. The specimens seem closer to taxa from south Gansu with pores in intervals 3, 5 and 7 (i.e., *H. hedini* and *H. heros*), but further work is needed to clarify their precise position.

OODINI LaFerté-Sénéctère, 1851

Tribal diagnosis. Mandibular scrobe without seta near anterior margin of excavation, mesocoxal cavities conjunct (mesepimeron does not reach middle coxal cavity), metepisternum separated from metepimeron by distinct suture, and parameres without setae, with left paramere “conchoid”, therefore a member taxon of Conchifera Jeannel, 1941 (Jeannel 1949b: 1047); head with one pair of supraorbital setae, its capsule “normal”, i.e. without annular constriction behind eyes and with ultimate maxillary palpomere elongate and well-centered with respect to penultimate palpomere, pronotum usually without anterolateral setae, anterior coxal cavities biperforate, elytron with internal plica, metepisternum laterally coadunate with elytral epipleuron, middle femur posterior margin without longer setae, metacoxa lacking posterior seta, and median lobe of aedeagus in lateral view long and considerably bent, with basal bulb decreased, indicate a member taxon of Callistidae Jeannel, 1941 (Jeannel 1949b: 1051); tegument glabrous, largely impunctate, antennomere 3 glabrous (excluding apical setae), posterior margin of pronotum not fringed, elytron with stria 7 ended before apex, stria 8 deeper than other striae, and interval 9 transformed into marginal gutter partly or



Figure 12. *Holosoma* sp., habitus of male from Wenxian, Gansu, China. Scale bar = 2 mm.

throughout, add traits peculiar to tribe (all genera, except for *Bamaroodes* gen. n., have also elytron with intervals 7 and 8 fused and forming a ridge posteriorly).

A key to the genera for adults of Oriental Oodini, including Oriental Chlaeniini with oodine facies

- 1 Interval 9 of elytra distinct, not transformed into marginal gutter. Stria 8 neither deeper than other striae (modestly deeper only in *Hololeius*) nor grooved. Integument more or less extensively punctate and pubescent. Antennomere 3 with a few short, scattered setae (in addition to apical setae)..... [Chlaeniini]...2
- Interval 9 of elytra transformed into marginal gutter throughout or at least along its anterior two-fifths. Stria 8 deeper than other striae, distinctly grooved posteriorly. Integument glabrous, impunctate or restrictedly punctate. Antennomere 3 glabrous (but with apical setae)..... [Oodini]...3
- 2 Penultimate segment of labial palpomere with 2–4 spines at front margin. All striae of elytra linear, stria 8 shallower than or as deep as other striae. Basal margin of pronotum nearly straight, only briefly rounded at posterior angle. Sterna 3–5 with pair of long ambulatory setae..... *Holosoma* Semenov, 1889
- Penultimate segment of labial palpomere without seta. Striae 1–7 punctiform, stria 8 linear, somewhat deeper than other striae (Figs 2–3). Basal margin of pronotum laterally oblique towards posterior angle. Sterna 4–5 with pair of long ambulatory setae, sternum 3 without such setae *Hololeius* LaFerté-Sénéctère, 1851
- 3 Tarsomere 5 setose ventrally. Mesocoxa lateral margin without seta. Body semi-elongate. Anterior and posterior margins of pronotum with similar widths. Claws nearly parallel (Figs 15–16, 21–22)..... 4
- Tarsomere 5 glabrous ventrally. Mesocoxa lateral margin with one or a few setae. Body elliptic or broadly oval. Anterior and posterior margins of pronotum with dissimilar widths. Claws widely separated..... 5

- 4 Elytra two-colored, mostly black with bluish hue, with yellow apical band (Fig. 13). Striae 2–7 obliterated apically; intervals 7 and 8 not fused posteriorly (Figs 15–16). Intervals uniformly flat throughout; interval 8 not forming a ridge posteriorly; interval 9 transformed into marginal gutter only anteriorly, distinct on posterior three fifths of elytra; marginal gutter ended before apex of elytron (Figs 14–16). Pronotum distinctly wider than long (PW/PL: 1.24–1.37), with sides finely bordered throughout; posterolateral setae present. Prosternal process unbordered *Bamaroodes* gen. n.
- Elytra unicolored, blackish (Fig. 19). Striae distinct toward apex; intervals 7 and 8 fused posteriorly (Figs 21–22). Intervals convex posteriorly; interval 8 forming a ridge posteriorly; interval 9 transformed into marginal gutter throughout; marginal gutter distinct to apex of elytron (Figs 20–22). Pronotum slightly wider than long (PW/PL: 1.18), with sides not bordered basally; posterolateral setae lacking. Prosternal process bordered. *Thaioodes* gen. n.
- 5 Labrum with three pores on anterior margin, central pore bearing two or four connate setae 6
- Labrum with six pores on anterior margin, each pore bearing a separate seta 10
- 6 Clypeus without setae. Mesepisternum without apodemal pit. Length of body 5–16 mm 7
- Clypeus with two setae. Mesepisternum with apodemal pit (in *Miltodes* pit very small). Length of body 3–5 mm 9
- 7 Smaller species, length of body less than 10 mm *Nanodiodes* Bousquet, 1996
- Larger species, length of body more than 13 mm 8
- 8 Elytra with striae 1–7 distinctly grooved, crenulated and complete; interval 3 with two discal punctures *Systolocranius* Chaudoir, 1857
- Elytra with striae extremely fine and smooth, stria 6 shortened, stria 7 obliterated; interval 3 without discal punctures *Megaloodes* Lesne, 1896
- 9 Head around 2.5 times narrower than width of base of pronotum. Apodemal pits very small, indistinct, with minute apertures. Interval 3 of elytra without discal setiferous punctures *Miltodes* Andrewes, 1922
- Head around two times narrower than width of base of pronotum. Apodemal pits deep, with wide apertures. Interval 3 of elytra with two small setiferous discal punctures *Oodinus* Motschulsky, 1864
- 10 Clypeus without setae *Anatrichis* LeConte, 1853
- Clypeus with two setae 11
- 11 Parascutellar striola of elytra vestigial or absent *Pseudosphaerodes* Jeannel, 1949
- Parascutellar striola of elytra complete 12
- 12 Protibia with lateral groove on external side. Interval 8 of elytra distinctly narrower than interval 7 (half as much behind shoulder to much narrower toward apex) 13
- Protibia without lateral groove on external side. Interval 8 of elytra as wide as or only slightly narrower than interval 7 14
- 13 Interval 8 of elytra carinate behind shoulder *Holcocoleus* Chaudoir, 1883
- Interval 8 of elytra as flat as internal intervals *Brachyodes* Jeannel, 1949
- 14 Mentum tooth subtriangular or triangular, rounded or pointed anteriorly. Non-metallic coloration *Oodes* Bonelli, 1810
- Mentum tooth sub-trapezoidal, truncate or emarginate anteriorly. Mostly metallic coloration (excl. *Simous nubilis* Andrewes, 1933) *Simous* Chaudoir, 1882

***Bamaroodes* gen. n.**

<http://zoobank.org/0209BE0A-64A2-46B9-BAFB-92BC758D1189>

Type species. *Hololeius cyaneus* Facchini, 2011

Diagnosis. Medium-sized species (8.0–8.5 mm) for Oriental oodines; habitus semi-elongate; color cyaneus on head and pronotum, piceocyaneus on elytra, with yellowish apical band, piceous to rufopiceous on ventral surface, scape, palpi, tibiae, and tarsomeres red-yellow to yellow; microsculpture isodiametric; integument of body glabrous and impunctate dorsally and ventrally, (only disc of head moderately punctate and striate laterally); head with conspicuously large eyes and minute tempora; frons with punctiform impressions and one pair of punctures; labrum with six setae along anterior margin; clypeus with two setae; labial palpomere glabrous; mentum tooth rounded anteriorly, bordered posteriorly; pronotum moderately transverse, without protruded angles, with anterior and posterior margins of similar width; sides of pronotum finely bordered throughout; anterolateral setae lacking, posterolateral setae present; laterobasal im-

pressions of pronotum faint, sublinear; elytra with fine striae, 1–7 obliterated apically, 5–7 obliterated basally; stria 7 separate to apex (not joined to stria 8), scarcely noticeable apically; stria 8 deeper than other striae, moderately grooved along posterior half; parascutellar striola well-developed, long, located between suture and stria 1; intervals uniformly flat and smooth throughout; intervals 7 and 8 not fused posteriorly, interval 8 not forming ridge externally; interval 9 transformed into marginal gutter at anterior two fifths of elytra, distinct on posterior three fifths; parascutellar pore present; discal pores in interval 3 lacking; interval 7 with two subapical pores; prosternal process unbordered; marginal gutter ended before apex of elytron; mesosternum concave; metepisternum laterally coadunate with elytral epipleuron; sterna 4–5 with pair of minute ambulatory setae; apical sternum with two marginal pores in female; mesocoxa without lateral seta, with posteromedial one; metacoxa with anterior pore; mesofemur without posterior setae; metafemur glabrous or with single pore on dorsal surface; tarsomere 5 of all legs setose ventrally.

Etymology. A compound word, based on the ethnic name of the people in the region where the type species was first found, Bamar, and *Oodes* (for its etymology see Bousquet 2012: 955). It is treated as a Latin masculine.

Affinities. In 2011, Facchini described eight new species of Chlaeniini from the Afrotropical and Oriental region, among them *Hololeius cyaneus* from Myanmar (Facchini 2011: 350–351). The author noted also that the holotype of the species has sympatrically been collected with specimens of *H. ceylanicus*, the type species of the genus. Facchini differentiated the latter from the former by: 1, size of the body; 2, coloration of the integument, including the color of femora and epipleura; 3, shape of the pronotum; 4, shape and striation of the elytra; 5, punctuation of the elytral intervals; 6, chaetotaxy of the last abdominal sternum in the females; 7, distance between the joints of the claws of tarsomere 5. Examination of the paratype and another specimen of *H. cyaneus* from Thailand confirms that these distinguishing features are valid (except for the color of epipleura, which is not markedly different) and well-chosen for ready differentiation of these taxa. However, they are inadequate to give an idea of a more precise systematic position of the species, though some of the differences noted by Facchini are of generic value.

Careful study ascertained significant structural differences between *H. cyaneus* and *H. ceylanicus* (Table 2).

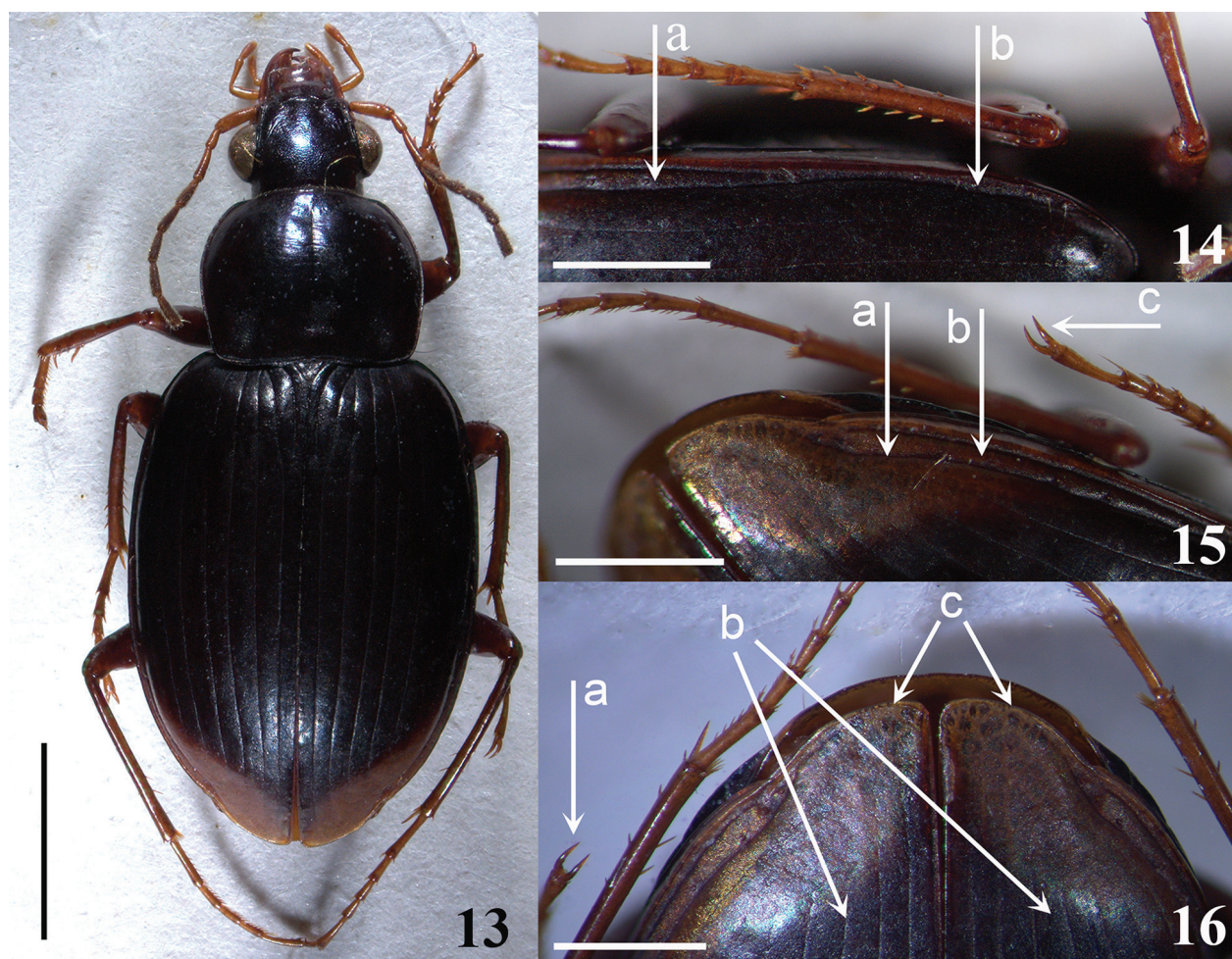
Five of the listed character states (1, 2, 3, 9, and 11) are of tribal magnitude, though one of them (i.e., attribute 9) shows transitional conditions in the two species. All the states are characteristic of Oodini and atypical for Chlaeni-

ini (Jeannel 1949a, Bousquet 1996). Point 11 exhibits a unique condition in *H. cyaneus* that is hitherto unknown in the two tribes. However, a complete character state transformation of this feature occurs in the Oodini. Except for *Bamaroodes* gen. n., all other examined oodines possess a ninth interval of elytra completely transformed into a marginal gutter throughout. In my view, this special feature may be morphological evidence for transition between the two tribes, but this needs further examination. The losses of the mesocoxa lateral seta (point 13) and parallel position of the joints of the tarsal claws (attribute 14) are conditions hitherto not found together in the aforementioned tribes. Among the Oodini, the three character states occur together only in *H. cyaneus* and *Thaioodes* gen. n. *piceus* sp. n. I believe that they have arisen as a consequence of a specific adaptation and survival strategy for an aquatic manner of living. The remaining character states (i.e., 4, 5, 6, 7, 8, 10, 12, 15, and 16) demonstrate marked differences of a grade higher than the grade usual for species from one and the same genus. I treat each of these nine differences as of generic significance.

In conclusion, there are quite a number of considerable morphological differences between *Hololeius ceylanicus* and *H. cyaneus*, which taken together are cause for the separation of the latter in a separate genus. That is why *Bamaroodes* gen. n. is proposed to accommodate this species. The new taxon does not share main tribal characters of chlaeniines but shows important similarities with oodines. *Bamaroodes cyaneus* is therefore removed to a new tribal placement within Oodini. The relationships of the new genus are discussed below (see ‘Discussion’).

Table 2. Diagnostic character state combinations shown by exemplars of *Hololeius ceylanicus* and *H. cyaneus*.

No.	Characters	<i>Hololeius ceylanicus</i>	<i>Hololeius cyaneus</i>
01	Pubescence of integument	partly pubescent	glabrous
02	Punctuation of integument	punctate (Figs 1–3)	impunctate (Figs 13–16)
03	Antennomere 3	with a few short and scattered setae	glabrous
04	Mentum tooth form anteriorly	truncate	rounded
05	PW/PL	1.14–1.15 (Fig. 1)	1.24–1.37 (Fig. 13)
06	Basal margin of pronotum at posterior angles	oblique (Fig. 1)	gradually rounded (Fig. 13)
07	Pronotum	bordered laterally and lateroapically, not bordered medioapically and basally (Fig. 1)	bordered throughout (Fig. 13)
08	Elytral striae 1–8	1–7 punctate, 8 impunctate (Fig. 2)	impunctate (Fig. 14)
09	Stria 8	not or hardly deeper than other striae (Figs 2–3)	evidently deeper than other striae (Figs 14–16)
10	Elytral intervals	punctate (Figs 2–3)	impunctate (Figs 14–16)
11	Interval 9	distinct throughout	transformed into marginal gutter along anterior 2/5 of elytra, distinct in posterior 3/5
12	Number of umbilicate pores	23–25	15–16
13	Mesocoxa lateral margin	with one long seta	without seta
14	Joins of claws	opposite, distantly situated from each other	nearly parallel, closely situated to each other (Figs 14–15)
15	Number of pores on last sternum in female	four pores	two pores
16	Apical stylomere of ovipositor	subtriangular, as wide as basal stylomere, with 36 long ensiform setae at dorsomedial, dorsolateral and ventral position, and with nematiform setae, shorter than ensiform setae (Figs 10–11)	subelongate, nearly twice as narrow as basal stylomere, with 11 short ensiform setae at dorsomedial and dorsolateral position, and with nematiform setae, nearly twice as long as ensiform setae (Figs 17–18)



Figures 13–16. *Bamaroodes* gen. n. *cyaneus* (Facchini, 2011) from Khon Kaen, Thailand, female. **13.** Habitus; **14–16.** Elytra (**14.** left anterolateral view; a – distinct interval 9; b – transformed interval 9 into marginal gutter; **15.** left posterolateral view; a – deepened stria 8; b – distinct interval 9; c – parallel joints of tarsal claw of left middle leg; **16.** posterodorsal view; a – parallel joints of tarsal claw of right middle leg; b – obliterated striae 1–7 and flat intervals; c – lack of marginal gutter at apex). Scale bars = 2 mm (Fig. 13); = 1 mm (Figs 14–16).

***Bamaroodes cyaneus* (Facchini, 2011), comb. n.**

Fig. 8 (Facchini 2011: 337); Figs 13–18, 29 (present work)

Hololeius cyaneus Facchini, 2011: 350 (type locality: “Myanmar, Rangoon”)

Type material. Paratype ♀, “XII.1996 Burma Rangoon Klícha M. Lgt.” [printed, white], “*Mesosterno solcato* sulle linea mediana cavita coxali ... biperforate.” [handwritten, white], “Paratype *Hololeius cyaneus* n. sp. Det. Facchini 2011” [printed, red], “*Bamaroodes cyaneus* (Facchini) det. B.Guéorguiev 2014” [printed, white] (CFa).

Other material examined. 1♀, “NO-Thailand Khon Kaen 26.1.1981 lux leg. S.Saowakontha” [printed, white], “*Bamaroodes cyaneus* (Facchini, 2011) det. B.Guéorguiev 2014” [printed, white] (MNHUB).

Diagnosis. Same as the generic diagnosis.

Redescription (based on female sex). *Habitus.* Body semi-elongate, moderately convex (Fig. 13); tegument

wholly glabrous (excl. antennomeres 4–11), smooth, only disc of head moderately punctate and wrinkled. *Measurements* (data for paratype in parentheses brackets). BL: 8.5 (8.2) mm; BW: 3.65 (3.6) mm. *Ratios.* PW/HW: 1.39 (1.5); PW/PL: 1.24 (1.37); PbW/PaW: 1.34 (1.31); EW/PW: 1.59 (1.54); EL/EW: 1.38 (1.28). *Color.* Head and pronotum dark with strong bluish reflection, elytra mostly blackish with slight bluish color, with oblique yellow apical band (starting externally at apical fourth of elytron and directed obliquely to apical ninth of suture), mouthparts and femora dark reddish, tibia and tarsi red-yellow, palpi, antennomeres 1–3 and base of antennomere 4 yellowish, antennomeres 4–11 blackish. *Microsculpture.* Isodiametric on whole dorsal and most of ventral surface of body, transverse on prosternum medially and prosternal process, meso- and metacoxa, and metatrochanter. *Lustre.* Dorsal and ventral surfaces shiny. *Head.* Slightly narrower with respect to pronotum; disc moderately punctate and slightly wrinkled laterally, with a pair of supraorbital setae, frontal furrows indistinct; eyes fairly large, very prominent,

with vertical diameter longer than length of antennomere 1, tempora minute; clypeus punctate, subtrapezoid, with distinct clypeal suture, anterior margin slightly concave and two pores remote from anterior margin at distance as long as two diameters of pores; labrum subrectangular, with straight anterior margin and six setae removed back from margin, four medial setae closer to each other than to lateral setae; mandibles moderately large, pointed and hooked at apex; maxillae not exceeding mandibles, maxillary palpi considerably longer than labial palpi, with glabrous and elongate palpomeres, terminal palpomere slightly fusiform, palpomere 2 longer than 4; labium not fused, with distinct suture between mentum and submentum, mentum emarginate, with two setae, distinct labial pits, anterior margin bordered, median tooth large, simple, widely rounded at tip, and short epilobes, exceeding mentum tooth anteriorly; submentum with four long setae, two basal and two lateral, distance between two basal setae at least three times longer than distance between basal and lateral seta, basal setae longer than lateral ones and as long as transverse length of mentum; ligula broadened apically, its anterior margin with two long ventral setae, paraglossae slightly exceeding ligula in front, labial palpi elongate, glabrous, terminal palpomere slightly fusiform, penultimate palpomere slightly shorter than terminal one; antennae filiform, with antennomeres 1–3 and base of 4 glabrous, stipes 1.1 times longer than antennomere 3, with dorsal seta distally, pedicel with one ventral seta, antennomere 3 with six apical setae. *Pronotum*. Semi-round to semi-rectangular, moderately transverse, wider than long, widest before middle, margins with fine border throughout; disc slightly convex, smooth, midline finely impressed, longer than half pronotal length, not reaching anterior and posterior margins; sides more rounded anteriorly than posteriorly, without lateral setae, with laterobasal setae; anterior margin slightly concave, shorter than posterior margin, anterior angles round, not prominent; posterior margin convex laterally and concave medially, posterior angles briefly rounded; basal impressions faint, sublinear, parallel. *Elytra*. Oval, widest at middle, with convex disc; basal margin complete, touching parascutellar striola; sides regularly rounded from middle towards base and apex; shoulder broadly rounded, without denticle; striae linear, impunctate, and moderately impressed for most of length, 1–7 becoming punctiform and obliterated in apical fifth to fourth; striae 5–7 obliterated basally; stria 8 deeper than other striae throughout (Figs 14–15); parascutellar striola distinct, long, situated between suture and stria 1; intervals wide, flat and smooth throughout; intervals 7 and 8 separate (not fused) apically (Figs 15–16); interval 9 transformed into marginal gutter at anterior two fifths of elytra, distinct on posterior three fifths (Figs 14–15); marginal gutter ended at preapical situation, before apex of elytron (Fig. 16); parascutellar pore present, inside stria 1, close to meeting point of striae 1 and 2, discal punctures in interval 3 lacking, stria 7 with two punctures before apex, umbilicate series with 15–16 pores. *Hind wings*. Well-developed. *Ventral surface (thorax and abdomen)*. Sternal

part of thorax and abdomen smooth and shiny; intercoxal process of prosternum unbordered, prosternal keel moderately protruding posteriorly; mesosternum concave; metepisternum longer than wide, slightly narrowed behind, laterally coadunate with elytral epipleuron, with medial margin longer than anterior one, lateral margin longer than both anterior and medial margins. Abdomen with pair of ambulatory setae on sterna 4–5, sternum 6 with pair of marginal pores, each pore removed proximally from apical margin a distance about twice as long as diameter of pore. *Legs*. Long and fairly slender; procoxa without seta, mesocoxa with single posterior seta, metacoxa with anterior pore; pro- and mesotrochanter with one distal seta, metatrochanter without seta; profemur anterior, ventral and posterior faces glabrous, dorsal face with three-four short setae in distal half; mesofemur anterior face with five short and thick setae, ventral and posterior faces glabrous, dorsal face with 16–18 short, thick setae arranged in two rows; metafemur glabrous or with single pore on dorsal surface; protarsomere 1 longer than 2 and 3 combined, meso- and metatarsomere 1 as long as 2 and 3 combined, tarsomere 5 of all legs with two-four pairs of fine setae ventrally. *Male genitalia*. Unknown. *Female genitalia*. Ovipositor consists of valvifer and stylomere (Figs 17–18); distal margin of valvifer with some long setae; basal stylomere subconical, its ventral surface with 10–11 thin setae directed to apical stylomere, two medial setae rather short, others long (some of lateral setae longer than half length of apical stylomere); apical stylomere subelongate, nearly twice as narrow as basal stylomere, with 11 short, subtriangular, moderately chitinated ensiform setae (3 dorsomedial and 8 dorsolateral) and two thin nematiform setae, nearly twice as long as ensiform setae.

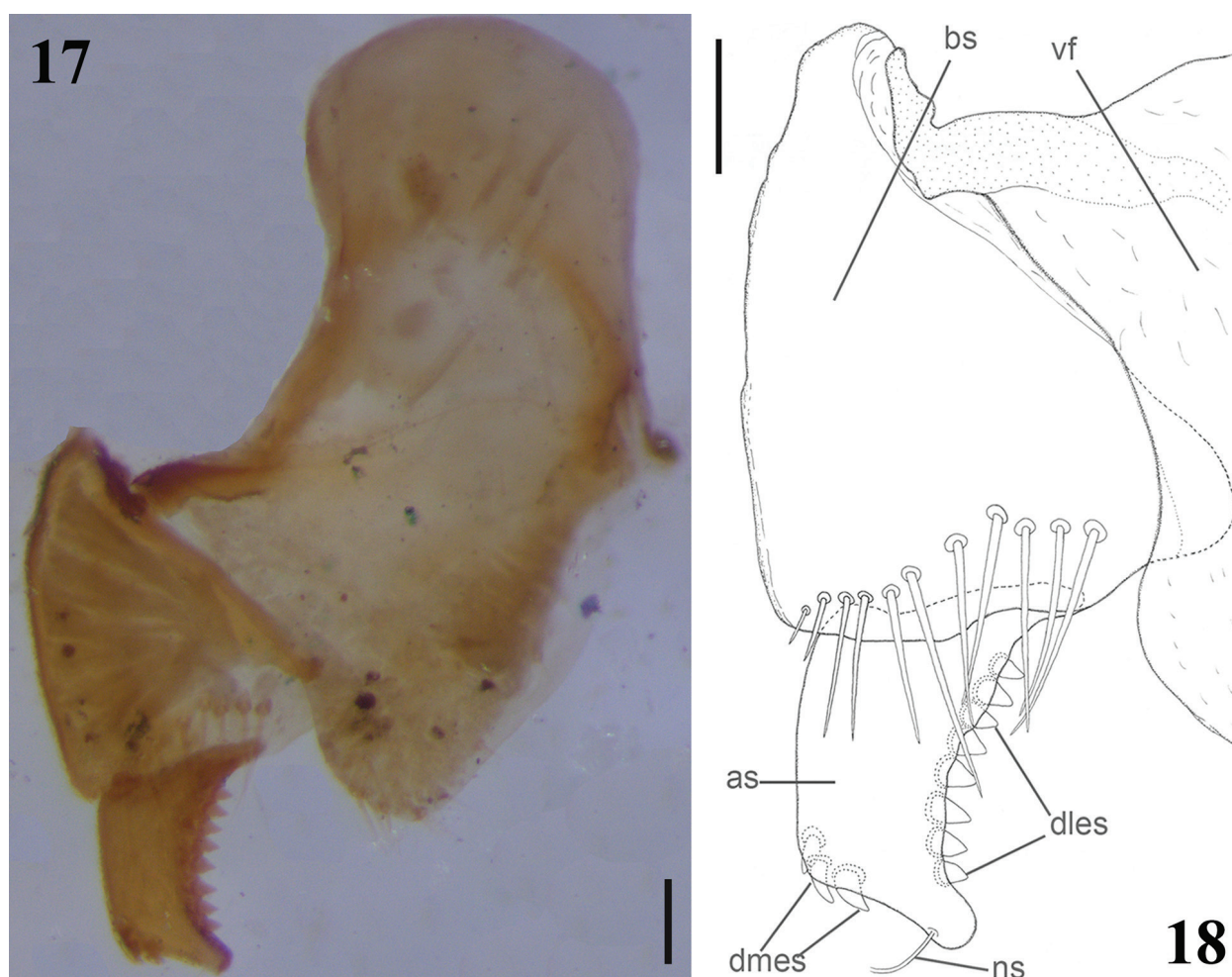
Distribution. Myanmar, Rangoon (Facchini 2011: 351); Thailand, Khon Kaen Province.

Thaioodes gen. n.

<http://zoobank.org/605266A8-7B56-45DE-AD3F-B4B112FCD209>

Type species. *Thaioodes piceus* B. Guéorguiev sp. n.

Diagnosis. Small to medium-sized species (6.7–6.9 mm) for Oriental Oodini, habitus semi-elongate; color piceous on dorsal and ventral surface, with slight bluish color dorsally, antennomeres 1–3 of antennae, palpi, tibiae, tarsomeres red-yellow to yellow; microsculpture isodiametric; tegument completely glabrous and impunctate, only disc of head lightly punctate; head with conspicuously large eyes and minute tempora; frons with punctiform impressions and one pair of supraorbital punctures; labrum with six setae along anterior margin; clypeus with two setae; labial palpomere glabrous; mentum tooth rounded anteriorly, bordered posteriorly; pronotum subquadrate, rounded, without protruded angles, with anterior and posterior margins of nearly equal width; sides of pronotum bordered apically and laterally, not bordered basally; anterolateral and posterolateral setae lacking; laterobasal impressions faint, sublinear; elytra with well-im-



Figures 17–18. *Bamaroodes* gen. n. *cyaneus* (Facchini, 2011) from Khon Kaen, Thailand, left ovipositor, ventral view. **17.** Photograph; **18.** Line drawing (as – apical stylomere; bs – basal stylomere; dles – dorsolateral ensiform setae; dmes – dorsomedial ensiform setae; ns – nematiform setae; vf – valvifer). Scale bars = 0.1 mm.

pressed striae, distinct to apex; striae 5–7 obliterated basally; stria 8 grooved along most of its length, deeper than striae 1–7; parascutellar striola well-developed, long, situated between suture and stria 1; intervals impunctate, smooth, subconvex in anterior half, convex posteriorly; interval 3 at apex nearly twice as broad as intervals 1 and 2; intervals 7 and 8 fused posteriorly or not to apex; interval 8 (or its substitute interval 7) forming outward ridge, moderately elevated, more distinct along posterior half of elytra; interval 9 transformed into marginal gutter throughout; marginal gutter distinct to apex of elytron; prosternal process bordered; mesosternum concave; metepisternum laterally coadunate with elytral epipleuron; sterna 4–5 with pair of minute ambulatory setae; apical sternum without setae in male; mesocoxa without lateral seta, with posteromedial seta; metacoxa with anterior pore; mesofemur without posterior setae; metafemur glabrous; protarsomeres 1 and 3 in males longer than wide, tarsomere 2 subquadrate, each with variable number of small round adhesive setae with oval discs underneath; tarsomere 5 of all legs setose ventrally.

Etymology. A compound word, based on the ethnic name of the predominating people in the country where the type species was found, Thai, and *Oodes* (for the etymology of this name see Bousquet 2012: 955). It is treated as a Latin masculine.

Affinities. Specific characters of the new genus correspond with the basic features of Oodini as far as these have been outlined by Jeannel (1949a) and Bousquet (1996): 1, integument of body glabrous and largely impunctate; 2, antennomere 3 glabrous, excluding apical setae; 3, stria 8 deeper than other striae; 4, interval 8 forming outward ridge posteriorly; 5, interval 9 transformed into marginal gutter.

Thaioodles gen. n. is most closely allied to *Bamaroodes* gen. n. (see ‘Discussion’). The former genus differs from the latter genus by: 1, tegument unicolored dorsally (vs. tegument bicolored dorsally); 2, pronotum slightly wider than long (PW/PL: 1.18), with sides partly bordered (vs. pronotum distinctly wider than long, PW/PL: 1.24–1.37, with sides finely bordered throughout); 3, anterolateral and basolateral setae of pronotum lacking (vs. anterolateral seta lacking, basolateral setae present); 4, all striae

of elytra distinct to apex (vs. elytral striae 1–7 obliterated before apex); 5, stria 7 ending before apex or joining stria 8, thus intervals 7 and 8 fused posteriorly (vs. stria 7 separate before apex, thus intervals 7 and 8 not fused posteriorly); 6, intervals convex posteriorly (vs. intervals uniformly flat throughout); 7, interval 8 forms ridge posteriorly (vs. interval 8 not forming ridge posteriorly); 8, interval 9 transformed into marginal gutter throughout (vs. interval 9 transformed into marginal gutter only at anterior two fifths of elytron); 9, marginal gutter distinct to apex of elytron (vs. marginal gutter ended before apex of elytron); 10, umbilicate series of elytra with 19–20 pores (vs. umbilicate series with 15–16 pores); 11, prosternal process bordered (vs. prosternal process unbordered).

In my estimation, the presented series of differences and their opposed states are enough to differentiate *T. piceus* sp. n. from *B. cyaneus* at a generic level.

Thaioodes piceus sp. n.

<http://zoobank.org/7DBEBADB-7668-4C93-80D4-12C9F0C60FE2>

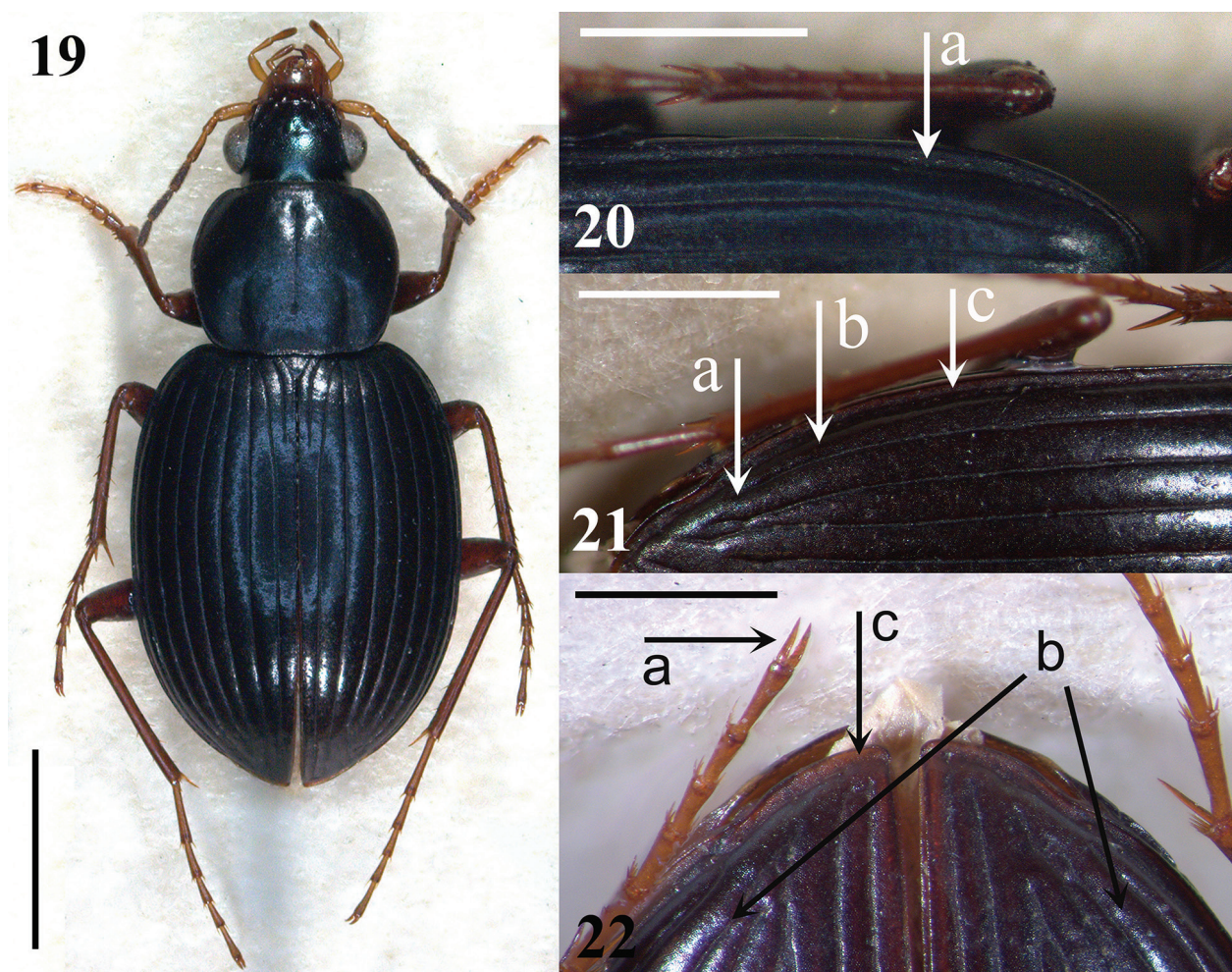
Figs 19–29

Type material. Holotype ♂, well-preserved (segments 7–11 of both antennae lacking), mounted on card, genitalia dissected and deposited in euparal on a plastic vial pinned under the card, “Nordost Thailand Khon Kaen, lux 23.11.1980 leg. S.Saowakontha” [printed, white], “HOLOTYPE *Thaioodes* gen. nov. *piceus* sp. nov. B.Guéorguiev des. 2014” [printed, red] (MNHUB).

Diagnosis. Same as the generic diagnosis.

Description (based on male sex). *Habitus.* Body semi-elongate, moderately convex; tegument wholly glabrous (excl. antennomeres 4–11), smooth, only disc of head finely punctate (Fig. 19). *Measurements.* BL: 6.8 mm; BW: 3.1 mm. *Ratios.* PW/HW: 1.44; PW/PL: 1.18; PbW/PaW: 1.25; EW/PW: 1.59; EL/EW: 1.34. *Color.* Body black dorsally and ventrally, mouthparts and femora reddish, palpi, antennomeres 1–3, base of antennomere 4, tibia and tarsi yellowish, antennomeres 4–11 blackish. *Microsculpture.* Isodiametric on whole dorsal and most of ventral surface (proepisternum, metepisternum, abdomen) of body, transverse on prosternum medially and prosternal process, meso- and metacoxa, and metatrochanter. *Lustre.* Dorsal and ventral surfaces shiny. *Head.* Somewhat narrower with respect to pronotum; disc finely punctate, with one pair of supraorbital setae, frontal furrows indistinct; eyes fairly large, very prominent, with vertical diameter longer than length of antennomere 1, tempora minute; clypeus subtrapezoidal, with perceptible clypeal suture, anterior margin slightly concave and two pores removed back from anterior margin at distance longer than diameter of pores; labrum subrectangular, with concave anterior margin and six setae removed back from margin, four medial setae closer to each other than to lateral setae; mandibles moderately large, pointed and hooked at apex; maxillae not exceeding mandibles, maxillary palpi considerably longer than labial palpi, with

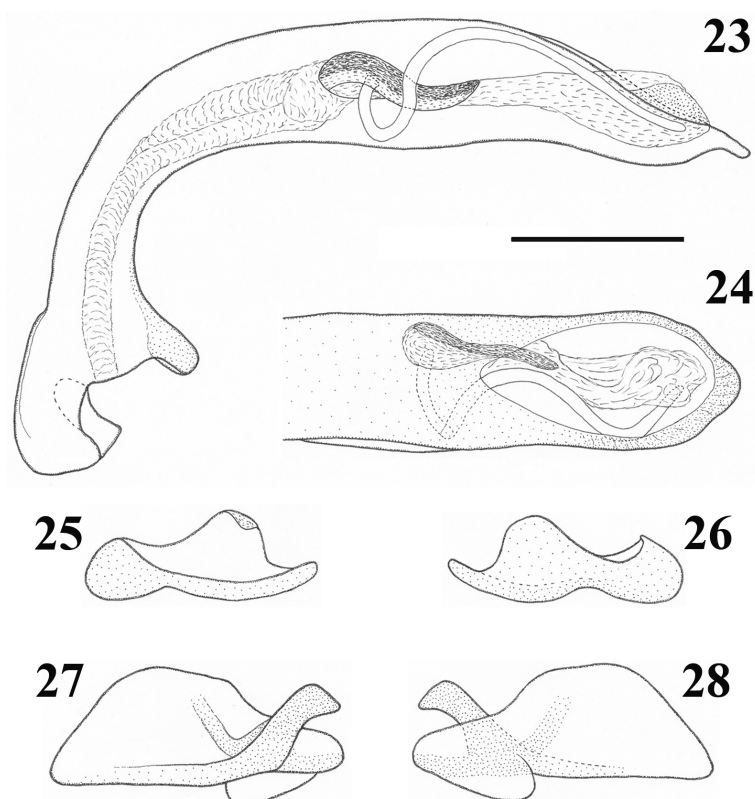
glabrous and elongate palpomeres, terminal palpomere slightly fusiform, palpomeres 2 and 4 nearly of equal length; labium not fused, with distinct suture between mentum and submentum, mentum emarginate, with two setae, indistinct labial pits, anterior margin bordered, median tooth large, simple, widely rounded at tip, epilobes short, slightly exceeding tooth anteriorly; submentum with four long setae, two basal setae and two lateral setae, distance between two basal setae at least two times longer than distance between basal and lateral seta, basal setae longer than lateral ones and as long as transverse length of mentum, ligula broadened apically, its anterior margin with two long ventral setae, paraglossae rounded, distinctly exceeding anterior margin of ligula, labial palpi elongate, glabrous, terminal palpomere slightly fusiform, penultimate palpomere slightly shorter than terminal palpomere; antennae filiform (antennomeres 7–11 in both antennae lacking), with antennomeres 1–3 and base of 4 glabrous, stipes 1.13 times longer than antennomere 3, with dorsal seta distally, pedicel with one ventral seta, antennomere 3 with six apical setae. *Pronotum.* Round, nearly as long as wide, widest just before middle, margins with fine border apically (border somewhat reduced medially), laterally and basally to posterior angles, not bordered basally between impressions; disc slightly convex, smooth, with midline finely impressed, longer than half pronotal length, not reaching anterior and posterior margins; sides evenly rounded anteriorly and posteriorly, without lateral and laterobasal setae; anterior margin slightly concave, somewhat shorter than posterior margin, anterior angles rounded, not prominent; posterior margin between basal impressions nearly straight, posterior angles completely rounded; basal impressions faint, sublinear, parallel, stretching at distance of one third of pronotum length. *Elytra.* Oval, widest about middle, with convex disc; basal margin complete, touching parascutellar striola; sides regularly rounded from middle towards base and apex; shoulder completely rounded, without denticle; striae impunctate, moderately impressed, striae 5–7 obliterated basally (Fig. 20); stria 7 ends before apex (left elytron) or joins stria 8 (right elytron) (Fig. 22); stria 8 deeper than other striae, more deepened apically than basally (Figs 20–21); parascutellar striola distinct, long, situated between suture and stria 1; intervals impunctate, smooth, subconvex in anterior half, convex posteriorly; interval 3 at apex about twice as wide as intervals 1 and 2; intervals 7 and 8 fused posteriorly (left elytron) or interval 7 (replacing interval 8) continues to apex (Fig. 22); interval 8 (or its substitute interval 7) elevated externally, more pronouncedly along posterior half of elytra (Figs 20–22); interval 9 transformed into marginal gutter throughout (Figs 20–21); marginal gutter distinct to apex of elytron (Fig. 22); parascutellar puncture present, inside stria 1, close to meeting point of striae 1 and 2; discal punctures in interval 3 lacking; junction of joined striae 7+8 and marginal gutter with two punctures before apex (situated behind last umbilicate pore); umbilicate series with 19–20 punctures.



Figures 19–22. *Thaioodes* gen. n. *piceus* sp. n. from Khon Kaen, Thailand, holotype. **19.** Habitus; **20–22.** Elytra (**20.** left anterolateral view; a – transformed interval 9 into marginal gutter; **21.** left posterolateral view; a – end of stria 7 and fusion of intervals 7 and 8; b – outward ridge formed by interval 8; c – transformed interval 9 into marginal gutter; **22.** posterodorsal view; a – parallel joints of tarsal claw of right hind leg; b – impressed striae 1–7 and convex intervals; c – presence of marginal gutter at apex). Scale bars = 2 mm (Fig. 19); = 1 mm (Figs 20–22).

Hind wings. Well-developed. *Ventral surface (thorax and abdomen).* Sternal part of thorax and abdomen smooth and shiny; intercoxal process of prosternum bordered, indistinctly at sides, distinctly posteriorly, prosternal keel moderately protruding posteriorly; mesosternum concave; metepisternum slightly longer than wide, narrowed behind, laterally coadunate with elytral epipleuron, with medial margin slightly longer than anterior one, lateral margin distinctly longer than anterior and medial margins. Abdomen with pair of minute pores on sterna 4–5, sternum 6 without apical setae. *Legs.* Long and fairly slender; procoxa without seta, mesocoxa with one posterior seta, metacoxa with anterior pore; pro- and mesotrochanter with one distal seta, metatrochanter without seta; profemur anterior, ventral and posterior faces glabrous, dorsal face with one-two, short, thick setae in distal half; mesofemur anterior face with five short and thick setae in one row, ventral and posterior faces glabrous, dorsal face with about 12 short, thick setae arranged in two rows, anterior row widely interrupted, consists of one proximal

and two distal setae, posterior row continuous, consists of 9–10 setae; metafemur glabrous; protarsomeres 1–3 of male slightly dilated, nearly symmetrical, protarsomere 1 longer than wide, subtriangular, longer than following two protarsomeres, distal half with 16 (on left leg) and 17 (on right leg) small, round adhesive discs ventrally; protarsomere 2 as long as wide, subquadrate, wider, and as long as protarsomere 3, with 17 (on left leg) and 13 (on right leg) round adhesive discs ventrally; protarsomere 3, longer than wide, sub-rectangular, with 7 (on left leg) and 8 (on right leg) round adhesive discs ventrally; meso- and metatarsi with tarsomere 1 as long as or longer than tarsomeres 2 and 3 combined; tarsomere 5 of all legs with two pairs of setae ventrally. *Male genitalia.* Median lobe of aedeagus long, slender, curved laterally, with complex internal structure (Figs 23–24); basal part short, narrow, with small bulb and orifice deeply concave in lateral aspect, regularly bent towards massive and broadened medial part, dorsal margin convex to straight, ventral margin undulating, apical lamella goes down at tip;



Figures 23–28. *Thaiodes* gen. n. *piceus* sp. n. from Khon Kaen, Thailand, holotype, male genitalia. **23.** Median lobe of aedeagus, left lateral view; **24.** Median lobe of aedeagus, dorsal view; **25–26.** Right paramere, internal and external face; **27–28.** Left paramere, internal and external face. Scale bar = 0.3 mm.



Figure 29. Map of Southeast Asia with localities (blue circle – Rangun, type locality of *Bamaroodes* gen. n. *cyaneus* (Facchini, 2011); red circle – Khon Kaen, type locality of *Thaiodes* gen. n. *piceus* sp. n. and second known locality of *Bamaroodes* gen. n. *cyaneus* (Facchini, 2011)).

median lobe long, straight, almost symmetrical in dorsal aspect, slightly widened distally, with apical orifice elliptic and lamella broadly rounded off; inner sac with two chitinized, differently shaped structures: proximal paddle-like sclerite and medial threadlike filament; parameres different in shape, right one elongate, thick, with dorsal margin contiguously widely elevated and broadly concave (Figs 25–26), left paramere conchoidal, with thick, strongly chitinized and oblique process internally (Figs 27–28). *Female genitalia*. Unknown.

Distribution. Thailand, Khon Kaen Province.

Etymology. The specific epithet *piceus* is Latin, draws attention to the predominant glossy black color of this beetle. An adjective in the nominative singular.

Discussion

Representatives of Chlaeniini and Oodini share features, which also occur in the two new genera: 1, frontal impressions punctiform; 2, head with one pair of supraorbital setae; 3, penultimate segment of labial palpi glabrous; 4, pronotum without anterolateral setae; 5, metepisternum laterally coadunate with the elytral epipleuron; 6, mesofemur posterior margin without longer setae; 7, metacoxa lacking posterior seta; 8, median lobe of aedeagus with reduced basal bulb. Regardless of this characterization *Bamaroodes* gen. n. and *Thaioodes* gen. n. display common character states with the oodines, which are not present in the chlaeniines: 1, tegument of body glabrous (excl. antennomeres 4–11); 2, tegument of body largely impunctate; 3, posterior margin of pronotum not fringed; 4, stria 7 ended before apex; 5, stria 8 deeper than other striae; 6, interval 9 transformed into marginal gutter partially or throughout. In addition, *Thaioodes* gen. n. exhibits: intervals 7 and 8 fused posteriorly to form a ridge posteriorly that extends to, or very close to, the suture. This condition was noted as the most fundamental feature of Oodini (Jeannel 1942: 961, 979, 1949a: 775, 828, Bousquet 1996: 448). Also, it is considered as one of the two synapomorphies in the tribe (Bousquet *ibid.*).

Special traits shared by the two new genera imply that they form clade:

- 1) *Body shape semi-elongate*. This habitus is owing to *pronotum anterior and posterior margin with similar widths* and *pronotum posterior margin narrower than basal margin of elytra*. All other examined Oodini have elliptic or broadly oval (amariform) shape of body which is due to a subtrapezoidal pronotum having the anterior margin distinctly narrower than the posterior margin, as well pronotum posterior margin and basal margin of elytra of similar width.
- 2) *Discal punctures in interval 3 lacking*. The majority of oodines from the Old World have two small discal setiferous punctures in the interval 3 of elytra.
- 3) *Mesocoxa lateral margin without seta*. This state is not typical of any other Oodini that I know. The spe-

cies from this tribe usually have one, long and thick seta, and rarely two such setae on the lateral margin of the mesocoxa. It is also not typical of Chlaeniini, which commonly possess two or more such setae.

- 4) *Tarsomere 5 of all tarsi setose ventrally*. As far as I know, all representatives of Oodini (except for a few species of *Systolocranius*) have the last segment of the tarsi without setae. To the contrary, the species of Chlaeniini have tarsomere 5 always setose ventrally.
- 5) *Joints of the claws of tarsomere 5 parallel, situated closely to each other*. As a rule, all epigeous carabid beetles have opposite joining of claws, situated distantly from one another. Such a position is certainly convenient to their movement on the ground. However, the convergence of the joints of the claws is a modification to a different way of moving, perhaps to aid movement in an aquatic environment.

To my knowledge, these character states do not occur together in other taxa of the Oodini. Characters 3 and 5 exhibit derived characteristics shared by the two new genera. This fact reveals that most probably the taxa form a clade. Additionally, attributes 1, 3, and 5 are not present in any other group of oodines. Characters 1, 2 and 4 are typical for many Chlaeniini, so that they are considered symplesiomorphies in *Bamaroodes* gen. n. and *Thaioodes* gen. n. But this assumption should be cleared up by future study. Attributes 1 and 4 are also clearly plesiotypic in the Carabidae Conchifera. The reduction of the elytral discal pores is a homoplasy that has occurred many times in different lineages.

All of the above facts make me believe that the lineage of these genera may be an adelphotaxon of the rest of the Oriental Oodini.

In conclusion, the two genera appear remotely related to *Hololeius*, which, however, displays many primitive conditions, conforming to its current position in Chlaeniini. It is worth noting that each of the three genera possesses the following character states: 1, penultimate labial palpomere glabrous; 2, antennomeres 1–3 lighter colored than the other antennomeres; 3, pronotum posterior margin not fringed; 4, stria 8 deeper than the other striae; 5, discal punctures of elytra lacking; 6, intercoxal process of prosternum glabrous; 7, abdominal sternum 3 without ambulatory setae; 8, tarsomere 5 of all legs setose ventrally. Together *Bamaroodes* gen. n. and *Thaioodes* gen. n. differ from *Hololeius* (in parentheses) in: 1, mentum tooth rounded (vs. mentum tooth truncate); 2, antennomere 3 glabrous (vs. antennomere 3 with a few short and scattered setae); 3, all striae of elytra impunctate (vs. elytral striae 1–7 punctate); 4, elytral intervals impunctate (vs. elytral intervals punctate); 5, interval 9 transformed into marginal gutter partially or throughout (vs. interval 9 distinct throughout); 6, mesocoxa lateral margin without seta (vs. mesocoxa lateral margin with a long seta); 7, joints of the claws parallel, situated closely to each other (vs. joins of claws opposite, situated distantly from each other).

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References

- Andrewes HE (1923) Descriptions of some new Carabidae from Ceylon. (Part I). *Spolia Zeylandica* 12: 223–251.
- Andrewes HE (1935) Schwedisch-chinesische wissenschaftliche Expeditionennachden Nordwestlichen Provinzen Chinas, unter Leitung von Dr. Sven Hedin und Prof. Su Ping-Chang. Insecten gesammelt von schwedischen Artz der Expedition Dr. David Hummel 1927–1930. 18. Coleoptera. 4. Carabidae und Cicindelidae. C. Harpalinae: Apotomini, Broscini, Pogonini, and Chlaeniini. *Arkiv för Zoologi* 27A (4): 8–12.
- Andrewes HE (1940) Keys to some Indian genera of Carabidae (Col.). X. The genus *Oodes*. The Proceedings of the Royal Entomological Society of London (B) 9: 203–208.
- Basilewsky P (1953) Exploration du Parc National de l'Upemba. Mission G. F. De Witte. Carabidae (Coleoptera Adephaga). Institut des Parcs Nationaux du Congo Belge 10: 3–252, 10 pls.
- Bates HW (1892) Viaggio di Leonardo Fea in Birmania e regioni vicine. XLIV. List of the Carabidae. *Annali del Museo Civico di Storia Naturale di Genova* 32: 267–428.
- Bousquet Y (1987) Notes about the relationships of the Callistini (= Chlaeniini) (Coleoptera: Carabidae). *The Coleopterists Bulletin* 41: 165–166.
- Bousquet Y (1996) Taxonomic revision of Nearctic, Mexican, and West Indian Oodini (Coleoptera: Carabidae). *The Canadian Entomologist* 128: 443–537. doi: 10.4039/Ent128443-3
- Bousquet Y (2012) Catalogue of Geadephaga (Coleoptera, Adephaga) of America, north of Mexico. *ZooKeys* 245: 1–1722. doi: 10.3897/zookeys.245.3416
- Chaudoir M de (1857) Mémoire sur la famille des carabiques. 6-e partie. (Continuation.). *Bulletin de la Société Impériale des Naturalistes de Moscou* 30 (3): 1–64.
- Chaudoir M de (1882) Monographie de oodides 1^{re} partie. *Annales de la Société Entomologique de France* (6^e Série) 2: 317–378.
- Chaudoir M de (1883) Monographie de oodides 2^{re} partie. *Annales de la Société Entomologique de France* (6^e Série) 2: 485–554.
- Darlington PJr (1968) The carabid beetles of New Guinea Part III. Harpalinae (continued): Perigonini to Pseudomorphini. *Bulletin of the Museum of Comparative Zoology* 137 (1): 1–253. <http://www.biodiversitylibrary.org/part/11926>
- Dejean PFMA (1826) *Species général des coléoptères, de la collection de M. le Comte Dejean*. Tome second. Crevot, Paris, viii + 501 pp.
- Erwin TL (1974) The Genus *Coptocarpus* Chaudoir of the Australian Region with Notes on Related African Species (Coleoptera: Carabidae: Oodini). *Smithsonian Contributions to Zoology* 184: 1–25.
- Facchini S (2011) Otto nuove specie e un nuovo genere di Chlaeniini Brullé, 1834 delle Regioni Afrotropicale e Orientale (Coleoptera Carabidae, Chlaeniini). *Giornale Italiano di Entomologia* 12/56: 381–394.
- Guéorguiev B (2013) Taxonomic, nomenclatural, and faunistic records for species in tribes Melaenini, Moriomorphini, Pterostichini, Licinini, and Sphodrini (Coleoptera: Carabidae). *Zootaxa* 3709 (1): 052–070 (3 September 2013). doi: 10.11646/zootaxa.3709.1.2
- Habu A (1956) On the genera and species of the Oodini (Coleoptera, Carabidae) from Japan. *The Bulletin of the National Institute of Agricultural Sciences (C)* 6: 49–73.
- Habu A (1958) Additional notes on the study of the Oodini from Japan (Coleoptera, Carabidae). *Kontyû* 26: 191–194.
- Heller KM (1923) Die Coleopterenausbeute der Stotzerschen Sze-Tschwan-Expedition. *Entomologischen Blätter* 19: 61–79.
- ICZN [International Commission on Zoological Nomenclature] (1999) International Code on Zoological Nomenclature, fourth edition, adopted by the International Union of Biological Sciences. International Trust for Zoological Nomenclature, London, online version: <http://www.iczn.org/iczn>
- Ito N (2003) Note on Species of the Genus *Holosoma* (Coleoptera: Carabidae: Oodinae: Simoini). *The Entomological Review of Japan* 58 (1): 95–104.
- Ito N (2012) Two New Species and One Subspecies of the Genus *Holosoma* from China (Coleoptera, Carabidae, Oodini). *Elytra*, Tokyo, New Series 2 (2): 303–310.
- Jakobson GG (1906) Fasc. 4. In: Devrien AF (Ed.) *Zhuki Rossii i Zapadnoi Evropy*. A.F. Devrien, Sankt-Petersburg, 241–320.
- Jeannel R (1942) Faune de France. Vol. 40. Coléoptères Carabiques II. Lechevalier, Paris, 600 pp.
- Jeannel R (1949a) Coléoptères carabiques de la région Malgache (troisième partie). Faune de l'Empire Français, IX. Office de la Recherche scientifique colonial, Paris, 767–1146.
- Jeannel R (1949b) Ordre des Coléoptères (Coleoptera Linné, 1758). Partie Systématique (part). In: Grassé P-P (Ed.) *Traité de Zoologie. Anatomie, Systématique, Biologie*. Tome IX. Masson, Paris, 1026–1077.
- Jedlička A (1931) Neue Carabiden aus China-Szechuan. *Časopis Československé Společnosti Entomologické* 1/2: 21–30.
- Jedlička A (1936) Neue Carabiden aus Ostasien. (XI. Teil). *Entomologisches Nachrichtenblatt* 10 (1): 51–55.
- Kirschenhofer E (1995) Neue Arten Gattung *Holosoma* Semenov, 1889 aus China (Col. Carabidae, Oodiinae, Trib. Simoini). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 47: 77–84. http://www.landesmuseum.at/pdf_frei_remote/ZAOE_47_0077-0084.pdf
- Kirschenhofer E (1998) Neue Chlaeniinae der palaearktischen und orientalischen Region (Coleoptera, Carabidae). *Entomofauna* 19/20: 317–332. http://www.landesmuseum.at/pdf_frei_remote/ENT_0019_0317-0329.pdf

- LaFerté-Sénéctère F de (1851) Révision de la tribu des patellimanes de Dejean, Coléoptères pentamères de lades carabiques. Annales de la Société Entomologique de France (2^e série) 9: 209–294. <http://www.biodiversitylibrary.org/part/16123#/summary>
- Lorenz W (1998) Systematic list of extant ground beetles of the world (Insecta Coleoptera “Geadephaga”: Trachypachidae and Carabidae incl. Paussinae, Cicindelinae, Rhysodinae). First edition. Published by the Author, Tutzing, ii + 502 pp.
- Lorenz W (2005) Systematic list of extant ground beetles of the World. (Insecta, Coleoptera, Adephaga: Trachypachidae & Carabidae incl. Paussinae, Cicindelinae, Rhysodinae). Second edition. Published by the Author, Tutzing, ii + 530 pp.
- Louwerens CJ (1951) New Carabidae from the Malay Archipelago (2nd Communication on Oriental Carabidae). Treubia 21: 117–132. <http://www.repository.naturalis.nl/document/150515>
- Moore BP (1979) Chemical defence in carabids and its bearing on phylogeny. In: Erwin TL, Ball GE, Whitehead DR, Halpern AL (Eds) Carabid beetles: their evolution, natural history, and classification. Junk, The Hague: 193–203. http://link.springer.com/chapter/10.1007/978-94-009-9628-1_9
- Niether J (1856) Entomological papers, being chiefly descriptions of new Ceylon Coleoptera with such observations on their habits as appear in any way interesting. Journal of the Asiatic Society of Bengal 25: 381–394, 523–554.
- Schrank F de Paula (1781) Enumeratio insectorum Austriae indigenorum. Vidvum Eberhardi Klettel et Franck, Augustae Vindelicorum, [24] + 548 + [2] pp. + 4 pls.
- Semenov AP (1889) Aperçu des genres paléarctiques de la tribu des anchomenides (famille des carabiques). Bulletin de la Société Impériale des Naturalistes de Moscou (nouvelle série) 2: 686–693. [1888]
- Semenov AP (1927) Analecta coleopterologica. Koleopterologicheskie zametki. XX. Russkoe Entomologicheskoe Obozrenie 21: 230–239.
- Sloane TG (1910) Revisional Notes on Australian Carabidae. Part iii. Tribes Oodini, Chlaeniini, and Sphodrini [Coleoptera]. Proceedings of the Linnean Society of New South Wales 35: 435–480.
- Spence JR (1983) Taxonomic status, relationships, and biogeography of *Anatrichis* LeConte and *Oodinus* Motschulsky (Carabidae: Oodini). The Coleopterist Bulletin 36 (4): 567–580. <http://www.jstor.org/stable/4007993>
- Tryon H (1890) Coleoptera collected by Mr. A.C. English in the St. Joseph River District of British New Guinea, under the auspices of His Honour the Administrator. Second Annual Report of the Administrator on British New Guinea, Appendix V: 109–112.

A taxonomic revision of *Parallelodemus* Faust from South China (Coleoptera, Curculionidae, Baridinae), with notes on sexually dimorphic characters

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Abstract

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Nine species of *Parallelodemus* Faust are reported from China. In addition to the previously recorded *P. impar* Voss, we found *P. docile* Faust, *P. vicinum* Faust and the following six species newly described herein: *P. dimetans* **sp. n.**, *P. feae* **sp. n.**, *P. petilum* **sp. n.**, *P. plumosum* **sp. n.**, *P. setifrons* **sp. n.** and *P. tumens* **sp. n.** *Parallelodemus tarsale* Voss from Java is transferred to *Lepidomyctides* Yoshihara and Morimoto (**comb. n.**). Lectotypes are designated for *P. docile*, *P. imperfectum* Faust, *P. perfectum* Faust, *P. tardum* Faust and *P. vicinum*. Several morphological modifications with unknown functions are documented, illustrated and discussed. Males of some species have special setae on rostrum, antennal scape and mesotarsus. A medially notched epistome apparently occurs in both sexes but seems to wear off in females, probably during the preparation of oviposition sites. The mandible is unusual in having a convex, edentate inner face and incisor-like structures on the outer face.

Introduction

Among the currently accepted 548 genera of baridine weevils, *Parallelodemus* Faust is notable for having numerous morphological peculiarities. Faust (1894) noticed modified setae on the male mesotarsus of two of his five species and a loss of the two distal tarsites in another [actually present but minute]. Voss (1941) commented on the basally bifurcate prosternum of female *P. impar* Voss, and Marshall (1945) and Morimoto and Yoshihara (1996) on apparently abducent mandibles. To this one may add the frequently worn female epistome and marked sexual dimorphism of further body parts, such as rostrum, antennal scape and eye, in at least some species. However, this interesting genus is taxonomically challenging because of great morphological similarity of the species, pronounced sexual dimorphism and scarcity of material in collections. China is presently the only country with noteworthy collections of *Parallelodemus*. In this paper, we revise the Chinese species and document taxonomically important characters of the genus.

Material and methods

Our study is based primarily on specimens of the Institute of Zoology of the Chinese Academy of Sciences (IZCAS), which were collected during the past 60 years. Their collecting data are transcribed herein to Pinyin (original Chinese spelling is given for primary types) and we provide the unique IZCAS database identifiers in square bracket behind the collecting date. Additional specimens were studied from the following collections: Forschungsmuseum Alexander Koenig, Bonn, Germany (AKMB); Natural History Museum, London, UK (BMNH); Bernice P. Bishop Museum, Honolulu, Hawaii (BPBM); Canadian Museum of Nature, Ottawa, Canada (CMNC); Naturhistorisches Museum Basel, Switzerland (NHMB); Jens Prena personal collection, Rostock, Germany (JPPC); Museo civico di storia naturale Giacomo Doria, Genoa, Italy (MSNG); Senckenberg Naturforschendes Museum, Frankfurt a. Main, Germany (SFFM); Senckenberg Naturhistorische Sammlungen, Dresden, Germany (SNSD); Zhejiang A & F

University, Zhejiang, China (ZAFU) and Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia (ZIN). The above codens are used to refer to collections in the text. A total of 154 specimens was examined. Faust returned approximately half of the type series of his newly described species to L. Fea (the owner) and shared the rest with L. v. Heyden. Whenever possible, we designated as lectotype a male from the material returned to Fea and ignored the unpublished designations in Faust's retained material, which were made by museum staff subsequent to the acquisition of his collection.

If not provided on the label, coordinates of collecting sites were determined with GoogleEarth. Approximate collecting sites of Fea's specimens, from his 1885–89 journey to Myanmar, were estimated based on his travel itinerary (Vinciguerra 1890; Fea 1896). Descriptions are structured hierarchically, i.e., constant generic characters are not repeated in the descriptions of species. We found no evidence for a species with a sexually dimorphic epistome. However, the female epistome apparently wears off so we described it only for the male. Measurements of length were taken with an ocular micrometer in a stereomicroscope. Total length was measured from the anterior margin of eye to the abdominal apex in dorsal view. Length-width ratios of the penis are approximate values which do not take into account curvature. Illustrations were prepared from images taken with a Micropublisher 5.0 RTV digital CCD camera mounted on a Zeiss STEREO Discovery V12 or a Canon EOS 650D on a Leica DM2500 compound microscope. Aldus Freehand was used for vector graphics and Adobe Photoshop for pixel-based artwork. All genitalia illustrations were prepared from specimens collected in China. Explanations for morphological terms can be found at <http://weevil.info/glossary-weevil-characters>. Our weevil classification follows Oberprieler et al. (2014) except that we maintain Baridinae and Ceutorhynchinae as separate subfamilies.

Taxonomy

Genus *Parallelodemas* Faust

Parallelodemas Faust, 1894: 306. Type species *Parallelodemas perfectum* Faust, by subsequent designation (Morimoto and Yoshihara 1996). Gender originally female, changed to neuter because of the grammatical gender of the Ancient Greek base word δέμας (Alonso-Zarazaga and Lyal 1999).

Diagnosis. Species of *Parallelodemas* can be recognized by characteristically elongate body (Fig. 1), medially notched epistome (which often is worn in females) and exodontous mandibles with evenly convex inner face (Fig. 3). Superficially, they resemble species of the conoderine subtribe Phaenomerina (see Morimoto 1961), but those have incrassate, ventrally dentate femora and larger eyes. The characters on the mandible and epistome separate

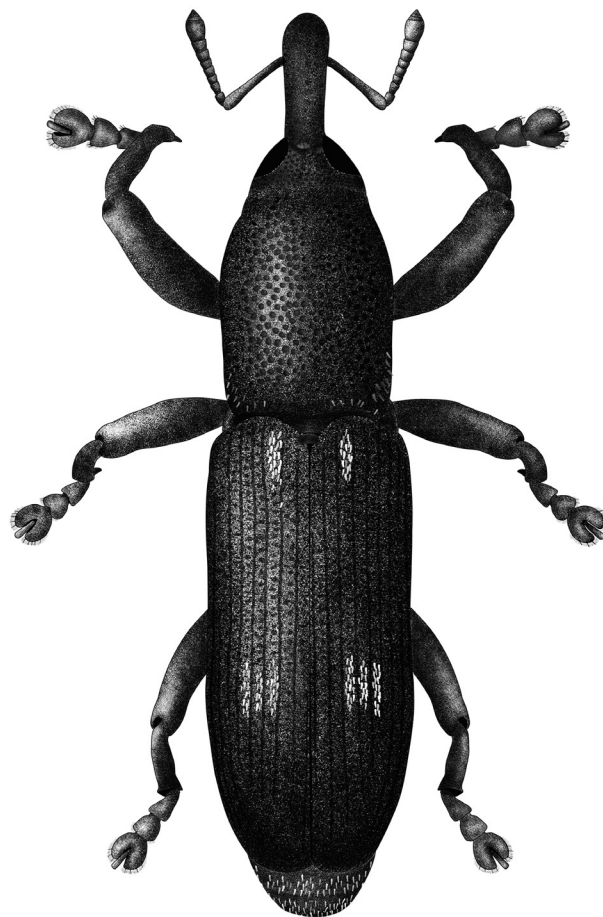


Figure 1. *Parallelodemas docile*, dorsal habitus (length 5.2 mm).

Parallelodemas from certain grass- and sedge-associated, primarily Palaeotropical Baridinae with similarly slender rostrum and elongate body. The latter complex includes *Eumycterus* Schönherr, 1838; *Trephognathus* Marshall, 1945; *Neosharpia* Hoffmann, 1956; *Caenobaris* Nasreddinov, 1980; *Lepidomyctides* Yoshihara & Morimoto, 1994 and several species currently placed in other genera.

Misplaced species. Yoshihara and Morimoto (1994) recognized that *Parallelodemas tarsale* Voss, 1937 is a species near *Eumycterus* and *Lepidomyctides* but they had very little material of those genera. We studied five Oriental species near *P. tarsale* (BPBM, IZCAS, SNSD, ZIN) and several species of *Caenobaris*, *Eumycterus*, *Neosharpia* and *Trephognathus* Marshall from Africa, Central Asia and India. While *Eumycterus* and its probable synonym *Trephognathus* can be distinguished by vertically moving mandibles (Marshall 1945; Korotyaev 2002), we were unable to recognize or to confirm the generic limits of the remaining species. We transfer here *P. tarsale* to *Lepidomyctides* in the widest sense, as *Lepidomyctides tarsalis* (Voss), new combination.

Redescription. Habitus: Total length 3.0–7.8 mm, width 0.8–2.2 mm; body slender subcylindrical (Fig. 1); integument black or brown, appendages and ventrites sometimes rufous; vestiture uniform or locally condensed to short vittae, setae either simple, squamiform, scalloped, deeply

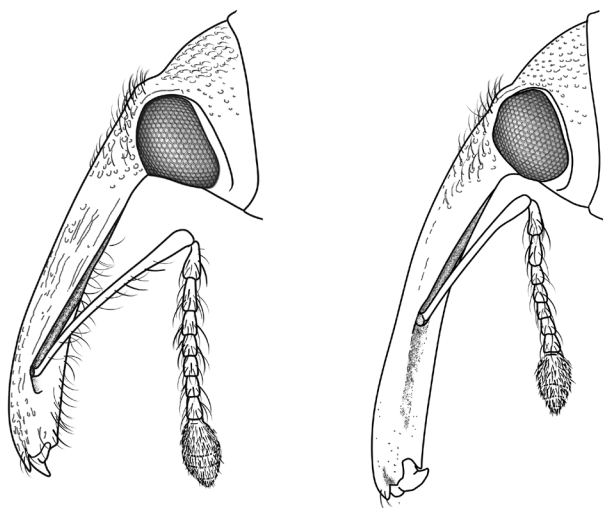


Figure 2. Rostrum of *P. impar*, male (left) and female (right), lateral view.

split or plumose. Head: Subspherical, contour often slightly warped at rostral base; eyes large, slightly encroaching on rostrum, bulging or flush with head contour, dorsally separated by width of rostrum at base; frontal fovea small to moderate; rostrum moderately elongate and slender, slightly curved, female with apical portion slightly inflated (Fig. 2); epistome produced and more or less notched, often worn off in females (Fig. 3); scrobe laterally descending, antenna inserted between midlength and apical fourth; funicle with 7 desmomes; club compact, spindle-shaped, basal article approximately as long as remainder of club, not annexed to distal desmome; mandibles with apparently abducent movement (away from center line and slightly ventrad), outer face with 1 large and 1–2 small secondary teeth, inner face convex and without teeth (Fig. 3). Prothorax: Barrel-shaped, elongate, nearly as wide as elytra. Anterior margin of pronotum not projected over frons, subapical constriction absent; basal margin bisinuous to accommodate projecting base of elytron; postocular lobe feeble or absent. Prosternum without median channel, rarely slightly depressed in front of coxae; subapical constriction slight to moderate; basal lobe partially projected over mesosternum, with basal margin bifurcate or (rarely) truncate. Pterothorax: Mesoscutellum visible, trapezoid to subquadrate. Mesosternum unmodified. Mesepimeron smaller and narrower than mesepisternum, ascending between pronotum and elytron and visible in dorsal view. Metasternum medially depressed in male, flat or convex in female. Elytra: Elongate, sides subparallel, apices rounded individually, humerus developed, subapical callus feeble or absent, base at interstriae 3–6 slightly depressed and somewhat projected; striae 10, narrow but distinct, stria punctures not or slightly affecting edge of interstriae, stria setae absent; interstriae flat, punctate to transversely rugose, interstria setae uniform or heterogeneous, modified setae restricted to basal and submedian vittae if present. Hindwings: Fully developed, length-width ratio 3.4–3.7, fore margin basally concave, anal lobe moderate, hind margin with setal fringe; venation



Figure 3. Rostrum of *P. plumosum*, male (left) and female (right), dorsal view, showing apex with epistome and mandibles.

agreeing with modal arrangement of subfamily (Zherikhin and Gratshev 1995). Abdomen: Ventrites unmodified, not or indistinctly sexually dimorphic. Sclerolepidia small to medium-sized, densely packed, digitate. Stridulatory devices absent. Male genitalia and associated structures: Tergite VII without plectra for stridulation; tergite VIII shorter than wide, distally without transverse carina; sternite VIII laterally with sclerotized pyriform area, medially desclerotized; sternite IX variously strongly curved, distal prongs narrowly to widely diverging but always symmetrical; penis dorsoventrally depressed, longer than basal apodemes; internal sac extending approximately to midlength of apodemes when inverted, with sclerite at insertion of duct or with pigmented flagellum; tegmen with ring dorsally closed, basal apodeme obsolete, parameroid lobes developed. Female genitalia and associated structures: Tergite VII longer than wide, without transverse carina, setal vestiture squamiform basally and piliform distally, plectra for stridulation absent; sternite VIII distally forked into weakly sclerotized, widely dilated, U-shaped arms; hemisternite pigmented, stylus 1.9–2.2× as long as wide, distal setae half as long as stylus; bursa pouch-like, half as long as vagina; spermatheca sclerotized, collum short, often somewhat bulbous, ramus inserted on outer face of collum (facing away from cornu), rudimentary to long; spermathecal duct unpigmented, at most slightly longer than spermatheca, inserted distally in bursa. Legs: Procoxae separated by less than 1/3 diameter of coxa; pro- and mesofemora clavate, hindfemur less expanded and often partially sulcate ventrally; tibiae straight to curved (depending on ventral profile of femur), ventrodistal spine spiniform, robust and large on pro- and mesotibiae but somewhat smaller on metatibia; tarsus with 5 segments, third with anterior margin faintly to deeply excised, fifth long to greatly reduced, claws flat and basally fused, or miniaturized and medially fused to single blade.

Diversity and distribution. With the six new species described in this study, *Parallelodemas* includes now a total of twelve. The scarce material gives an unrepresentative picture of the distributional ranges of individual species. Species of *Parallelodemas* have been found

in China, India, Laos, Malaysia, Myanmar, Taiwan and Vietnam. Their distribution is primarily Oriental but several reach the Palaearctic part of China, northward up to Shaanxi and Zhejiang.

Biology. The host plant of *Parallelodemus* apparently is unknown. One specimen of *P. docile* is labeled as being taken from Buttontree, *Anogeissus acuminata* (Roxburgh ex Candolle) Guillemain et al. (Combretaceae). Other specimens were swept from low vegetation. Females with fully developed eggs occur from late April to early June.

Sexual dimorphism. Rostrum. Species of *Parallelodemus* exhibit marked sexual dimorphism of characters on the rostrum. Females generally have a longer and smoother rostrum than males, with a more basally inserted antenna and slightly inflated apical portion (Fig. 2). Gender-related differences in the basal width of the rostrum (Fig. 8) are apparent but often inconspicuous. The ventral side of the rostrum is setose in male *P. impar*, *P. petilum* and *P. plumosum*. However, the most striking difference, the length and shape of the epistome, may be acquired secondarily rather than being truly sexually dimorphic. Nearly all examined males have a projected, medially notched epistome, whereas it is almost always short and truncate in females (Fig. 3). However, the presence of projected epistomes in some female *P. feae*, *P. impar*, *P. imperfectum* and *P. setifrons* suggests a secondary loss, probably through abrasion during the preparation of oviposition sites, because the distally divergent mandibles afford no protection of the epistome as in other weevils. However, this needs to be confirmed with freshly emerged specimens and field observations.

Antenna. Males generally have a longer scape than females (usually as long as the funicle). The distal margins of the male scape can be setose, such as in *P. impar* (Fig. 2).

Mandible. At a first glance, it appears as if *Parallelodemus* has swapped the left with the right mandible or rotated them by 180 degrees (Fig. 3). The inner face not only lacks any trace of incisors, it also is evenly convex from base to apex and seems therefore dysfunctional. Moreover, the outer face is concave and armed with two apparently ordinary incisors, just like the inner mandibular face of most baridine weevils. However, three landmarks on the mandible leave no doubt that the seemingly abducent mandibular movement evolved by reversing the function of the abductor and adductor tendons rather than by rotating the mandible, a trend seen in some weevils with a very slender rostrum (Marshall 1945): (1) The dorsal and ventral mandibular sockets (prearticular and postarticular) are formed and located as in other Baridinae; (2) the mandibular setae are located on the outer face (between the basal incisors); and (3) the pharyngeal process is attached to the inner basal angle of the mandible. From this it follows that the incisors on the outer face are secondarily evolved structures and analogous to the inner incisors of other weevils. Morimoto and Yoshihara (1996) suggested an inversion of the mandibular movement from adducent to abducent. The laterally deeply excised mandibular articulation and widely divergent mandibles in many mounted specimens support this conclusion. Unfortunately,

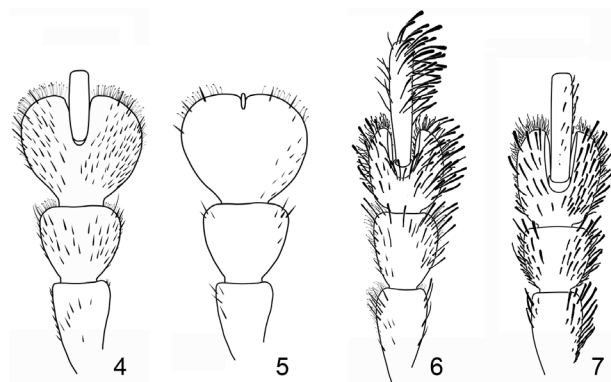
we could obtain neither direct field observations nor fresh specimens for scanning the abductor and adductor tendons.

Eye. While almost all Baridinae have eyes that are flush with the head contour, they are protruded in several *Parallelodemus* species. The eyes of male *P. setifrons* protrude more than those of females (Fig. 8), but the dorsal and ventral distance between them and their circumference are not affected. The increased eye surface affords more facets in the male but facet diameter is the same.

Leg. Several *Parallelodemus* species have large, deviant setae on the mesotarsus which crowd toward the distal (outer) half. These setae are arranged asymmetrically on the fifth (claw-bearing) tarsite and are much larger and more numerous in males than in females (Figs 6, 7). The individual tarsites, in particular the fifth, are often more elongate in males than in females. Males often have faintly thicker pro- and mesofemora than females.

Tergites. Like in other Baridinae, the eighth tergite is developed in males but internalized in females. Because the distal external tergite protrudes beyond the elytral apex well enough to expose the suture between the seventh and eighth tergites in males, this character is very useful for sexing specimens.

Ventrites. The male metaventricle is medially depressed and, together with the first abdominal ventrite, may have less setae than the female's. Voss (1941) mentioned a sexually dimorphic basal process on the prosternum of *P. impar*, but he either had a mixed series or his observation was incorrect.



Figures 4–7. Left mesotarsus of *Parallelodemus*, dorsal view: 4. *P. docile*; 5. *P. imperfectum*; 6. *P. vicinum*, male; 7. *P. vicinum*, female. Not to scale.

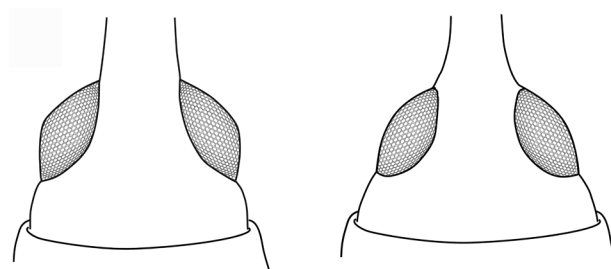


Figure 8. *Parallelodemus setifrons*, dorsal view of head showing sexually dimorphic protrusion of eyes and rostral width (left male, right female).

Key to the species of *Parallelodemus* found in China

- 1 Thoracic sternites with plumose or deeply split setae 2
- Thoracic sternites with simple or scalloped, indistinctly split setae 5
- 2 Thoracic sternites with bi- and trifid setae, plumose setae absent 3
- Thoracic sternites with plumose setae 4
- 3 Eyes slightly bulging; male rostrum glabrous ventrally; total length 3.6–4.3 mm *P. dimetans*
- Eyes distinctly bulging; male rostrum hirsute ventrally; total length 3.0–3.7 mm *P. petilum*
- 4 Frons at most with a few setae; eyes slightly bulging in both sexes; penis with apex gradually rounded (Fig. 14), internal sac with harpoon-shaped sclerite; total length 3.6–5.4 mm *P. plumosum*
- Frons hirsute; eyes distinctly bulging in male; penis with apex distinctly pointed and produced (Fig. 15), internal sac medially with small, fennel-seed-like sclerite and near duct with sclerotized area with spinose lateral projection; total length 3.0–3.9 mm *P. setifrons*
- 5 Tarsite 3 large, anterior margin slightly to moderately excised (Figs 4, 5); claws miniaturized, not longer than fifth tarsomere wide 6
- Tarsite 3 small, anterior margin deeply excised beyond middle (Figs 6, 7); claws longer 7
- 6 Tarsite 5 inserted near middle and exceeding anterior margin of tarsite 3 by half its own length (Fig. 4); male rostrum distinctly shorter than pronotum; total length 4.5–6.2 mm *P. docile*
- Tarsite 5 minute, inserted in distal fifth and barely exceeding margin of tarsite 3 (Fig. 5); male rostrum as long as pronotum; total length 5.4–6.4 mm; Myanmar *P. imperfectum*
- 7 Eyes bulging; profemur slender, subdistally gradually converging; male rostrum ventrally setose; male antenna inserted in apical third of rostrum *P. impar*
- Eyes nearly flush with head contour; profemur clavate, subdistally noticeably constricted in lateral view; male rostrum ventrally glabrous; male antenna inserted in mid-third of rostrum 8
- 8 Male mesotarsus without clavate setae; male antenna with scape glabrous along proximal edge; prosternum in front of coxa often tumescent in lateral view; aedeagus apically lancet-shaped 9
- Male mesotarsus with clavate setae; male antenna with scape setose along proximal edge; prosternum in front of coxa usually gradually sloping in lateral view; aedeagus subparallel 10
- 9 Rostrum shorter (male $<0.95\times$, female $1.04\times$ length of pronotum); male antenna inserted more distally (prorostrium $0.33\times$ length of rostrum); total length 5.4–6.6 mm; Myanmar *P. tardum*
- Rostrum longer (male $>1.05\times$, female $1.20\times$ length of pronotum); male antenna inserted more basally (prorostrium $0.42\times$ length of rostrum); total length 3.8–4.8 mm; China (Guizhou) *P. tumens*
- 10 Profemur hirsute ventrally; metepisternum with squamiform setae rather evenly distributed; total length 4.9–6.5 mm *P. feae*
- Profemur squamose ventrally; metepisternum with squamiform setae increasingly larger and denser in distal section; total length 6.4–7.8 mm 11
- 11 Metepisternum distally with imbricate squamiform setae; male profemur moderately expanded ventrally; penis with apex truncate (Fig. 20) *P. vicinum*
- Metepisternum distally with more widely spaced squamiform setae; male profemur strongly clavate, ventrally almost angular; penis with apex narrowly rounded (as *P. feae*, Fig. 19); Myanmar *P. perfectum*

***Parallelodemus dimetans* Prena & Zhang, sp. n.**

<http://zoobank.org/596CADD7-085B-42F5-A76D-7DF7F6B4CDC2>

Diagnosis. This small species can be recognized by the presence of slender, bi- or trifid setae on the thoracic ventrites and ventrally glabrous male rostrum. *Parallelodemus petilum* is the only other known species with such setae but the male rostrum is hirsute.

Description. Length 3.6–4.3 mm, width 1.0–1.2 mm; integument dark brown, antenna, tarsus, apex of female rostrum and often other parts of leg brown or rufous; ventral side and pygidium with simple, slender setae, thoracic sterna also with bi- and some trifid setae, basic vestiture of fine setae on pronotum and elytron, somewhat larger white setae at base of elytral interstria 3 and postmedially on interstriae 3 and 4; eyes slightly bulging;

frons and base of rostrum with some recumbent setae; male rostrum $1.07\times$ as long as pronotum, ventrally without setae, prorostrium $0.41\text{--}0.42\times$ rostral length, slightly spatulate and apically diverging in dorsal view, epistome slightly notched, antennal scape with a few long setae, club $1.7\times$ as long as wide; female rostrum $1.02\text{--}1.11\times$ as long as pronotum, prorostrium $0.47\text{--}0.51\times$ rostral length; prosternum gradually sloping in front of coxa, basal lobe notched; all femora hirsute ventrally; tarsus with tarsite 3 relatively small and excised to basal third, tarsite 5 shorter than 2+3 and distinctly protruding beyond anterior margin of 3, male mesotarsus with long, distally pointed setae; penis $2.5\times$ as long as wide, apex roundly narrowed and slightly projected medially (Fig. 12), internal sac with harpoon-like sclerite and small sclerotized area near duct; spermatheca with nodulus and ramus short (Fig. 21).

Distribution. The species is known only from China (Guizhou).

Material examined. Holotype: China, Guizhou Province, Suiyang County, Kuankuoshui [宽阔水] Natural Reserve, Xiangguang Village [香广山村], 27.9798 N 107.1661 E, 1550 m, 4.vi.2010 [#1500871], Wang Zhiliang [王志良], male (IZCAS). Paratypes (3 males, 10 females): CHINA. Guizhou: Suiyang, Kuankuoshui Natural Reserve, Forestry Station Holiday Center, 1206 m, 5.vi.2010 [#1500879], Wang Zhiliang (IZCAS 1); Suiyang, Kuankuoshui Natural Reserve, Gongtong ravine, 6.vi.2010 [#1500880], Nie Cuie (IZCAS 1); Suiyang, Kuankuoshui Natural Reserve, Jinzi Village, 3.vi.2010 [#1500876–78], Wang Zhiliang (IZCAS 3); Suiyang, Kuankuoshui Natural Reserve, Xiangguang Village, 4.vi.2010 [#1500872–74], 8.vi.2010 [#1500875], Wang Zhiliang (IZCAS 4); Suiyang, Kuankuoshui Natural Reserve, 3.vi.2010 [#1500867–68], 4.vi.2010 [#1500869], Liu Wangang (IZCAS 3); Suiyang, Kuankuoshui Natural Reserve, Baishao ravine, 8.vi.2010 [#1500882], Nie Cuie (IZCAS 1).

Etymology. The name is a participle presence active of *dimeto* (=to delimit, to mark-off; Latin).

***Parallelodemas petilum* Prena & Zhang, sp. n.**

<http://zoobank.org/ED12DF0F-C531-4943-B5CA-14C8AECAAB0A>

Diagnosis. Our material includes seven small specimens from three sites (3 Shaanxi, 1 Sichuan, 3 Vietnam), which form a close-nit complex of probably three species. They have bulging eyes, thoracic ventrites with bifid setae, a ventrally setose male rostrum and a slender penis with very long flagellum. Differences occur in the apical shape of the penis (Shaanxi – triangular; Sichuan – narrowly rounded; Vietnam – slightly projected) and the first abdominal ventrite (Vietnamese specimens with a pair of tubercles between the metacoxae). We describe the three specimens from Shaanxi as *P. petilum* and informally assign to this complex the four others. Similar species are *P. dimetans* (with nearly flush eyes) and *P. setifrons* (with plumose setae).

Description. Length 3.0–3.7 mm, width 0.8–1.0 mm; integument dark brown to nearly black, appendages partially light brown; meso- and metathoracic sternites with bi- and trifid setae, pronotum and elytron with basic vestiture of very fine setae; eyes bulging; frons and base of rostrum with recumbent setae; male rostrum 0.93–1.12× as long as pronotum, ventrally with long setae, prorostrum 0.39–0.40× rostral length, slightly spatulate and apically diverging in dorsal view, epistome moderately deeply notched, antennal scape with a few long setae, club 2.6× as long as wide; female rostrum 1.14× as long as pronotum, prorostrum 0.50× rostral length; prosternum gradually sloping in front of coxa, basal lobe moderately notched; all femora hirsute ventrally; tarsus with tarsite 3 excised to basal third, tarsite 5 as long as 2 and distinctly protruding beyond anterior margin of 3, male mesotarsus

with moderately long, clavate, outward directed setae; penis 7× as long as wide, apex triangularly narrowed (as *P. plumosum*, Fig. 14), with sclerotized flagellum almost as long as penis and apodemes combined; spermatheca with collum and nodulus forming poorly differentiated bulbous unit, ramus as long as wide (Fig. 22).

Distribution. The species (in the strict sense) is known from the Chinese province Shaanxi.

Material examined. Holotype: China, Shaanxi Province, Huoditang forest farm [火地塘林场], 1559 m, 33.4343 N 108.4480 E, 14.viii.2013, Jiang Chunyan [姜春燕], male, dissected, #1941160 (IZCAS). Paratypes (1 male, 1 female): same data as holotype, male, #1941162 (IZCAS 1), female, #1941161 (IZCAS 1). Other material: CHINA. Sichuan: Mount E'mei, Jiulao cave, 1800–1900 m, 1.viii.1957 [#1500865], Lu Youcai, male (IZCAS 1). VIETNAM. Cao Bang Prov.: Mount Pia Oac, 7.vi.2011, S. Lingafelter, 2 males, 1 female (IZCAS 1, JPPC 2).

Etymology. The name is a Latin adjective for slender or gaunt.

***Parallelodemas plumosum* Prena & Zhang, sp. n.**

<http://zoobank.org/1D130D15-F6BC-4F76-AC26-78B10E438383>

Diagnosis. This species can be distinguished from *P. setifrons*, the other known species with plumose setae, by glabrous frons and slightly protruding eyes in both sexes. *Parallelodemas dimetans* and *P. petilum* have at most trifid setae.

Description. Length 3.6–5.4 mm, width 1.0–1.4 mm; integument black, antenna and tarsi dark brown; ventral side with plumose setae, pygidium with bifid setae, pronotum and elytron with basic vestiture of very fine setae, elytron also with short vittae of plumose white setae at base of interstria 3 and postmedially on interstriae 3–5; eyes very slightly bulging; frons and base of rostrum with a few recumbent setae; male rostrum 0.94–1.06× as long as pronotum, ventrally without setae, prorostrum 0.40–0.43× rostral length and slightly spatulate in dorsal view, epistome moderately notched, antennal scape with a few long setae, club 1.8× as long as wide; female rostrum 1.00–1.04× as long as pronotum, prorostrum 0.49–0.51× rostral length; prosternum gradually sloping in front of coxa, basal lobe truncate; pro- and mesofemora hirsute ventrally; tarsus with tarsite 3 moderately large and excised to basal third, tarsite 5 nearly as long as 1 and distinctly protruding beyond anterior margin of 3, with long, distally unmodified setae in both sexes; penis 3× as long as wide, roundly narrowed to subtriangular tip (Fig. 14), internal sac with harpoon-like sclerite; spermatheca with nodulus short and thick, ramus as long as wide (Fig. 24).

Distribution. The species occurs in China (Fujian, Hainan) and Taiwan.

Material examined. Holotype: China, Fujian Province, Jianyang [建阳], Chong'an Xin Village [崇安星村], Sangang [三港], 740 m, 27.7489 N 117.6831 E, Pu Fuji [蒲富基], 14.v.1965, male, dissected, #1799537 (IZ-

CAS). Paratypes (13 males, 6 females): CHINA. Fujian: Jianyang, Chong'an Xin Village, Qili Bridge, 12.vii.1963 [#1500864], Zhang Youwei (IZCAS 1); Jianyang, Chong'an Xin Village, Sangang, 29.v.1960 [#1799132], 4.vi.1960 [#1500862], 7.vi.1960 [#1799540], Jiang Shengqiao (IZCAS 3), 6.vii.1960 [#1799529], Pu Fuji (IZCAS 1), Zhang Yiran (IZCAS 1), 14.v.1965 [#1500863]; Jianyang, Chong'an Tongmuguan Guanping, 22.v.1960 [#1799136], Jiang Shengqiao (IZCAS 1); Mount Wuyi, Guadun, 3.vii.1982 [#1500861], Jiang Fan (IZCAS 1). Hainan: Qiongzong, Mount Wuzhi, ancient plant path, 29.vii.2009 [#1500852], Liang Hongbin (IACAS 1), 30.xi.2009 [#1879661–62, #1879689], Zhang Kuiyan & Lin Meiyang (IZCAS 3); Qiongzong, Mount Wuzhi, main peak, 28.xi.2009 [#1879660], Huang Lina (IZCAS 1); Qiongzong, Mount Wuzhi, Shuiman Village, 30.vii.2009 [#1500853–54], Huang Xinglei (IZCAS 2); Mount Diaoluo, Holiday Village, 12.xii.2008 [#1500851], Wang Zhiliang (IZCAS 1). TAIWAN. Nanjing: Wushe, 3.v.1983 (2×), 10.v.1983, H. Townes (CMNC 3).

Etymology. The name is a Latin adjective meaning plumed, or with feathers.

***Parallelodemas setifrons* Prena & Zhang, sp. n.**

<http://zoobank.org/3F48D0AF-32EE-47DE-A838-8B37AECD3F7B>

Diagnosis. Useful characters for identification are plumose setae, hirsute frons and sexually dimorphic eyes. *Parallelodemas petilum* is similar but has at most trifid setae and a ventrally hirsute male rostrum.

Description. Length 3.0–3.9 mm, width 0.9–1.0 mm; integument dark brown, antenna, legs and apex of rostrum light brown; meso- and metathoracic sterna with plumose setae (condensed on metepisternum), prosternum, abdominal ventrites and pygidium mostly with bi- and trifid setae, pronotum and elytron with basic vestiture of fine setae, elytron also with short vittae of white, moderately wide, simple or bifid setae at base and postmedially on interstriae 3–5; eyes distinctly (male) or slightly (female) bulging; frons and base of rostrum with recumbent setae; male rostrum 0.84–0.90× as long as pronotum, ventrally with long setae, prorostrum 0.43–0.48× rostral length and slightly spatulate in dorsal view, epistome slightly notched, antennal scape without long setae, club 1.4–2.4× as long as wide (depending on length of rostrum); female rostrum 0.84–1.00× as long as pronotum, prorostrum 0.49–0.57× rostral length; prosternum gradually sloping in front of coxa, basal lobe notched; all femora hirsute ventrally; tarsus with tarsite 3 relatively small and excised to basal third, tarsite 5 nearly as long as 1 and distinctly protruding beyond anterior margin of 3, male mesotarsus with moderately long, clavate, outward directed setae; penis 2.5× as long as wide, with small, apically rounded projection (Fig. 15), internal sac medially with small, fennel-seed-like sclerite and with sclerotized area with spinose lateral projection near duct; spermatheca (Fig. 24)

with nodulus as long as wide and perpendicular to long axis of collum, ramus as long as nodulus.

Distribution. The species is known from China (Fujian, Guangdong, Guizhou, Hunan).

Material examined. Holotype: China, Fujian, Jianyang, Chong'an Xin Village [崇安星村], Sangang [三港], 27.7489 N 117.6831 E, 740 m, 29.v.1960, Zuo Yong [左永], male, dissected, #1799533 (IZCAS). Paratypes (5 males, 14 females): CHINA. Fujian: Dazhulan, Shaowu, 19.–25.v.1945 [#1941180] (IZCAS 1); Kuatun [=Guatun], 5.v.1938 (2×), 5.vi.1938, J. Klapperich (AKMB 3); Jianyang, Huangkeng Changba, 8.iv.1960 [#1500856], Jiang Shengqiao (IZCAS 1); Jianyang, Huangkeng Guilin, 5.iv.1960 [#1799536, #1799549], 14.iv.1960 [#1799139, #1799158], Jiang Shengqiao (IZCAS 4); Jianyang, 17.v.1965 [#1500855] (IZCAS 1); Jianyang, Sangang, Chong'an Xin Village, 14.v.1960 [#1799135], Pu Fuji (IZCAS 1), 29.v.1960 [#1799533], Zuo Yong (IZCAS 1). Guangdong: Ruyuan, Huangling, Mount Xiaohuang, 18.vii.2008 [#1799020], Li Yingchao (IZCAS 1); Nanling, Ruyang Natural Reserve Station, 19.vii.2008 [#1799016], Li Yingchao (IZCAS 1). Guizhou: Kuankuoshui Natural Reserve, Gongtong ravine, 7.vi.2010 [#1500866], Nie Cuie (IZCAS 1); Suiyang, Kuankuoshui Natural Reserve, Jinzi Village, 3.vi.2010 [#1500859], Wang Zhiliang (IZCAS 1); Suiyang, Kuankuoshui Natural Reserve, Xiangguang Village, Suiyang, 4.vi.2010 [#1500857–58], Wang Zhiliang (IZCAS 2); Suiyang, Kuankuoshui Natural Reserve, 4.vi.2010 [#1500860], Liu Fanggang (IZCAS 1). Hunan: Yizhang, Mount Mang, forest park west gate, 17.vii.2008 [#1799015], Li Yingchao (IZCAS).

Etymology. The name is a Latin noun in apposition composed of *seta* and *frons*.

***Parallelodemas docile* Faust**

Parallelodemas docilis [sic] Faust 1894: 309. Lectotype male, designated here, labeled “Carin Cheba/ 900-1100 m/ L. Fea V XII-88”, “docilis/ Faust”, “P./ docilis/ sp. n.”, “*Parallelodemas/ docilis/ ♂ sp. n.*”, “SYNTYPUS/ *Parallelodemas/ docilis/ Faust, 1894*”, “Museo Civico/ di Genova”, “Lectotype/ *Parallelodemas docile/ Faust (Prena & Zhang/ design. 2014)*” (MSNG). Paralectotypes 6: Carin Cheba, Myanmar (MSNG 3, SFFM 1, SNSD 2).

Diagnosis. The large, subcordate third and relatively short fifth tarsite (Fig. 4) are diagnostic for this species. *Parallelodemas imperfectum* Faust, the only other species with enlarged third tarsite, has an extremely miniaturized fifth tarsite (incorrectly stated to be absent by Faust 1894). Other useful characters are the short male rostrum and presence of dense vestiture on the distal three fourths of the metepisternum.

Redescription. Length 4.5–6.2 mm, width 1.1–1.6 mm; integument black, teneral specimens with ventrites

and legs partially dark rufous; ventral side with undivided setae, basic vestiture inconspicuous on pronotum and elytron, imbricate white squamiform setae at base of elytral interstria 3, postmedially on interstriae 3–5, on dorsal apex of mesepimeron, distal 3/4 of metepisternum, flank of prosternum, ventral face of pro- and mesofemora, dorsal face of metafemur and occasionally on basolateral angles of pronotum; eyes flush with head contour; frons and base of rostrum glabrous; male rostrum $0.78\text{--}0.83\times$ as long as pronotum, ventrally without setae, prorostrum $0.38\text{--}0.41\times$ rostral length and subcylindrical in dorsal view, epistome very slightly notched, antennal scape ventrally without long setae, club $1.6\times$ as long as wide; female rostrum $1.02\text{--}1.13\times$ as long as pronotum, prorostrum $0.50\text{--}0.53\times$ rostral length; prosternum gradually sloping in front of coxa, basal lobe slightly notched; pro- and mesofemora ventrally with recumbent squamiform setae; tarsus with tarsite 3 moderately large, subcordate and excised to middle, tarsite 5 as long as 3 and only moderately protruding beyond anterior margin of 3 (Fig. 4), inconspicuously setose in both sexes; penis $2.5\times$ as long as wide, apex subtriangular (Fig. 16), internal sac without discernible sclerite; spermatheca with nodulus and ramus short (Fig. 25).

Distribution. The species is known from China (Yunnan) and Myanmar.

Material examined. CHINA. Yunnan: Xishuangbanna Prefecture, Menglun, 12.iv.1994, 13.vi.1994 [#1799526, #1941179], Yang Long (IZCAS 2); Xishuangbanna Prefecture, Menglun, Highway G213, 21.xi.2009 [#1500899–901], 22.xi.2009 [#1500902–05], 26.xi.2009 [#1500906–07], Tang Guo & Yao Zhiyuan (IZCAS 9); Xishuangbanna Prefecture, Tropical Plant Garden, 19.viii.2007 [#1500898], Zheng Guo (IZCAS 1). MYANMAR. Kaya: Karen Hills, Iadó [=Yahku?], XII/1887 (MSNG 2). Kayin: Karen Hills, Leitó [=Leiktho], V/1888, L. Fea (MSNG 2, SFFM 1, SNSD 1).

Parallelodemas imperfectum Faust

Parallelodemas imperfecta [sic] Faust 1894: 310. Lectotype male (dissected), designated here, labeled “Carin Cheba/ 900-1100 m/ L. Fea V XII-88”, “*imperfecta*/ Faust”, “*P./ imperfecta*/ sp. n.”, “*Parallelodemas/ imperfecta*/ ♂ ♀”, “SYNTYPUS/ *Parallelodemas/ imperfecta*/ Faust, 1894”, “Museo Civico/ di Genova”, “Lectotype/ *Parallelodemas imperfectum*/ Faust (Prena & Zhang/ design. 2014)” (MSNG). Paralectotypes 2: Carin Cheba, Myanmar (MSNG 1, SNSD 1).

Diagnosis. This species can be recognized by its characteristic tarsus: the enlarged third tarsite is barely excised anteriorly and the fifth is greatly reduced (Fig. 5). *Parallelodemas docile* has a larger fifth tarsite and is more elongate.

Redescription. Length 5.4–6.4 mm, width 1.5–2.1 mm; integument black, antenna and sometimes parts of

legs and ventrites brown; ventral side with undivided setae, basic vestiture on pronotum and elytron absent, imbricate yellowish white squamiform setae at base of elytral interstria 3, postmedially on interstriae 3–4, ventrally and laterally on thorax and abdomen (including basolateral angles of pronotum) and on ventral face of pro- and mesofemora; eyes flush with head contour; frons and base of rostrum glabrous; male rostrum $0.94\times$ as long as pronotum, ventrally without setae, prorostrum $0.35\times$ rostral length and slightly spatulate in dorsal view, epistome moderately notched in 1 female [worn in other specimens including male], antennal scape ventrally without long setae, club $1.4\times$ as long as wide; female rostrum $1.02\text{--}1.07\times$ as long as pronotum, prorostrum $0.50\times$ rostral length; prosternum gradually sloping in front of coxa, basal lobe slightly notched; pro- and mesofemora ventrally with recumbent squamiform setae; tarsus with tarsite 3 moderately enlarged, subcordate, anterior margin straight and only indistinctly excised, tarsite 5 minute (Fig. 5); penis $3.0\times$ as long as wide, slightly tapering in apical third as in *P. docile* (Fig. 16) but with apex more pointed, internal sac with Y-shaped sclerite; spermatheca with nodulus and ramus short (as *P. docile*, Fig. 25).

Distribution. The species is known from one site in Myanmar.

Material examined. MYANMAR. Kayin: Karen Hills [ca. 25–35 km NE of Taungoo, 900–1100 m], V/1888, L. Fea (MSNG 2, SNSD 1).

Parallelodemas impar Voss

Parallelodemas impar Voss 1941: 895. Holotype female, Tienmushan, China (NKMB). Paratype retained by Voss not traceable and probably destroyed (see Weidner 1979: 400).

Diagnosis. The ventrally hirsute male rostrum separates *P. impar* from all other Chinese species with simple, undivided setae. Another good character is the absence of wide setae on elytron and metepisternum.

Redescription. Length 4.4–5.8 mm, width 1.0–1.5 mm; integument dark brown, antenna, tarsus and apex of female rostrum light brown; vestiture consisting of inconspicuous, evenly distributed, simple, cupreous setae; eyes slightly bulging; frons and base of rostrum with recumbent setae; male rostrum $0.98\text{--}1.07\times$ as long as pronotum, ventrally with long setae, prorostrum $0.28\text{--}0.30\times$ rostral length and spatulate in dorsal view, epistome deeply notched, antennal scape ventrally with long, cupreous setae, club $2.0\times$ as long as wide; female rostrum $1.13\text{--}1.16\times$ as long as pronotum, prorostrum $0.48\text{--}0.49\times$ rostral length; prosternum gradually sloping in front of coxa, basal lobe notched; all femora hirsute ventrally; tarsus with tarsite 3 relatively small and excised to basal third, tarsite 5 as long as 1 and moderately protruding beyond anterior margin of 3, male mesotarsus with long, clavate, outward directed setae; penis $3.0\times$ as long as wide, apex

with narrowly rounded, subtriangular projection (Fig. 17), internal sac with thick, tubular, basally curved sclerite; spermatheca with nodulus long and perpendicular to long axis of collum, ramus obsolete (Fig. 26).

Distribution. The species is known from China (Sichuan, Yunnan, Zhejiang) and Laos. The record from Guatun in Fujian, by Voss (1956), applies to *P. setifrons*.

Material examined. CHINA. Sichuan: Wushan County, Liziping, 2.vii.1993 [#1941174] (IZCAS 1). Yunnan: Xishuangbanna Prefecture, Menghun, 17.v.1958 [#1500892], Meng Xuwu (IZCAS 1). Zhejiang: West Lin'an, Mount Tianmu, 15.6.1957 [#1799534], 28.6.1957 [#1500891, #1500893, #1799531] (IZCAS 4), 9.vi.2012 (ZAFU 1); Kaishanlaodian, Mount Tianmu, 23.vi.1998 [#1941175–76] (IZCAS 2); Mount Tianmu (NHMB 1). LAOS. Luang Prabang: Ban Kiukacham env., 19.vi.2009, M. Geiser & D. Hauck (NHMB 5). Xieng Khouang: Phonsavan to Phu Padaeng, 30/31.v.2009, M. Geiser (NHMB 2).

Parallelodemus tardum Faust

Parallelodemus tarda [sic] Faust 1894: 309. Lectotype male, designated here, labeled “Carin Cheba/ 900–1100 m/ L. Fea V XII-88”, “tarda/ Faust”, “P./ tarda/ sp. n.”, “Parallelodemus/ tarda/ ♂ sp. n.”, “SYNTYPUS/ Parallelodemus/ tarda/ Faust, 1894”, “Museo Civico/ di Genova”, “Lectotype/ Parallelodemus tardum/ Faust (Prena & Zhang/ design. 2014)” (MSNG). Paralectotypes 3 (2 males, 1 female), same data (MSNG 2, SNSD 1).

Diagnosis. Two of the eight known species with undivided setae have an unmodified male mesotarsus, i.e., they lack special setae and the fifth tarsite is not enlarged. One is *P. tardum* described from Myanmar, the other is *P. tumens* from China. *Parallelodemus tardum* is larger than *P. tumens* (5.4–6.6 mm vs. 3.8–4.8 mm) and has a shorter rostrum with a more distally inserted antenna. The females may be distinguished by body length. A difference between female *P. perfectum* and *P. tardum* is not apparent (each with one known specimen). Female *P. feae* are very similar but have ventrally hirsute femora.

Redescription. Length 5.4–6.6 mm, width 1.6–1.9 mm; integument black; ventral side and pygidium with undivided setae, basic vestiture of fine setae on pronotum and elytron, moderately wide white setae at base of elytral interstria 3 and postmedially on interstriae 3–5, on metepisternum and basolateral angles of pronotum; eyes flush with head contour; frons and base of rostrum glabrous; male rostrum 0.89–0.94× as long as pronotum, ventrally without setae, prorostrum 0.32–0.33× rostral length, apically slightly diverging in dorsal view, epistome short and slightly notched, antennal scape glabrous, club 1.8× as long as wide; female rostrum 1.04× as long as pronotum, prorostrum 0.50× rostral length; prosternum slightly tumescent in front of coxae (apparently not in female), basal lobe notched; pro- and mesofemora

ventrally with erect squamiform setae; tarsus with tarsite 3 of moderate size and excised to basal third, tarsite 5 slightly longer than 3 and distinctly protruding beyond anterior margin of 3, male mesotarsus without specialized setae; penis 2.3× as long as wide, apex lancet-shaped and broadly rounded (as *P. tumens*, Fig. 18), internal sac with 2 small sclerites (hook and paired hook); spermatheca with collum bulbous, ramus short, nodulus obsolete (as *P. dimetans*, Fig. 21).

Distribution. Besides the type series from Myanmar, we have seen one female from India that might be this species.

Material examined. INDIA. Sikkim: Gopaldhara, Rungbong Valley, H. Stevens (BMNH 1). MYANMAR. Kayin: Karen Hills [ca. 25–35 km NE of Taungoo, 900–1100 m], V/1888, L. Fea (MSNG 3, SNSD 1).

Parallelodemus tumens Prena & Zhang, sp. n.

<http://zoobank.org/2295F76C-0867-4E0C-980C-1CFB6E45ACE0>

Diagnosis. Besides *P. tardum*, this is the only known species without split setae on the metepisternum and without a modified male mesotarsus. *Parallelodemus tumens* is smaller (<5 mm) than *P. tardum* and has a longer rostrum with a more basally inserted antenna. Differences in the genitalia are not apparent. Female *P. tumens* may be distinguished from female *P. perfectum* and *P. tardum* by smaller body size. All three species have specimens with a more or less tumescent prosternum.

Description. Length 3.8–4.8 mm, width 1.1–1.3 mm; integument black, antenna, tarsus, apex of female rostrum and often other parts of leg brown or rufous; ventral side and pygidium with undivided setae, basic vestiture of fine setae on pronotum and elytron, moderately wide white setae at base of elytral interstria 3 and postmedially on interstriae 4 and 5, on thoracic flank and basolateral angles of pronotum; eyes flush with head contour; frons and base of rostrum glabrous; male rostrum 1.06–1.08× as long as pronotum, ventrally without setae, prorostrum 0.41–0.42× rostral length, slightly spatulate and apically diverging in dorsal view, epistome short and truncate, antennal scape glabrous, club 1.8× as long as wide; female rostrum 1.20× as long as pronotum, prorostrum 0.53× rostral length; prosternum tumescent in front of coxae, basal lobe notched; pro- and mesofemora hirsute ventrally; tarsus with tarsite 3 of moderate size and excised to basal third, tarsite 5 slightly longer than 3 and distinctly protruding beyond anterior margin of 3, male mesotarsus without specialized setae; penis 2.5× as long as wide, apex lancet-shaped and broadly rounded (Fig. 18), internal sac with 2 small sclerites (hook and paired hook); spermatheca with nodulus and ramus short (as *P. dimetans*, Fig. 21).

Distribution. The species is known from the Chinese province Guizhou.

Material examined. Holotype: China, Guizhou Province, Libo County, Banzhai Village [板寨村], 24.v.1998,

Zhang Runzhi [张润志], #1500884, male, dissected (IZCAS). Paratypes (2 males, 1 female): CHINA. Guizhou: Libo County, Banzhai Village, 24.v.1998, Zhang Runzhi [#1500883] (IZCAS 1); Yunyi Prefecture, Suiyang County, Kuankuoshui Natural Reserve, 3.vi.2010 [#1500881], 4.vi.2010 [#1500870], Nie Cuie (IZCAS 2).

Etymology. The name is a participle presence active of *tumeo* (=to inflate, to distend; Latin).

***Parallelodemas feae* Prena & Zhang, sp. n.**

<http://zoobank.org/09E6371C-7BC3-4E5F-B117-C66FB9976068>

Diagnosis. From other species with undivided setae, *P. feae* can be separated by having ventrally hirsute femora and nearly flush eyes. Female *P. tardum* and *P. tumens* are very similar but have shorter and wider setae on the pro- and mesofemora.

Description. Length 4.9–6.5 mm, width 1.3–1.8 mm; integument dark brown to black, antenna and tarsus brown; ventral side and pygidium with undivided setae, basic vestiture of fine setae on pronotum and elytron, moderately wide white setae at base of elytral interstria 3, postmedially on interstriae 3 and 4 and on thoracic flank; eyes very slightly bulging; frons and base of rostrum glabrous; male rostrum 1.02–1.20× as long as pronotum, ventrally without setae, prorostrum 0.39–0.42× rostral length, slightly spatulate and apically diverging in dorsal view, epistome slightly notched, antennal scape with long setae, club 1.8× as long as wide; female rostrum 1.04–1.20× as long as pronotum, prorostrum 0.50–0.54× rostral length; prosternum gradually sloping in front of coxa, basal lobe notched; all femora hirsute ventrally; tarsus with tarsite 3 relatively small and excised to basal third, tarsite 5 nearly as long as 2+3 and distinctly protruding beyond anterior margin of 3, male mesotarsus with clavate, outward directed setae; penis 3.5× as long as wide, apex roundly narrowed and medially projected (Fig. 19), internal sac with thick, rod-like sclerite; spermatheca with nodulus long and perpendicular to collum (Fig. 27).

Distribution. The species is known from China (Fujian, Guangxi, Hainan, Hunan, Yunnan), India, Laos and Vietnam.

Material examined. Holotype: China, Hainan Province, Jianfeng [尖峰], Tianchi [天池], 18.iii.1980, Wang Shuyong [王书永], #1799133, male, dissected (IZCAS). Paratypes (9 males, 10 females): CHINA. Fujian: Jiangle County, Mount Longxi, 21.i.1991 [#1500887], Yang Longlong (IZCAS 1), 19.v.1991 [#1500886], Zhang Runzhi (IZCAS 1); Jianyang, Chong'an Xin Village Longdu, 7.v.1960 [#1799553], Ma Youcai (IZCAS 1); Jianyang, Chong'an Xin Village Sangang, 17.vi.1960 [#1799530], Jiang Shengqiao (IZCAS 1), 26.vi.1960 [#1799542], Zuo Yong (IZCAS 1); Jianyang, Huangkeng Dazhulan, 11.vi.1960 [#1500885], Zuo Yong (IZCAS 1), 24.vii.1960 [#1799535], Jiang Shengqiao (IZCAS 1); Jianyang, Huangkengguilin, 14.iv.1960 [#1799157], Zhang Yiran (IZCAS 1). Guangxi: Jinxiuhawang

Mountain Village, 20.v.1999 [#1799153], Han Hongxiang (IZCAS 1). Hainan: Jianfeng, Tianchi, 18.iii.1980 [#1500888], Wang Shuyong (IZCAS 1); Ledong County, Jianfengling Natural Reserve, 10.iv.1980 [#1500890], Wang Shuyong (IZCAS 1), 4.v.2007 [#1500889, #1854471], Ge Deyan (IZCAS 2); Gaotuo Shan [高陀山, not located], 17.v.1963 [#1799532], Zhou Yao (IZCAS 1). Hunan: Yanling County, Shidu Shennong Valley waterfall, 7.vii.2008 [#1799013], Jiao Tianyang (IZCAS 1). Yunnan: Xishuangbanna Prefecture, Meng'a, 11.v.1958 [#1799522], Hong Chunpei (IZCAS 1). LAOS. Houa Phan: Phou Pane Mountains, 1350–1500 m, 1.–16.vi.2009, M. Brancucci (NHMB 1). Xieng Khouang: Phou Sane Mountains, 30 km NE Phonsavan, 1400–1500 m, 10.–30.v.2009, Z. Kraus (NHMB 1). VIETNAM. Tinh Vinh Phuc: Tam Dao, 25.v.1995, A. V. Gorochoy (ZIN 1).

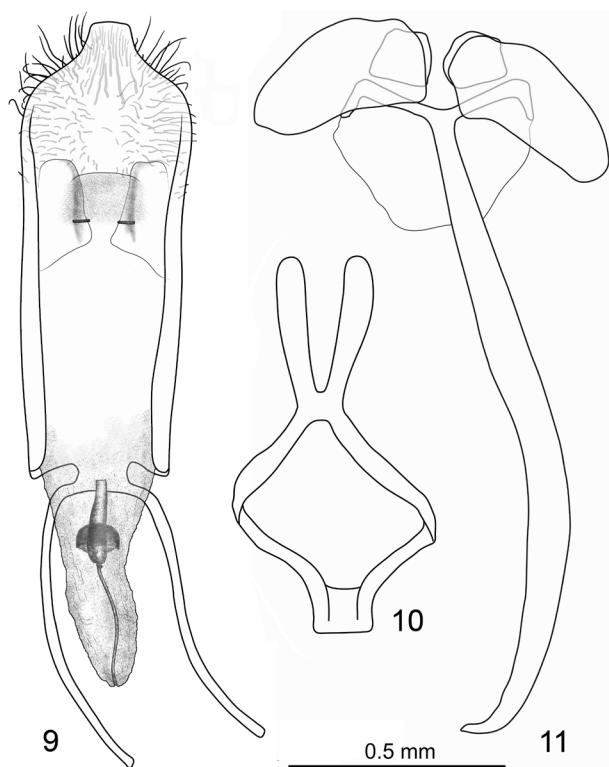
Etymology. The name is a patronym honoring the Italian zoologist and artist Leonardo Fea.

***Parallelodemas vicinum* Faust**

Parallelodemas vicina [sic] Faust 1894: 308. Lectotype male, designated here, labeled “Carin Cheba/ 900-1100 m/ L. Fea V XII-88”, “vicina/ Faust”, “P./ vicina/ sp. n.”, “Parallelodemas/ vicina/ ♂ sp. n.”, “SYNTYPUS/ Parallelodemas/ vicina/ Faust, 1894”, “Museo Civico/ di Genova”, “Lectotype/ Parallelodemas vicinum/ Faust (Prena & Zhang/ design. 2014)” (MSNG). Paralectotypes 9: Carin Cheba, Carin Ghecu and Teinzó, Myanmar (MSNG 4, SFFM 2, SNSD 3). Lyal and King (1996), elythro-tergal stridulation.

Diagnosis. A generally useful character for recognizing *P. vicinum* is the presence of imbricate squamiform setae on the distal half of the metepisternum. *Parallelodemas docile* has similar vestiture on the distal two thirds and an enlarged third tarsite. Small *P. vicinum* with more widely spaced setae on the metepisternum differ from the otherwise very similar *P. perfectum* by the apically truncate aedeagus and less curved female rostrum. These two and *P. feae*, a species with ventrally hirsute femora, are the only known species with undivided setae, flush eyes and clavate setae on the male mesotarsus.

Redescription. Length 6.4–7.8 mm, width 1.6–2.2 mm; integument black, teneral specimens with ventrites and legs partially dark rufous; ventral side with undivided setae, basic vestiture inconspicuous on pronotum and elytron, imbricate white squamiform setae at base of elytral interstria 3, postmedially on interstriae 3 and 4, on dorsal apex of mesepimeron, distal half of metepisternum, flank of prosternum, ventral face of pro- and mesofemora, dorsal face of metafemur and occasionally on basolateral angles of pronotum; eyes flush with head contour; frons and base of rostrum glabrous; male rostrum 1.06–1.15× as long as pronotum, ventrally without setae, prorostrum 0.36–0.38× rostral length and spatulate in dorsal view,

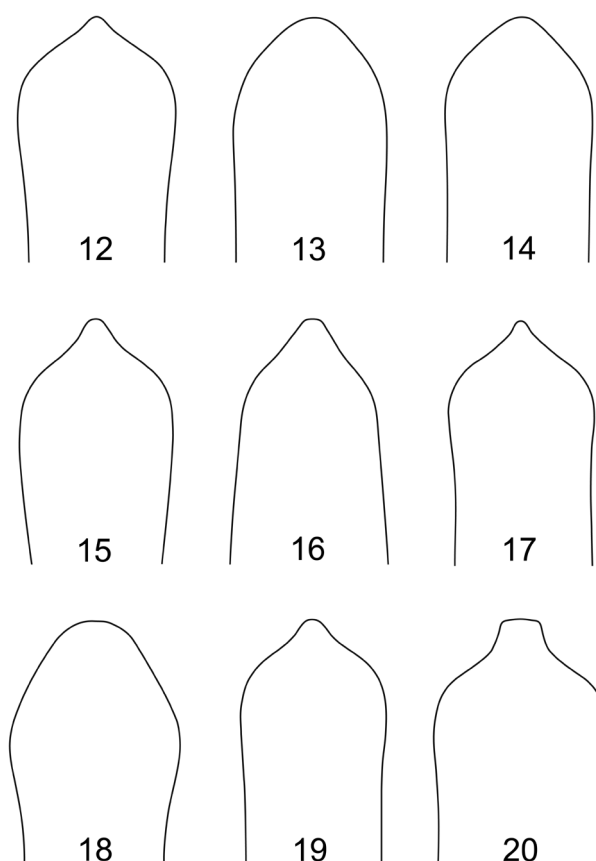


Figures 9–11. Male terminalia of *P. vicinum*: **9.** Penis, dorsal view; **10.** Tegmen; **11.** Sternites 8 and 9, ventral view.

epistome very slightly notched, antennal scape with long, cupreous setae, club 1.6× as long as wide; female rostrum 1.14–1.24× as long as pronotum, prorostrum 0.57–0.58× rostral length; prosternum gradually sloping in front of coxa, basal lobe notched; pro- and mesofemora ventrally with slender (male) or squamiform (female) setae; tarsus with tarsite 3 relatively small and excised to basal third, tarsite 5 as long as 2+3 and distinctly protruding beyond anterior margin of 3, male mesotarsus with moderately long, clavate, outward directed setae; penis 2.5× as long as wide, apex bottle-shaped (Fig. 9), internal sac with thick, tubular, basally curved sclerite; spermatheca with nodulus long and usually perpendicular to collum, ramus similarly long (as Fig. 27).

Distribution. The species is known from China (Yunnan), India and Myanmar.

Material examined. CHINA. Yunnan: Xishuangbanna Pref., Anma Xinzhai, 26.iv.2009 [#1941164], Meng (IZCAS 1); Xishuangbanna Pref., Menglun, Highway G213, 21.xi.2009 [#1500895–96]; 22.xi.2009 [#1500894], Tang Guo & Yao Zhiyuan (IZCAS 3); Xishuangbanna Pref., Menglun, 12.iv.1994 [#1500897], Chen Xiaolin (IZCAS 1); Xishuangbanna Pref., Meng'a, 6.vi.1958 [#1799544–45], Wang Shuyong (IZCAS 2); Cangyuan County, Banlao township, Dongnanhai, 2.v.2011 [#1941163], Huang Xinlei (IZCAS 1). INDIA. Sikkim: Gopaldhara, Rungbong Valley, H. Stevens (BMNH 3). West Bengal: Namsu River, 21.vi.1918, H. Stevens (BMNH 1); Nurbong [Estate], 1910s, W. K. Webb (BMNH 1). MYANMAR. Kachin: Teinshaw, V/1886, L. Fea (MSNG 1). Kayah:



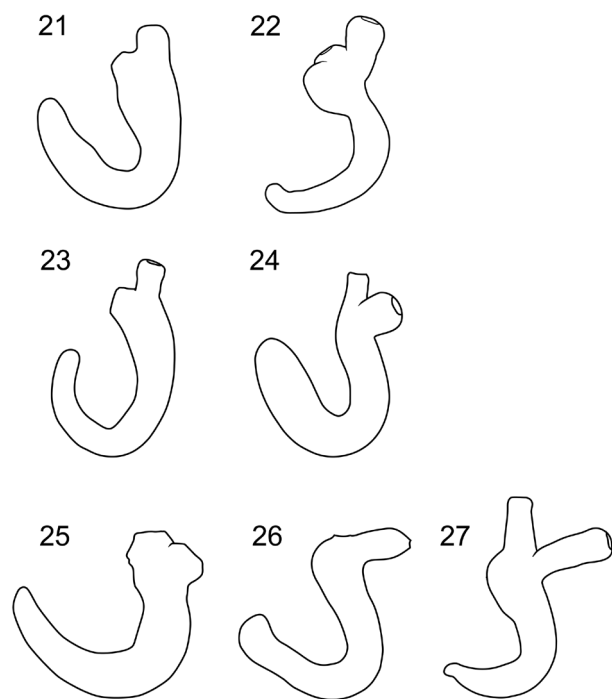
Figures 12–20. Male genitalia of *Parallelodemas*, apex of penis, dorsal view: **12.** *P. dimetans*; **13.** *P. petilum*; **14.** *P. plumosum*; **15.** *P. setifrons*; **16.** *P. docile*; **17.** *P. impar*; **18.** *P. tumens*; **19.** *P. feae*; **20.** *P. vicinum*. Not to scale.

Carin Ghécú [between Taó and Chialá, II–IV/1888] (MSNG 1). Kayin: Karen Hills [ca. 25–35 km NE of Taungoo], V/1888, L. Fea (MSNG 3, SFFM 2, SNSD 3).

Parallelodemas perfectum Faust

Parallelodemas perfecta [sic] Faust 1894: 307. Lectotype male, designated here, labeled “♂ Carin/ Cheba”, “perfecta/ Faust”, “Coll. J. Faust/ Ankauf 1900”, “Typus”, “Staatl. Museum für/ Tierkunde Dresden”, “Lectotype/ *Parallelodemas perfectum*/ Faust (Prena & Zhang/ design. 2014)” (SNSD). Paralectotypes 1 (female), Carin Cheba, 900–1100 m, V XII.1888 (MSNG). Morimoto and Yoshihara (1996: 17), designation as type species for *Parallelodemas*.

Diagnosis. Only two specimens of the sexually dimorphic *P. perfectum* are known, one of each gender. The species forms a complex with *P. feae*, *P. tardum*, *P. tumens* and *P. vicinum*, all of which have flush eyes, thoracic ventrites with undivided setae and a male mesotarsus with outward-directed clavate setae (Fig. 6). The profemur of the male *P. perfectum* is ventrally more expanded than in the other species. *Parallelodemas feae* has ventrally



Figures 21–27. Female genitalia of *Parallelodemas*, spermatheca: **21.** *P. dimetans*; **22.** *P. petilum*; **23.** *P. plumosum*; **24.** *P. setifrons*; **25.** *P. docile*; **26.** *P. impar*; **27.** *P. feae*. Not to scale.

hirsute femora; *P. tardum* has a shorter male rostrum; *P. tumens* is smaller (<5 mm); *P. vicinum* usually has denser vestiture on the mesepisternum and a less curved female rostrum. The few available female *P. perfectum* and *P. tardum* could not be distinguished with confidence.

Redescription. Length 7.0–7.8 mm, width 1.8–1.9 mm; integument black; ventral side with undivided setae, basic vestiture inconspicuous on pronotum and elytron, white squamiform setae at base of elytral interstriae 3 and 4, postmedially on interstriae 3–5, on dorsal apex of mesepimeron, metepisternum, prosternum, ventral face of pro- and mesofemora, dorsal face of metafemur and occasionally on basolateral angles of pronotum; eyes flush with head contour; frons and base of rostrum glabrous; male rostrum $1.06\times$ as long as pronotum, ventrally without setae, prorostrum $0.36\times$ rostral length and slightly spatulate in dorsal view, epistome very slightly notched, antennal scape with long, cupreous setae, club $1.6\times$ as long as wide; female rostrum $1.02\times$ as long as pronotum, prorostrum $0.58\times$ rostral length; prosternum slightly tumescent (male) or gradually sloping (female) in front of coxa, basal lobe notched; pro- and mesofemora ventrally with slender (male) or squamiform (female) setae, male profemur somewhat angularly produced ventrally; tarsus with tarsite 3 relatively small and excised to basal third, tarsite 5 longer than 3 and distinctly protruding beyond anterior margin of 3, male mesotarsus with moderately long, clavate, outward directed setae; penis $3.1\times$ as long as wide, apex roundly narrowed with slightly produced tip (as *P. feae*, Fig. 19), internal sac with short, complex sclerite (double hook); spermatheca with nodulus long

and perpendicular to long axis of collum, ramus obsolete (as *P. impar*, Fig. 26).

Distribution. The species is known from one site in Myanmar.

Material examined. MYANMAR. Kayin: Karen Hills [ca. 25–35 km NE of Taungoo], V/1888, L. Fea (MSNG 1, SNSD 1).

Discussion

Species of *Parallelodemas* display an unusually diverse and complex suite of deviant morphological structures. Several occur in only a few species, such as the enlarged third tarsite or the deeply split setae on the ventrites. Others are male-specific, such as the setal fringes on rostrum, scape and mesotarsus, or the tubercles found on the first ventrite of an undescribed species near *P. dimetans*. The structural heterogeneity is increased further by the apically exposed epistome that often is worn off in females but rarely in males. Most of these traits can be found also in other tropical weevils, particularly in Dryophthorinae and Baridinae (Davis 2009; Anderson et al. 2014; Prena et al. 2014), although not as accumulated as in *Parallelodemas*. Very little is known about their functions and the few available observations may not always be transferable to other species.

It is long-known that numerous weevil species lack incisors on the mandible (Lacordaire 1865; Ting 1936; Günther 1938). In some cases, the mandible moves almost vertically rather than transversely opposed as in most other beetles (Horn 1873; McClenahan 1904; Marshall 1945; Morimoto 1962; Pelsue and O'Brien 2011). However, distally diverging mandibles with a convex inner face and incisor-like structures on the outer face are uncommon. They occur in several Dryophthorinae, such as *Cyrtotrachelus* Schönherr, *Macrocheirus* Schönherr, *Otidognathus* Lacordaire, *Protocerius* Schönherr, *Rhinostomus* Rafinesque and, among the Baridinae, in *Parallelodemas* and some *Geraeus* Pascoe (Casey 1922; Vaurie 1970; Morimoto and Yoshihara 1996). Many Rhynchitinae (Attelabidae) and some Cholini, Eirrhini, Tychiini and Platypodinae (Curculionidae) have similar exodontous mandibles (Ting 1936; Hamilton 1990; Thompson 1992) but with normal interior incisors and decussate apices. Three functions have been attributed to exodontous mandibles. Daanje (1964) was the first to point out that they occur in Rhynchitinae that pupate in soil but not in Attelabinae that pupate in leaf rolls. He concluded that the exterior tooth supports the weevil's emergence to the surface. Depending on the species group, the teeth are sheared off after emergence of the beetle or are retained in one or both sexes (Daanje 1964; Dieckmann 1974; Riedel 2014). A second function of the exterior tooth is its usage during the preparation of the leaf roll in some Rhynchitinae (Daanje 1964, 1975). A third possible function is related to oviposition. Kissinger (in litt., quoted by Vaurie 1970) conjectured that the exterior tooth might be used for making oviposition holes, by rip-

ping through fibrous tissue of the monocotyledonous host plant. Eberhard (1983) observed that female *Rhinostomus barbirostris* (Fabricius) chew the oviposition hole and then withdraw the rostrum with a series of sharp jerks. The exodontous mandible may serve during the latter action for enlarging or cleaning the hole. While the mandibles of the above-mentioned dryophthorines have a thick, excavated outer face (Vaurie 1970), they are thin and blade-like in the baridines. It is conceivable that female *Parallelodemas* employ the outer face for ripping and cutting through plant tissue as suggested by Kissinger, perhaps on culms hollow inside or filled with pith, but chewing is necessary to at least initiate the oviposition hole. Our own observations showed that baridines without incisors are primarily pollen feeders and use their mandibles like pincers. Oviposition behavior has not been documented so far for any baridine with exodontous mandibles. The worn epistome of many female *Parallelodemas* may or may not be related to the aberrant morphology and movement of the mandible. Even though the epistome of *Rhinostomus* species is similarly exposed and unprotected as in *Parallelodemas*, we found no sign of wear in female *R. barbirostris* and *R. niger* (Drury). However, similar wear is apparent in female *Apostasimerus serrirostris* Boheman, a palm-associated Neotropical baridine with straight incisor area.

Gender-specific setae or setal patches occur relatively frequently on tibiae and ventrites of weevils (Eberhard 1983; Lyal 1993; Schat et al. 2007) but are less common on the rostrum. Short fringes or fuzzy patches occur for instance in *Datonychus* Wagner, *Mogulones* Reitter (Dieckmann 1972), *Metamasius* Horn (Vaurie 1968, 1970) and *Pterocolus* Say (Hamilton 1998). We noticed long setal fringes, like those present on the ventral rostrum of some male *Parallelodemas* species, in male *Acythopeus barbatus* Pascoe, *Conoproctus longipes* (Casey), *C. quadripustulatus* (Fabricius), *Mycterus barbirostris* Pascoe and *M. imberbis* Lea (probably a synonym of the former; all Baridinae). Observations on the usage of these setae are available only for one species of *Rhinostomus*, the “bottle brush weevil”. Eberhard (1983) described how male *R. barbirostris* gently wipe the rostrum on the female’s pronotum and elytron thereby apparently pacifying or immobilizing their chosen mate. Because this did not explain the presence of setae on the dorsal side of the rostrum, the author speculated that other sensory functions may be involved. However, his observations provided evidence that the setae have a behavioral, mating-related function. If and how this applies to the exterior setae on the fifth mesotarsite of some male *Parallelodemas* species remains unknown. Similar setae occur in other weevils on the interior (proximal) face of the basal three tarsites or all around, particularly on the protarsus, but not on the exterior face of the fifth.

The weevil tarsus typically is cryptopentamerous (with a miniaturized fourth tarsite) but there are a few exceptions and numerous modifications. The fourth and fifth tarsites are lost in species of genera such as *Anoplobaris* Morimoto & Yoshihara, *Anoplus* Germar,

Atelicus Waterhouse, *Diabathrarius* Schönherr, *Macrobaris* Champion, *Syarbis* Pascoe and *Viticis* Lea, and are greatly reduced in several others. An enlarged third tarsite is particularly common in African Dryphthorinae (e.g., *Belorhynus* Guérin-Méneville, *Ichthyopisthen* Aurivillius, *Korotyaevius* Alonso-Zarazaga and Lyal) and American grass-associated Baridinae (e.g., *Macrobaris*, *Nertinus* Voss, *Trachymeropsis* Champion). In many cases, the enlargement of the third tarsite is accompanied by a reduction of the fifth. Many if not all of these species live on swaying parts of their host plants and it is perceivable that the adhesive strength of the tarsus is increased by enlarging the surface of individual tarsites.

Although the structural diversity of these predominantly tropical weevils is appealing for morphological and behavioral studies, systematic fieldwork is greatly hampered by the still prevailing paucity of taxonomical and ecological information. Even the functions of rather ubiquitous structures, like the “prosternal horns” (Davis 2009; Davis and Engel 2010) present in Anthribidae, Nemomychidae and the curculionid subfamilies Baridinae, Conoderinae, Curculioninae and Molytinae, have remained largely unknown or were interpreted as being generally indicative for ritual fighting, even though the latter usage has been observed in just one species (Eberhard and Garcia 2000; own observations) while similar structures have other functions (Lacordaire 1863, p. 5; Lesne 1899, p. 143; Wood 1969, p. 43; Daanje 1975, p. 288; Thompson 1992, p. 869). It is our hope that increased taxonomic and biogeographic knowledge will stimulate interest among local researchers to conduct their own research on these fascinating aspects of weevil diversity.

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References

- Alonso-Zarazaga MA, Lyal CHC (1999) A world catalogue of families and genera of Curculionoidea (Insecta: Coleoptera) (Excepting Scolytidae and Platypodidae). Entomopraxis SCP, Barcelona.
- Anderson RS, Marvaldi AE (2014) Dryophthorinae Schoenherr, 1825. In: Leschen RAB, Beutel RG (Eds) Handbook of Zoology, Coleoptera, Vol. 3. DeGruyter, Berlin, 477–483.
- Casey TL (1922) Studies in the rhynchophorous subfamily Barinae of the Brazilian fauna. Memoirs on the Coleoptera 10: 1–520.
- Daanje A (1964) Über die Ethologie und Blattrolltechnik von *Deporaus betulae* L. und ein Vergleich mit den anderen blattrollenden Rhynchitinen und Attelabinen-Coleoptera, Attelabinae. Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, Afdeling Natuurkunde 56: 1–215.
- Daanje A (1975) Some special features of the leaf-rolling technique of *Byctiscus populi* L. (Coleoptera: Rhynchitini). Behaviour 53: 285–316. doi: 10.1163/156853975x00236
- Davis SR (2009) Morphology of Baridinae and related groups (Coleoptera, Curculionidae). ZooKeys 10: 1–136. doi: 10.3897/zookeys.10.47
- Davis SR, Engel MS (2010) Antiquity and evolution of prosternal horns in baridine weevils (Coleoptera: Curculionidae). Journal of Paleontology 84: 918–926. doi: 10.1666/09-160.1
- Dieckmann L (1972) Beiträge zur Insektenfauna der DDR: Coleoptera – Curculionidae: Ceutorhynchinae. Beiträge zur Entomologie 22: 3–128.
- Dieckmann L (1974) Beiträge zur Insektenfauna der DDR: Coleoptera – Curculionidae (Rhinomacerinae, Rhynchitinae, Attelabinae, Apoderinae). Beiträge zur Entomologie 24: 5–54.
- Eberhard WG (1983) Behavior of adult bottle brush weevils (*Rhinostomus barbirostris*) (Coleoptera: Curculionidae). Revista Biología Tropicales 31: 233–244.
- Eberhard WG, Garcia-C JM (2000). Ritual jousting by horned *Paroschoenus expositus* weevils (Coleoptera, Curculionidae, Baridinae). Psyche 103: 55–84. doi: 10.1155/2000/16361
- Faust J (1894) Viaggio di Leonardo Fea in Birmania e regioni vicine. LX. Curculionidae. Annali del Museo civico di storia naturale di Genova 34: 153–370. doi: 10.5962/bhl.title.48832
- Fea L (1896) Quattro anni fra i Birmani e le tribù limitrofe. Hoepli, Milano.
- Günther K (1938) Revision der Gattung *Otidognathus* Lac. (Coleoptera Curculionidae Calandrinae). Temminckia 3: 45–108.
- Hamilton RW (1990) A revision of the weevil genus *Eugnamptus* Schoenherr (Coleoptera: Rhynchitidae) in America north of Mexico. Transactions of the American Entomological Society 115: 475–502.
- Hamilton RW (1998) Taxonomic revision of the New World Pterocolinae (Coleoptera: Rhynchitidae). Transactions of the American Entomological Society 124: 203–269.
- Horn GH (1873) Contributions to a knowledge of the Curculionidae of the United States. Proceedings of the American Philosophical Society 13: 407–469.
- Korotyaev BA (2002) The weevil tribe Neosharpiini Hoffmann belongs in the subfamily Baridinae (Coleoptera: Curculionidae). Zoosystematica Rossica 11: 192.
- Lacordaire T (1863) Histoire naturelle des insectes. Genera des Coléoptères ou exposé méthodique et critique de tous les genres proposés jusqu'ici dans cet ordre d'insectes. Vol. 6. Roret, Paris, 637 pp. doi: 10.5962/bhl.title.67686
- Lacordaire T (1865) Histoire naturelle des insectes. Genera des Coléoptères ou exposé méthodique et critique de tous les genres proposés jusqu'ici dans cet ordre d'insectes. Vol. 7. Roret, Paris [1866], 620 pp. doi: 10.5962/bhl.title.67686
- Lesne P (1899) Sur l'usage des appendices mandibulaires caducs des Brachyrrhinidae [Col.]. Bulletin de la Société Entomologique de France 68: 143–144.
- Lyal CHC (1993) Cryptorhynchinae (Insecta: Coleoptera: Curculionidae). Fauna of New Zealand. Vol. 29. Manaaki Whenua Press, Lincoln.
- Lyal CHC, King T (1996) Elytro-tergal stridulation in weevils (Insecta: Coleoptera: Curculionoidea). Journal of Natural History 30: 703–773. doi: 10.1080/00222939600770391
- Marshall GAK (1945) On *Trephognathus*: a new genus of African Baridinae (Col. Curc.). Proceedings of the Royal Entomological Society of London (B) 14: 21–24. doi: 10.1111/j.1365-3113.1945.tb00005.x
- McClenahan EM (1904) The development of the rostrum in the rhynchophorous Coleoptera. Psyche 11: 89–102. doi: 10.1155/1904/95750
- Morimoto K (1961) On new Curculionidae from Japan (Coleoptera). Kontyû 29: 22–27.
- Morimoto K (1962) Comparative morphology and phylogeny of the superfamily Curculionidae of Japan (Comparative morphology, phylogeny and systematics of the superfamily Curculionidae of Japan. I). Journal of the Faculty of Agriculture, Kyûshû University 11: 331–373.
- Morimoto K, Yoshihara K (1996) On the genera of the Oriental Baridinae (Coleoptera, Curculionidae). Esakia 36: 1–59.
- Oberprieler RG, Anderson RS, Marvaldi AE (2014) Curculionoidea Latreille, 1802: Introduction, Phylogeny. In: Leschen RAB, Beutel RG (Eds) Handbook of Zoology, Coleoptera, Vol. 3. DeGruyter, Berlin, 285–300.
- Pelsue FW Jr, O'Brien CW (2011) A redefinition of the Curculionini of the world, with a key to subtribes and genera, and two new genera: *Pseudoculio* and *Megaoculis* (Coleoptera: Curculionidae: Curculioninae). Zootaxa 3102: 27–49.
- Prena J, Colonnelli E, Hespeneide HA (2014) Conoderinae Schoenherr, 1833. In: Leschen RAB, Beutel RG (Eds) Handbook of Zoology, Coleoptera, Vol. 3. DeGruyter, Berlin, 577–589.
- Riedel A (2014) Attelabidae Billberg, 1820. In: Leschen RAB, Beutel RG (eds). Handbook of Zoology, Coleoptera, Vol. 3. DeGruyter, Berlin, 328–355.
- Schat M, Sing SE, Peterson RKD (2007) External rostral characters for differentiation of characters in the biological control agent *Mecinus janthinus* (Coleoptera: Curculionidae). Canadian Entomologist 139: 354–357. doi: 10.4039/n06-033
- Thompson RT (1992) Observations on the morphology and classification of weevils (Coleoptera, Curculionidae) with a key to major groups. Journal of Natural History 26: 835–891. doi: 10.1080/00222939200770511
- Ting PC (1936) The mouth parts of the coleopterous group Rhynchophora. Microentomology 1: 93–114.
- Vaurie P (1968) New weevils of the genus *Metamasius* from Central and South America (Coleoptera, Curculionidae, Rhynchophorinae). Novitates Zoologicae 2316: 1–10.
- Vaurie P (1970) Weevils of the tribe Sivalini (Coleoptera, Curculionidae, Rhynchophorinae) Part 1. The genera *Rhinostomus* and *Yuccaborus*. American Museum Novitates 2419: 1–57.
- Vinciguerra D (1890) Viaggio di Leonardo Fea in Birmania e regioni vicine. XIV. Pesci. Annali del Museo civico di storia naturale di Genova 9: 129–362, 1 map, plates VII–XI.

- Voss E (1937) Ein weiterer Beitrag zur Kenntnis der Curculioniden Javas. *Tijdschrift voor Entomologie* 80: 127–166.
- Voss E (1941) Bemerkenswerte und unbeschriebene Rüsselkäfer aus China und Japan (Col., Curc.). (92. Beitrag zur Kenntnis der Curculioniden). *Mitteilungen der Münchener Entomologischen Gesellschaft* 31: 887–902.
- Voss E (1956) Über einige in Fukien (China) gesammelte Rübler, V, nebst einer neuen Gattung und Art aus Yunnan. (Col., Curc.) 115. Beitrag zur Kenntnis der Curculioniden. *Entomologische Blätter* 51 [1955]: 21–45.
- Weidner H (1979) Die Entomologischen Sammlungen des Zoologischen Instituts und Zoologischen Museums der Universität Hamburg. Nachtrag zum IX. Teil Insecta VI. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 76: 395–468.
- Wood SL (1969) Additions to the horned bark beetle genus *Cactopinus* Schwarz (Scolytidae). *Coleopterists Bulletin* 23: 42–51.
- Yoshihara K, Morimoto K (1994) A new genus of the subfamily Bari-dinae (Coleoptera, Curculionidae) from East Asia. *Japanese Journal of Entomology* 62: 723–729.
- Zherikhin VV, Gratshev VG (1995) A comparative study of the hind wing venation of the superfamily Curculionoidea, with phylogenetic implications. In: Pakaluk J, Ślipiński SA (Eds) *Biology, Phylogeny, and Classification of Coleoptera: Papers celebrating the 80th Birthday of Roy A. Crowson*. Muzeum i Instytut Zoologii PAN, Warszawa, 634–777.

Description of the male of *Ctenophilothis altus* (Lewis, 1885): supplement to the revision of the genus *Ctenophilothis* Kryzhanovskij, 1987 (Coleoptera, Histeridae, Saprininae)

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Abstract

A description of the male, including illustrations of the male genitalia, and a colour image of the habitus of the extremely rare species *Ctenophilothis altus* (Lewis, 1885) are provided for the first time. Further support for the monophyly of the genus *Ctenophilothis* Kryzhanovskij, 1987 is given.

Key Words

Coleoptera
Histeridae
Saprininae
Ctenophilothis

In 2013 I published a revision of the genus *Ctenophilothis* Kryzhanovskij, 1987 (Lackner 2013). At the time of that revision this genus consisted of only two psammophilous Saharan species, both very rare. Although *C. chobauti* (Théry, 1900) has been found several times in the Moroccan and Algerian Sahara (Olexa 1990, Gomy et al. 2014), the other species, *C. altus* (Lewis, 1885) was known only from the female holotype and another female, collected in upper Egypt (Lackner 2013). During my recent visit to the Zoological Museum of the Humboldt University Berlin, Germany (ZMHUB) I discovered in the collection a male of this species, collected in Asyut, central Egypt.

In this short correspondence I publish the discovery of the third specimen of the extremely rare *C. altus*, together with the color image and illustration of its hitherto unknown male genitalia. Both Egyptian localities of this species are likewise mapped herein. As already noted by Lackner (2013) the genus *Ctenophilothis* is most probably monophyletic, sharing e.g. the absence of the antennal cavity, shortened or strongly reduced

lateral costa of the antennal groove or the peculiar shape of protibia (Lackner 2013: 281). The comparison of the male genitalia of both species reveals their striking similarities as well (compare figs 2–10 with those of Lackner 2013, figs 11–17) suggesting further support for the genus' monophyly. The main difference between the male terminalia lies in the shape of spiculum gastrale that in *C. chobauti* belongs to the most common type found in the Saprininae, having both 'head' and 'stem' sensu Caterino and Tishechkin (2013). On the other hand, the spiculum gastrale of *C. altus* is of a rather peculiar type, lacking typical 'head' or 'stem' (compare figs 7–8 with those of Lackner 2013, figs 14–15). Especially seen from the lateral view, the spiculum gastrale of *C. altus* is extremely flat, almost without projections (Fig. 8). According to my studies on the morphology of the Saprininae, the shape of the spiculum gastrale is very diverse and it was very difficult to parse this extraordinary diversity into discrete character states (Lackner in press).

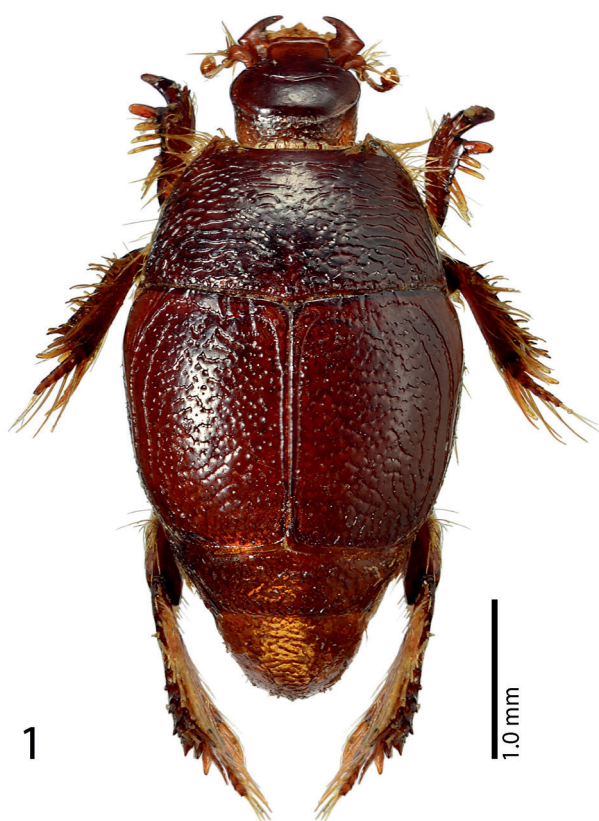
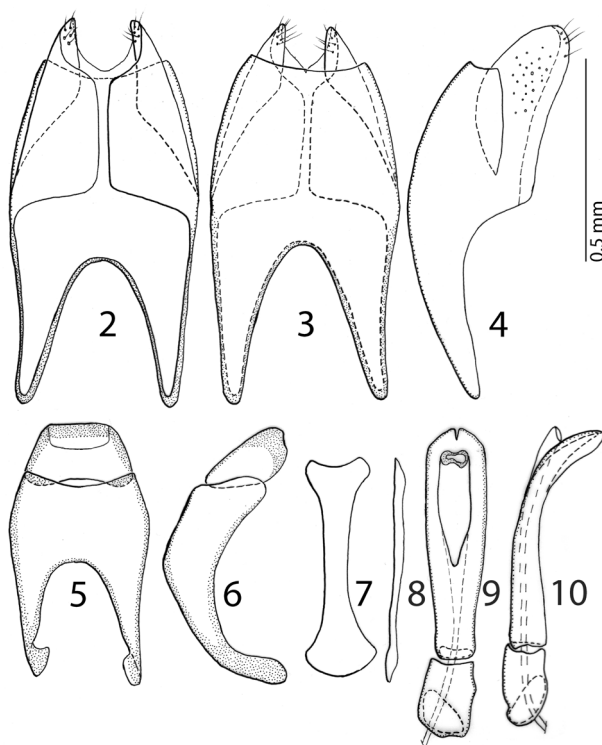


Figure 1. *Ctenophilothis altus* (Lewis, 1885) habitus, dorsal view.



Figures 2–10. *Ctenophilothis altus* (Lewis, 1885) 2 – eighth sternite and tergite, ventral view; 3 – ditto, dorsal view; 4 – ditto, lateral view; 5 – ninth and tenth tergites, dorsal view; 6 – ditto, lateral view; 7 – spiculum gastrale, ventral view; 8 – ditto, lateral view; 9 – aedeagus, dorsal view; 10 – ditto, lateral view.

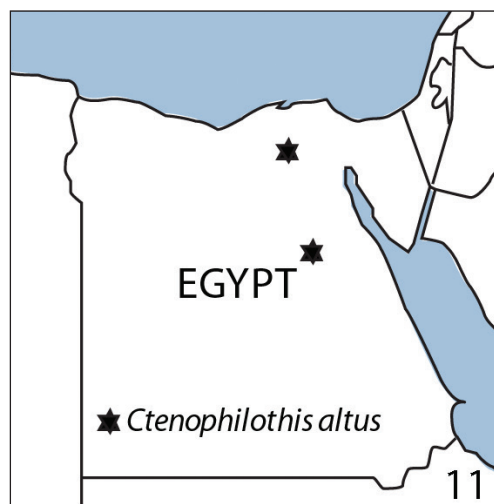


Figure 11. Distribution of *Ctenophilothis altus* (Lewis, 1885) in Egypt.

The second known locality of *C. altus* (Asyut, 27°11'00"N 31°10'00"E) lies more south than the single one published previously (Fig. 11). The presumed rarity of the species can be most likely ascribed by the insufficient collection aimed at the psammophilous Histeridae in Egypt. While efforts aimed at collecting psammophilous Saprininae of the Algerian and Moroccan Sahara yielded remarkable results (see e.g. Olexa 1990 or Gomy et al. 2014), there has been practically no such activity performed in Egypt.

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References

- Caterino MS, Tishechkin AK (2013) A systematic revision of *Operclipygus* Marseul (Coleoptera, Histeridae, Exosternini). *ZooKeys* 271: 1–401. doi: 10.3897/zookeys.271.4062
- Gomy Y, Labrique H, Francois A (2014) Contribution à la connaissance des Histeridae du Maroc (Coleoptera) (Troisième note) 1^{re} Partie. *Bulletin de la Société Entomologique de Mulhouse* 70(2): 23–35.
- Lackner T (2013) Revision of the genus *Ctenophilothis* Kryzhanovskij, 1987 (Coleoptera: Histeridae: Saprininae). *Zootaxa* 3691(2): 273–282. doi: 10.11646/zootaxa.3691.2.6
- Lackner T (in press) Phylogeny of the Saprininae subfamily reveals interesting ecological shifts in the history of the subfamily (Coleoptera: Histeridae). *Zoological Journal of the Linnean Society*.
- Olexa A (1990) On the genus *Philothis* and related genera (Coleoptera: Histeridae). *Acta Entomologica Bohemoslovaca* 87: 141–155.

Systematic position of *Eulachnus cembrae* Börner with description of hitherto unknown sexual morphs of *E. pumilae* Inouye (Hemiptera, Aphididae, Lachninae)

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Abstract

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Key Words

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The identity of *Eulachnus cembrae* Börner, 1950, **stat. rev.** from Europe, treated as a synonym of *E. pumilae* Inouye, 1939 from East Asia is clarified based on characters of sexual morphs. The oviparous female and alate male forms of *E. pumilae* are described and figured in detail for the first time and the poorly known sexual forms of *E. cembrae* are redescribed and figured in detail as well. Sexual morphs of the two similar species are compared, and significant differences clearly distinguishing those species are presented. A key to the identification of oviparous females and males of *E. cembrae* and *E. pumilae* as well as notes on host plants and distribution of these species are provided. The status of *E. pumilae* in the European aphid-fauna is clarified. Morphological characters of the sexual generation that may be useful for species identification are discussed.

Introduction

The Palaearctic genus *Eulachnus* Del Guercio, 1909 comprises about 13–18 species of small, narrow-bodied aphids, of which about 12 are known from Europe. They live often singly or in small colonies on the needles of *Pinus* spp., are hidden while feeding and become very active when disturbed (Blackman and Eastop 1994; Kanturski and Wieczorek 2014). Taxa from the genus *Eulachnus* are good examples for species and species-groups of unclear identity (Blackman and Eastop 2014). Such an example is the species pair *E. pumilae* Inouye, 1939 and *E. cembrae* Börner, 1950, stat. rev. In comparison to the other *Eulachnus* species they are characterized by the absence of dorsal sclerites and scleroites on the abdomen.

E. pumilae was described by Inouye (1939) from Hokkaido (Japan) from *Pinus pumila*, whereas Börner (1950) described *E. cembrae* from the Eastern Alps from *P. cembra*. Many authors treated those two species as synonyms (Inouye 1970; Ghosh 1982; Blackman and Eastop 1994). However,

Remaudière and Remaudière (1997) stated that *E. cembrae* should be treated as a separate species due to a difference in the number of accessory setae on the apical segment of the rostrum (2 setae in *E. pumilae*, no setae in *E. cembrae*), which is a difference also mentioned in Blackman and Eastop (2014). The problem of the identity of *E. cembrae* has not been resolved yet. The most recent papers of Mamontova (2011, 2012) still treat these two species as synonyms. Moreover, in the Fauna Europaea *E. pumilae* is recorded as European species (Nieto Nafria et al. 2014), known only from Slovakia (Goffova and Wojciechowski 2013).

The descriptions of *E. pumilae* and *E. cembrae* were based on characters of the viviparous generation, although there were also sexual morphs in the type material of Börner (1950). Pintera (1968) briefly described the sexual generation of *E. cembrae*. Oviparae were characterized by numerous pseudosensoria; males were winged with numerous rhinaria on the antennae. Similar information was reported by Szelegiewicz (1978). The life cycle and sexual forms of *E. pumilae* were not described.

Ghosh (1982) gave a description of sexual forms under the name *E. pumilae*, but this was in reality a description of sexual forms of *E. cembrae*.

The aim of this paper is to define the taxonomic status of these two species by morphological and biometric examination of their sexual morphs, especially sexual forms of *E. cembrae* from the type material. On the basis of the material deposited in the Natural History Museum, London (UK), a description of sexual forms of *E. pumilae* is provided as well as a redescription of the sexual generation of *E. cembrae*. Moreover, the role of the characters of the sexual generation is highlighted, especially the underestimated and rather rarely used features of the male genitalia.

Material and methods

Material examined

***E. pumilae*.** One oviparous female, one alate male, SOUTH KOREA, Seoul, 03.XI.1971, *Pinus koraiensis*, BM 1984-340, 688g, Paik leg. BMNH.

***E. cembrae*.** One oviparous female, one alate male (from type material), AUSTRIA: East Alps, 21.VIII.1942, *Pinus cembra*, 1/22, Franz leg. DEIC; two oviparous females, POLAND: Tatra Mountains, Zbocze Żabięgo, 07.IX.1977, *P. cembra*, R2046 4815, H. Szelegiewicz leg. ZMPA; one oviparous female, SWITZERLAND: Valais, Brüchen, 16.X.1985, *P. cembra*, 7042:10, Bergersen leg. MZLU; one alate male, two oviparous females, Les Plans sur Bex, 12.IX.1966, *P. cembra*, BM 1984-340 470, D. Hille Ris Lambers leg. BMNH; two oviparous females, one alate male, SLOVAKIA: High Tatra Mountains, Grúnik, 1.IX.1949, *P. cembra*, BM 1952-537, V. Pašek leg. BMNH; two oviparous females, FRANCE: Ravin de Molières, Mercantour A. M., X.1993, *P. cembra*, 22025, L. Dalstein leg., one alate male, *P. cembra*, 22026, L. Dalstein leg., three oviparous females, Risoul 1900 m, (Hautes Alpes), 16.X.1986, *P. cembra*, 22023, G. Remaudière leg., three oviparous females, *P. cembra*, 22024 G. Remaudière leg. all MNHN.

Methods

The specimens were examined using the light microscope Nikon Ni-U and were photographed with a Nikon DS-Fi2 camera. Drawings were made with a camera lucida. For each of the drawings a magnified view is provided. Measurements are given in mm (Table 1). The material studied is deposited in the Natural History Museum, London, UK (BMNH), Muséum national d'Histoire naturelle, Paris, France (MNHN), Deutsches Entomologisches Institut, Eberswalde, Germany (DEIC), Lund University, Lund Museum of Zoology, Lund, Sweden (MZLU), and Zoological Institute, Polish Academy of Sciences, Warsaw, Poland (ZMPA). Measurements and ratios of first segment of hind tarsus (HT I) were made after Szelegiewicz (1978) and Heie (1995) (Fig. 1f).

Table 1. Measurements (in mm) of oviparous female (n = 1), alate male (n = 1) of *Eulachnus pumilae* and oviparous females (n = 15) alate males (n = 3) of *E. cembrae*.

Character	Oviparous females		Alate males	
	<i>E. pumilae</i>	<i>E. cembrae</i>	<i>E. pumilae</i>	<i>E. cembrae</i>
Body length	3.50	2.62–3.25	2.95	2.7
Maximal width	1.37	0.90–1.32	0.90	0.75–0.92
Head width	0.52	0.46–0.68	0.54	0.52
Antennae length	1.32–1.38	1.48–1.67	0.69–0.70	2.11–2.20
Ant. segm. III	0.41–0.42	0.48–0.54	0.70–0.71	0.69–0.74
Ant. segm. IV	0.25	0.26–0.28	0.41–0.45	0.36–0.43
Ant. segm. V	0.26–0.27	0.30–0.34	0.41–0.42	0.45–0.49
Ant. segm. VI	0.24	0.26–0.28	0.27–0.29	0.33–0.35
Ant. segm. VIa	0.19–0.20	0.22–0.24	0.23–0.25	0.27–0.30
Ant. segm. VIb	0.04–0.05	0.04–0.05	0.04	0.05–0.06
Hind femora	1.15–1.20	1.10–1.27	1.15–1.17	1.22–1.25
Hind tibiae	1.75–1.80	1.67–1.97	2.02–2.05	1.95–2.05
HT I basal length	0.03	0.03–0.04	0.02–0.03	0.03
HT I dorsal length	0.08	0.10–0.12	0.10	0.11–0.12
HT I ventral length	0.12	0.14–0.16	0.13	0.14–0.15
HT I intersegmental length	0.05	0.04–0.05	0.04	0.04–0.05
HT II	0.20	0.24–0.28	0.23	0.25–0.28
ARS	0.09	0.09–0.10	0.10	0.09–0.10
Siphuncular sclerite	0.08–0.09	0.07–0.10	0.06	0.06–0.08
Siphuncular pore	0.03–0.04	0.03–0.04	0.03	0.03
Fore wings length	–	–	3.12–3.25	3.12–3.40
Subgenital plate length	0.25	0.13–0.15	–	–
Subgenital plate width	0.40	0.33–0.37	–	–

Results

Taxonomy

Eulachnus pumilae Inouye

Figs 1, 3a, c

Inouye 1939: 134, by original designation

Description. Oviparous female (Fig. 1; Table 1, 2). Colour in life unknown. Pigmentation of mounted specimens: several structures pigmented in a generally transparent body. Antennae brown, except segment I, which is pale at base and light-brown at apex. Fore and middle femora yellow with darker ends. Fore and middle tibiae light-brown. Hind legs brown, with only paler apices of femora. Tarsi brown. Siphuncular sclerites brown. Body elongated, oval (Fig. 1a). Head with big compound eyes, without triommatidia. Head width 0.36–0.37 times length of antennae. Head chaetotaxy: dorsal side with 11, ventral side with 12 fine and pointed setae, 0.08–0.11 mm long. Head setae arising from wart-like bases. Antennae (Fig. 1b, c) 6-segmented 0.39–0.40 times length of body. Ant. segm. III (Fig. 1b) shorter than segm. IV+V+VI with smooth proximal part and imbricated apex. Ant. segm. IV (Fig. 1b) only slightly shorter than ant. segm. V. Ant. segm. V (Fig. 1c) slightly longer than ant. segm. VI, with 1 rounded or oval primary rhinarium at apex. Rhinarium with little developed sclerotic rosette. Ant. segm. VI (Fig.

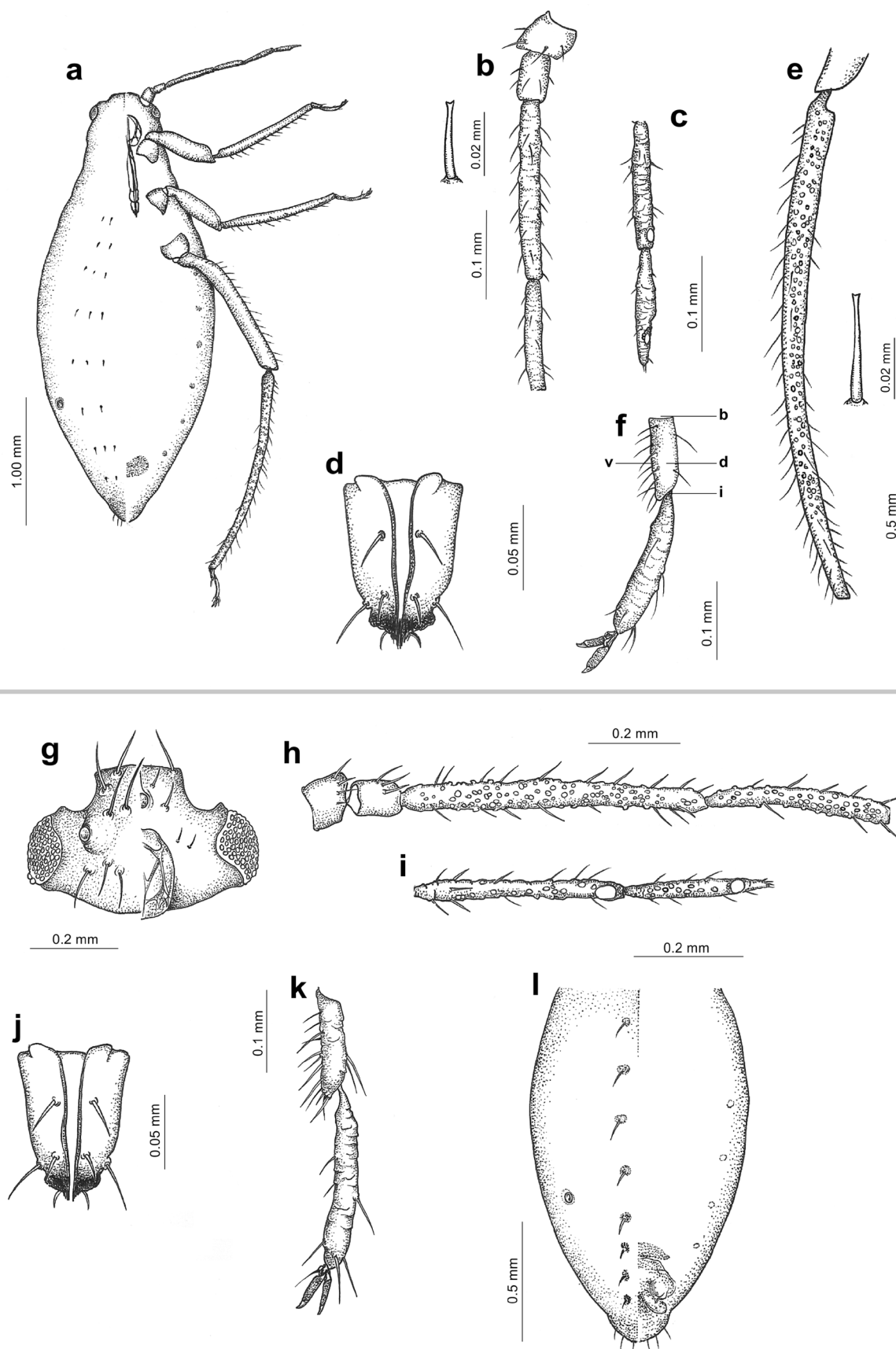


Figure 1. *Eulachnus pumilae* – oviparous female: (a) general view, (b) antennal segments I–IV, (c) antennal segments V and VI, (d) apical segment of rostrum, (e) hind tibia, (f) hind tarsus with HT I parts lengths: b – basal length, d – dorsal length, v – ventral length, i – intersegmental length. Alate male: (g) head, (h) antennal segments I–IV, (i) antennal segments V and VI, (j) apical segment of rostrum, (k) hind tarsus, (l) abdomen.

Table 2. Main morphological differences between oviparous females of *E. pumilae* and *E. cembrae* **AL**—antennae length, **BL**—body length, **ANT IV**—antennal segment IV length, **ANT III**—ant. segm. III length, **HT I bL**—first segment of hind tarsus basal length, **HT I dL**—HT I dorsal length, **HT I iL**—HT I intersegmental length, **HT I vL**—HT I ventral length **ARS**—apical segment of rostrum, **HT II**—second segment of hind tarsus length.

Character	<i>E. pumilae</i>	<i>E. cembrae</i>
AL/BL	0.39–0.40	0.49–0.57
ANT IV/ANT III	0.59–0.61	0.38–0.53
HT I bL/HT I dL	0.38–0.43	0.30–0.33
HT I dL/HT I iL	1.45–1.53	2.10–3.00
HT I bL/HT I vL	0.25–0.28	0.23–0.24
ARS/ANT III	0.21–0.22	0.18–0.20
ARS/HT II	0.42–0.45	0.35–0.41
Pseudosensoria	100–105	32–58
ARS accessory setae	2	0

1c) with very short terminal process (VIb), 0.20–0.26 times length of base (VIa) and with 1 rounded or oval primary rhinarium with little sclerotic rosette and 4 accessory rhinaria situated close to each other in about half of length of segment. Ant. segm. IV–VI imbricated on whole length. Other antennal ratios: VI:III 0.57–0.58, V:III 0.63–0.64, IV:III 0.59–0.61. Antennal chaetotaxy: segm. I with 4 setae, segm. II with 5 setae, segm. III with 20–23 setae, segm. IV with 7–9 setae, segm. V with 7–11 setae, segm. VI with 4–5 basal, 5–6 apical and 1 subapical setae. Ant. segm. III–IV with short and slightly forked setae (Fig. 1b), segm. V and VI with short and pointed setae, shorter, or as long as diameter of segments. Longest seta on ant. segm. III 1.00–1.05 times basal articular diameter of this segment (BD III). Rostrum short, reaching behind middle coxae. Apical segment of rostrum (ARS) blunt, with very short apical part (Fig. 1d), 0.21–0.22 times ant. segm. III, 0.37 times ant. segm. VI and 0.42–0.45 times second segment of hind tarsus (HT II), with 6 primary and 2 accessory setae. Dorsal side of thorax covered by short, 0.04–0.05 mm, and blunt setae. Hind legs long, covered by slightly blunt setae, which are as long as or slightly longer than width of tibiae. Distal, inner side of fore and middle tibiae with numerous short and pointed setae. Hind tibiae (Fig. 1e) slightly swollen, with 100–105 irregular pseudosensoria reaching about $\frac{3}{4}$ length of tibiae. Some setae of hind tibiae with slightly blunt apices (Fig. 1e), longest setae on distal part of tibiae pointed. First segment of hind tarsus (HT I) long, its basal length 0.38–0.43 times dorsal, 0.25–0.28 times ventral and 0.56–0.67 times intersegmental length, with 2 dorsal and 8–10 ventral, pointed setae (Fig. 1f). HT II 0.41–0.47 times length of ant. segm. III and 0.83 times ant. segm. VI. Dorsal side of abdomen membranous without sclerites and scleroites (Fig. 1a). Dorsal setae not numerous, very short, on abd. segm. I–VI 0.01–0.03 mm long and on segm. VII and VIII 0.05–0.08 mm long, pointed. Siphunculi very low, with narrow cone-shaped base. Subgenital plate in form of two sclerites. Cauda broadly rounded with many long, fine and pointed setae and very short spinules.

Description. Alate male (Figs 1, 3a, c; Table 1, 3). Colour in life unknown. Pigmentation of mounted specimens: several structures pigmented in a transparent body. Antennae dark brown with slightly lighter ant. segm. VI. Fore and middle femora light brown with darker ends. Hind femora dark brown with pale anterior parts. Tibiae and tarsi brown. Wings pale with light brown veins. Abdomen pale with light brown sclerites and scleroites. Siphuncular sclerites brown. Genitalia brown. Body elongated, oval. Head (Fig. 1g) with big and very well-developed compound eyes, without triommatidia and with 3 well-developed ocelli. Head width 0.25–0.26 times length of antennae. Head chaetotaxy: dorsal side with 14, ventral side with 10 long, fine and pointed setae, 0.11–0.13 mm long. Head setae arising from well-developed and brown, oval scleroites. Antennae (Fig. 1h, i) 6-segmented, 0.69–0.70 times length of body. Ant. segm. III (Fig. 1h) shorter than segm. IV+V+VI, with 125–136 secondary rhinaria. Almost all rhinaria small and rounded, situated on whole length and surface of segment. Ant. segm. IV (Fig. 1h) almost as long as ant. segm. V, with 55–64 secondary rhinaria. Ant. segm. V (Fig. 1i) longer than ant. segm. VI, with 1 rounded primary rhinarium at apex with little developed sclerotic rosette and 35–43 secondary rhinaria. Secondary rhinaria on ant. segm. IV and V small and rounded, situated on whole length and surface of segments. Ant. segm. VI (Fig. 1i) with very short VIb, 0.16–0.17 times VIa. VIa with 1 rounded or oval primary rhinarium with little sclerotic rosette, 4–5 accessory rhinaria situated close to each other in about half of length of segment and 11–14 secondary rhinaria, situated under the accessory rhinaria. Other antennal ratios: VI:III 0.38–0.41, V:III 0.57–0.60, IV:III 0.58–0.63. Antennae with pointed setae of various length. Longest seta on ant. segm. III 1.35–1.36 times BD III. Antennal chaetotaxy: segm. I with 4–7 setae, segm. II with 3–5 setae, segm. III with 18–19 setae, segm. IV with 7–9 setae, segm. V with 10–11 setae, segm. VI with 6–7 basal, 5–6 apical and 1 subapical setae. Rostrum short, reaching mesosternum. ARS blunt, with very short apical part (Fig. 1j), 0.14 times ant. segm. III, 0.34–0.37 times ant. segm. VI and 0.43–0.45 times HT II, with 6 primary and 2 accessory setae. Dorsal side of thorax covered by long, fine and pointed setae, 0.09–0.10 mm long. Media with 1 fork. Hind legs long, covered by long and pointed setae, which are longer than width of tibiae. HT I long, its basal length 0.27–0.30 times dorsal, 0.20–0.22 times ventral and 0.61–0.75 times intersegmental length, with 2 dorsal and 12 ventral, pointed setae (Fig. 1k). HT II 0.32 times length of ant. segm. III and 0.70–0.85 times ant. segm. VI. Dorsal side of abdomen membranous, with long and pointed setae, on abd. segm. I–V 0.07–0.09 mm long, on segm. VI–VIII 0.09–0.12 mm long. Spinal setae arranged in two pairs on each segment, arising from oval scleroites (Fig. 1l). Siphunculi very low, with narrow cone-shaped base. Abdominal sternite VI and VII sclerotized on whole surface. Cauda broadly rounded with many long, fine and pointed setae and very short spinules. Parameres present, located above basal part of phallus, clearly visible, basally

Table 3. Main morphological differences between alate males of *E. pumilae* and *E. cembrae*. **AL**—antennae length, **BL**—body length, **Ant. segm. VIb**—antennal segment VI terminal process length, **Ant. segm. VIa**—ant. segm. VI base length, **Ant. segm. VI**—ant. segm. VI length, **ANT III**—ant. segm. III length, **ARS**—apical segment of rostrum, **HT II**—second segment of hind tarsus length, **R III, IV, VI**—number of secondary rhinaria on ant. segm. III, IV and VI.

Character	<i>E. pumilae</i>	<i>E. cembrae</i>
AL/BL	0.69–0.70	0.78–0.81
Ant. segm. VIb/ant. segm. VIa	0.16–0.17	0.19–0.24
ANT VI/ANT III	0.38–0.41	0.45–0.51
ARS/HT II	0.43–0.45	0.32–0.40
ARS/ANT VI	0.34–0.37	0.27–0.29
HT II/ANT III	0.31–0.32	0.35–0.38
R III	125–136	80–120
R IV	55–64	29–42
R VI	11–14	4–10
ARS accessory setae	2	0

fused. Their lobate parts arise into distinct, finger-like projection toward base of phallus. Parameres dark pigmented, with numerous, long setae on entire surface. Basal part of phallus crescent-shaped, light brown, with numerous long setae. Sclerotized arms clearly visible, strongly sclerotized, dark pigmented. Proximal part robust, ends in triangular apex. Distal part also robust, strongly flattened with thorn-like process located in inner edge of arm. Sclerotized arms form upper half-circle-shaped structure that surrounds genital area (Fig. 3a, c).

Host plants. *Pinus koraiensis* (Inouye 1970; Lee et al. 1994; Pashchenko 1988; Szelegiewicz 1974), *P. parviflora* (Blackman and Eastop 1994), *P. pentaphylla* (Inouye 1970), *P. pumila* (Inouye 1939, 1970; Pashchenko 1988), *P. strobus* (Lee et al. 1994; Pashchenko 1988).

Distribution. India (Ghosh 1982), Japan (Inouye 1939, 1970), Korea (Lee et al. 1994; Szelegiewicz 1974), Russia-Far East (Pashchenko 1988).

Eulachnus cembrae Börner

Figs 2, 3b, d

Börner 1950: 2, by original designation

Redescription. Oviparous female (Fig. 2; Table 1, 2). Colour in life unknown. Pigmentation of mounted specimens: head, thorax and abdomen pale or yellowish. Antennae light-brown, except ant. segm. I, which is pale at base and light-brown at apex or antennae uniformly yellowish-brown. Fore and middle femora yellow with darker ends. Hind femora yellow or light brown with paler anterior part. Fore and middle tibiae yellow or light-brown. Hind tibiae brown. Tarsi brown. Siphuncular sclerite brown. Body elongated, oval (Fig. 2a). Head with big compound eyes, without triommatidia. Head width 0.29–0.40 times length of antennae. Head chaetotaxy: dorsal side with 9–10, ventral side with 12 blunt setae,

0.012–0.095 mm long. Head setae arising from wart-like bases. Antennae 6-segmented (Fig. 2b, c) 0.49–0.57 times length of body. Ant. segm. III (Fig. 2b) shorter than segm. IV+V+VI with smooth proximal part and imbricated apex. Ant. segm. IV (Fig. 2b) shorter than ant. segm. V. Ant. segm. V (Fig. 2c) longer than ant. segm. VI, with 1 rounded or oval primary rhinarium at apex with well-developed sclerotic rosette with smooth edge. Ant. segm. VI (Fig. 2c) with very short VIb, 0.16–0.22 times VIa. VIa with 1 rounded or oval primary rhinarium with little sclerotic rosette and 5–6 accessory rhinaria situated close to each other in about $\frac{3}{4}$ of length of segment. One of them much bigger, with very well-developed sclerotic rosette surrounded by 1 medium sized and 2–3 small other ones. Ant. segm. IV–VI imbricated on whole length. Other antennal ratios: VI:III 0.51–0.57, V:III 0.59–0.66, IV:III 0.38–0.53. Antennal chaetotaxy: segm. I with 4–6 setae, segm. II with 4–5 setae, segm. III with 17–23 setae, segm. IV with 6–9 setae, segm. V with 8–11 setae, segm. VI with 6–7 basal, 6 apical and without subapical setae. Ant. segm. III–IV with short, blunt or spatulate setae (Fig. 2b). Ant. segm. VI with short and pointed setae. Setae shorter than diameter of segments, longest seta on ant. segm. III 0.56–0.66 times BD III. Rostrum short, reaching behind hind coxae. ARS blunt, with very short apical part (Fig. 2d), 0.18–0.20 times ant. segm. III, 0.33–0.37 times ant. segm. VI and 0.35–0.41 times HT II, with 6 primary and without accessory setae. Dorsal side of thorax covered by short, 0.007–0.02 mm long blunt setae. Some setae on meso- and metanotum may arise from sclerites. Hind legs long, covered by slightly blunt setae, which are as long as or slightly longer than width of tibiae. Hind tibiae (Fig. 2e) slightly swollen, with 32–58 irregular pseudosensoria which are reaching mostly to half of length of tibiae. Basal length of HT I 0.30–0.33 times dorsal length, 0.23–0.24 times ventral length and 0.70–0.92 times intersegmental length, with 2 dorsal and 12 ventral, pointed setae (Fig. 2f). HT II 0.48–0.55 times length of ant. segm. III and 0.90–1.00 ant. segm. VI. Dorsal side of abdomen membranous. Abd. segm. I–VI without sclerites and sclerites (Fig. 2a). Abd. segm. I–VI with few, very short slightly blunt dorsal setae, 0.015–0.025 mm long. Abd. segm. VII and VIII with slightly longer and pointed dorsal setae, 0.035–0.062 mm. Setae on abd. segm. VII and VIII arising from oval sclerites. Siphunculi very low with a narrow cone-shaped base. Subgenital plate in the middle subdivided. Cauda broadly rounded with numerous long, fine and pointed setae and very short spinules.

Redescription. Alate male (Figs 2, 3b, d; Table 1, 3). Colour in life unknown. Pigmentation of mounted specimens: head and thorax sclerotized, yellow or brown. Antennae light brown with ant. segm. I, II and proximal part of segm. III pale. Legs yellow to light brown with darker apices of femora and sometimes darker tibiae. Tarsi dark. Wings pale with light brown veins and brownish pterostigma. Abdomen pale with light brown sclerites and sclerites. Siphuncular sclerites and genitalia brown. Body elongated, oval. Head (Fig. 2g) with big and very well-de-

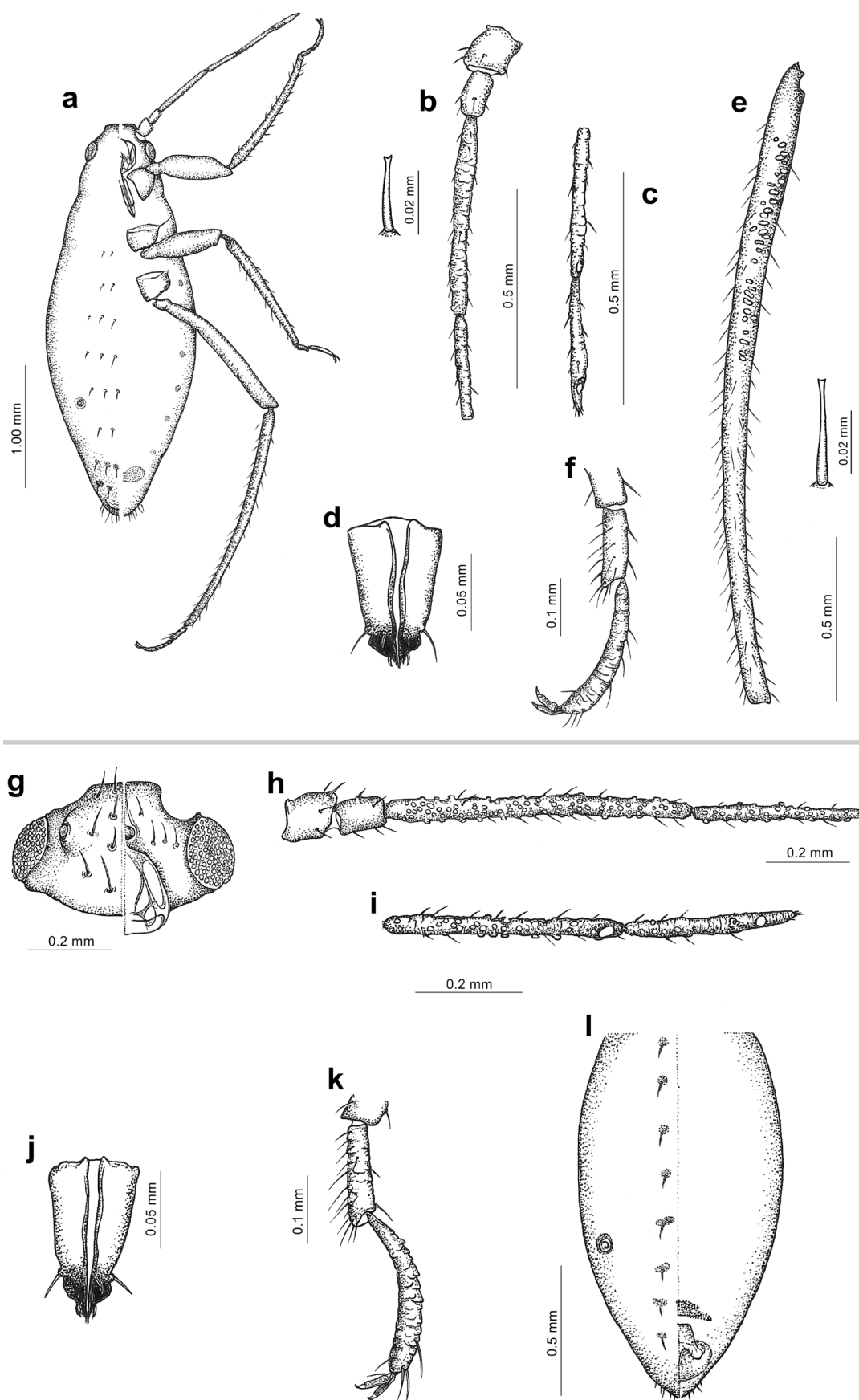


Figure 2. *Eulachnus cembrae* – oviparous female: (a) general view, (b) antennal segments I–IV, (c) antennal segments V and VI, (d) apical segment of rostrum, (e) hind tibia, (f) hind tarsus. Alate male: (g) head, (h) antennal segments I–IV, (i) antennal segments V and VI, (j) apical segment of rostrum, (k) hind tarsus, (l) abdomen.

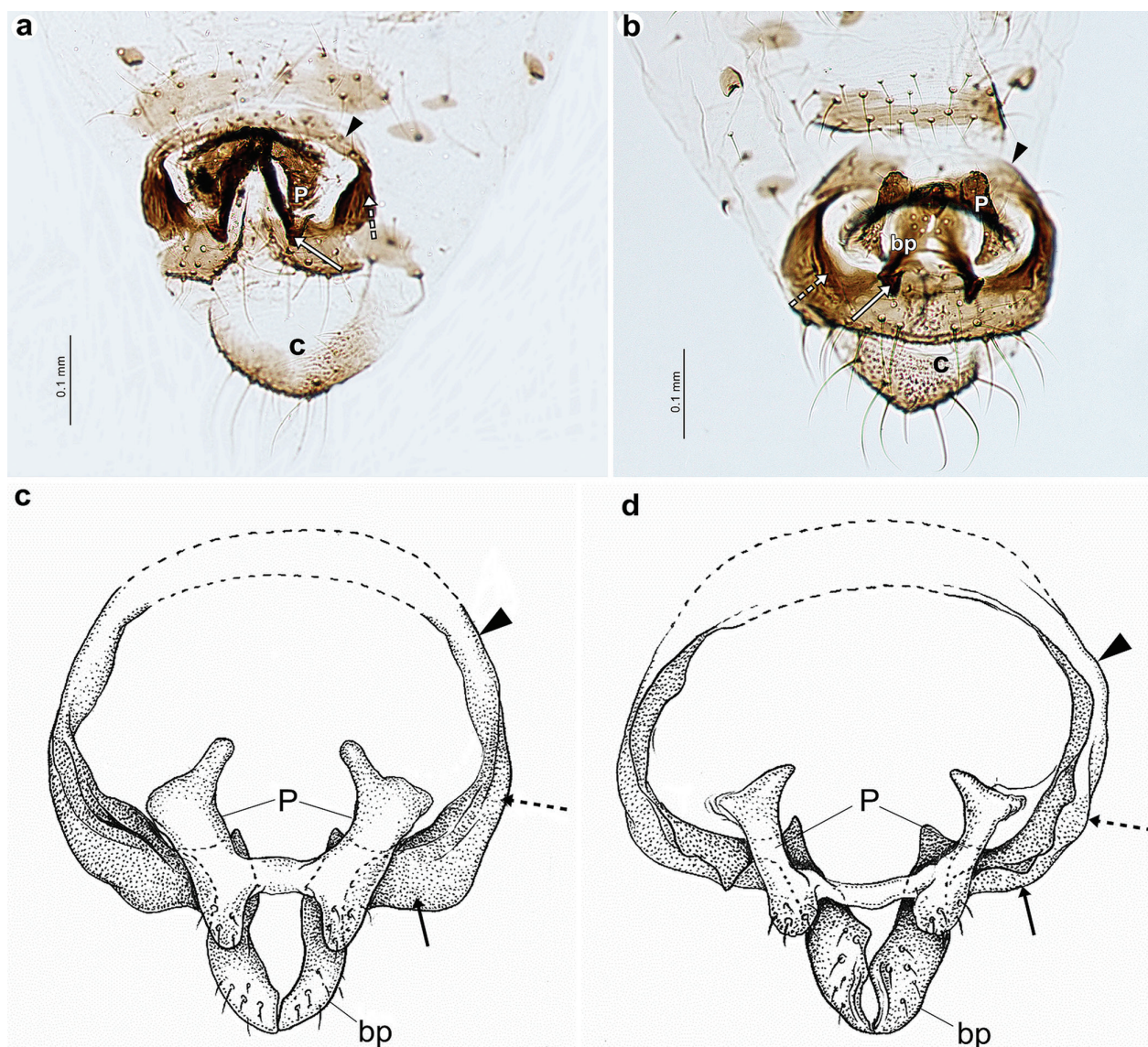


Figure 3. External male genitalia of *Eulachnus pumilae* (a, c) and *E. cembrae* (b, d): bp – basal part of phallus with sclerotized arms consists of short proximal (solid arrow), long distal (dotted arrow) part and upper half-circle-shaped structure that surrounds the genital area (arrow-head), P – parameres, C – cauda.

veloped compound eyes, without triommatidia and with 3 well-developed ocelli. Head width 0.23–0.24 times length of antennae. Head chaetotaxy: dorsal side with 11, ventral side with 10 blunt setae, 0.045–0.075 mm long. Head setae arising from well-developed and light brown, oval sclerites. Antennae (Fig. 2h, i) 6-segmented, 0.78–0.81 times length of body. Ant. segm. III (Fig. 2h) shorter than segm. IV+V+VI, with 80–120 secondary rhinaria. Ant. segm. IV (Fig. 2h) shorter than ant. segm. V, with 29–42 secondary rhinaria. Ant. segm. V (Fig. 2i) longer than ant. segm. VI, with 1 rounded primary rhinarium at apex, with little developed sclerotic rosette and 23–38 secondary rhinaria. All secondary rhinaria on ant. segm. III–V small and rounded, situated on whole length and surface of segment. Ant. segm. VI (Fig. 2i) with short VIb, 0.19–0.24 times VIa, with 1 rounded or oval primary rhinarium with little sclerotic rosette, 4–5 accessory rhinaria situated close to each other in about $\frac{2}{3}$ of length of segment and 4–10 small

and rounded secondary rhinaria, situated behind VIa. Other antennal ratios: VI:III 0.45–0.51, V:III 0.60–0.71, IV:III 0.50–0.62. Antennal chaetotaxy: segm. I with 4–5 setae, segm. II with 5–6 setae, segm. III with 14–17 setae, segm. IV with 6–11 setae, segm. V with 12–15 setae, segm. VI with 6–7 basal, 5–6 apical and without subapical setae. Ant. segm. III–IV with short, blunt or spatulate setae. Ant. segm. VI with short and pointed setae. Longest seta on ant. segm. III 0.62–0.67 times BD III. Rostrum reaching meso- or metasternum. ARS blunt, with very short apical part (Fig. 2j), 0.12–0.14 times ant. segm. III, 0.27–0.29 times ant. segm. VI and 0.32–0.40 times HT II, with 6 primary and without accessory setae. Dorsal side of thorax covered by fine and pointed setae, 0.012–0.025 mm long. Media with 1 fork. Hind legs long, covered by blunt and pointed setae, not longer than width of tibiae. Basal length of HT I 0.26–0.31 times dorsal, 0.21–0.23 times ventral and 0.68–0.80 times intersegmental length, with 2 dorsal

and 14 ventral, pointed setae (Fig. 2k). HT II 0.35–0.38 times length of ant. segm. III and 0.72–0.83 ant. segm. VI. Dorsal side of abdomen membranous with pointed setae, on abd. segm. I–VI 0.017–0.025 mm long, on segm. VII–VIII 0.032–0.052 mm long. Spinal setae arranged in two pairs on each segment arising from oval scleroites (Fig. 2l). Siphunculi very low with narrow cone-shaped base. Abd. segm. VI and VII sclerotised on whole surface. Cauda broadly rounded with numerous long, fine and pointed setae and very short spinules. Parameres present, located above basal part of phallus, clearly visible, basally fused. Their lobate parts, capitate in shape, arise into distinct, forceps-like projection toward base of phallus. Parameres dark pigmented, with numerous long setae on entire surface. Basal part of phallus club-shaped, brown, with few short setae in middle part. Sclerotized arms clearly visible, strongly sclerotized, dark pigmented. Proximal part robust and ends in triangular apex, distal part thinner. Sclerotized arms form upper half-circle-shaped structure that surrounds genital area (Fig. 3b, d).

Host plants. *Pinus cembra* (Binazzi 1978, 1984; Börner 1950, 1952; Börner and Franz 1956; Barbagallo and Patti 1994; Chumak 2004; Heinze 1962; Kanturski and Wiczorek 2014; Pašek 1952, 1954; Pintera 1968; Roberti 1993; Szelegiewicz 1962a, 1962b, 1968, 1978; Tashev 1985), *P. peuce* (Tashev 1985), *P. strobus* (Chumak 2004).

Distribution. Austria (Börner 1950, 1952; Börner and Franz 1956; Heinze 1962; Pintera 1968), Bulgaria (Tashev 1985), Italy (Barbagallo and Patti 1994; Binazzi 1978, 1984; Roberti 1993), France (MNHN collection), Poland (Szelegiewicz 1962a, 1962b, 1968, 1978; Kanturski and Wiczorek 2014), Slovakia (Pašek 1952, 1954), Switzerland (BMNH collection, MZLU collection), Ukraine (Chumak 2004).

Discussion

Aphids are a group of hemipterans whose classification is still controversial, as evidenced by uncertainties about the identity of many species in this group of insects (Blackman and Eastop 1994; Heie 1995). Many of these uncertainties at species level in aphid taxonomy might be resolved by studying morphs other than apterous and alate viviparous females, especially the sexual generation (i.e. oviparous females and males), which have strictly-established species characters and are likely to vary much less than the parthenogenetic forms (Hille Ris Lambers 1966; Wiczorek et al. 2013b).

The genus *Eulachnus* as a whole is an example for a group of aphids which needs revision, because many of the characters that have been used in species discrimination are subject to environmental influences (Blackman and Eastop 2014). This also applies to *E. cembrae*, *E. pumilae* and *E. piniarmandifoliae* Zhang from China, which form a separate group within the genus *Eulachnus* characterized by the absence of dorsal scleroites at the base of thoracic

and abdominal setae. The type species of the discussed genus, *E. agilis* (Kaltenbach), as well as other European and Asiatic species, are identified by the presence of numerous scleroites with setae of various lengths and shapes on the dorsal side of the abdomen. On the generic level, this specific character occurs also in sexual morphs: oviparous females of *E. pumilae* and *E. cembrae* (sexual forms of *E. piniarmandifoliae* are unknown) can be easily recognized by the absence of dorsal sclerites and scleroites on the abdomen whereas in males only spinal scleroites with short setae are present on the abdomen. Those two species are similar with respect to the absence of the dorsal sclerotization of the thorax and the abdomen, but otherwise they significantly differ with respect to both morphological and biometric characters. In particular, sexual forms of *E. pumilae* possess two accessory setae on the ARS, as mentioned by Remaudière and Remaudière (1997), but also longer setae on the head, antennae and the abdomen. Oviparous females of *E. pumilae* differ from those of *E. cembrae* with respect to the ratios of body length to antennal length, and also with respect to individual ratios of HT I basal, dorsal, ventral and intersegmental length; measuring those ratios is always a good method to distinguish closely related species, especially in the tribe Eulachnini (Szelegiewicz 1978; Heie 1995). The oviparous females also differ by the number of pseudosensoria on the hind tibiae (Table 2), which is one of the most easily recognizable characters of parthenogenetic and sexual aphid females. The alate males of *E. pumilae* and *E. cembrae* differ significantly with respect to the number of secondary rhinaria on antennal segments III, IV and VI and the ratios of the ARS to the antennal segments VI or HT II (Table 3). As males are the rarest morphs of aphids, appearing only for a short period of time, the taxonomic value of the characters of their genitalia has not been fully exploited as yet. However, a comparative, systematic study of the male genitalia of the Aphididae has revealed a number of characters that may potentially be useful in discussions on the phylogenetic relationships, species identity and identification of these insects (Wiczorek et al. 2011, 2012, 2013a). *E. pumilae* and *E. cembrae*, as most Lachninae, belong to a group of aphids with strongly modified genitalia, with parameres divided into lobate parts arising into projections, a well-developed basal part of the phallus and sclerotized arms forming the upper half-circle-shaped structure that surrounds the genital area (Wiczorek et al. 2012). On the species level, the shape of paramere projections (finger-like in *E. pumilae*, forceps-like in *E. cembrae*), the basal part of the phallus (crescent-shaped in *E. pumilae*, club-shaped in *E. cembrae*), and especially the structure of sclerotized arms (distal part robust, strongly flattened with a thorn-like process located on the inner edge in *E. pumilae* and thin in *E. cembrae*) are key characters in the identification of *E. pumilae* and *E. cembrae*.

According to Fauna Europaea (Nieto Nafria et al. 2014) *E. pumilae* is a European species, recorded from Slovakia. The checklist of Aphidomorpha from Slovakia (Goffova and Wojciechowski 2013) also reported this species. Goffova and Wojciechowski (2013) cited

the paper of Pašek (1952), whereas in this work on the genus *Eulachnus* (*Protolachnus* in the original) only *E. agilis*, *E. bluncki* (= *E. rileyi*), *E. nigricola* and *E. cembrae* were listed. The record of *E. pumilae* in Slovakia given by Fauna Europaea cites probably Holman and Pintera (1977), where the authors treated *E. cembrae* as a synonym of *E. pumilae*. The latter record from Ukraine presented by Mamontova (2012) should also be treated as *E. cembrae*. In the description as well as in the figure the author presents the apterous viviparous female with ARS without accessory setae, which is the key character to distinguish these two species. Moreover, the characters of sexual morphs overlap with features of *E. cembrae*. Thus all records of *E. pumilae* in Europe are in fact records of *E. cembrae*, and *E. pumilae* does not occur in Europe.

Separateness of these two similar species is also reflected by their biology: *E. cembrae* is a European species, recorded mostly from locations in central European mountain ranges (the Alps, the Carpathians) (Börner 1950; Heinze 1962; Pašek 1952; Szelegiewicz 1968; Chumak 2004). It may also occur in other, submontane regions (e.g. artificial plantings of *P. cembra* in Zakopane,

Poland (Szelegiewicz 1978) or in the Botanical Garden in Cracow (Kanturski and Wieczorek 2014)). *E. pumilae*, on the other hand, should be treated as an East Palaearctic species, recorded from Japan, Korea, India and East Siberia (Inouye 1939, 1970; Szelegiewicz 1974; Ghosh 1982; Pashchenko 1988; Lee et al. 1994). Host plants of both species mostly belong to the subsection *Cembrae* of the *Pinus* section *Strobus*. *E. cembrae* is always associated with the Swiss stone pine *P. cembra* and occasionally with *P. strobus* (Holman 2009), whereas *E. pumilae* is associated with *P. koraiensis*, *P. parviflora*, *P. pentaphylla*, *P. pumila* and *P. strobus* (Blackman & Eastop, 2014). Recent molecular studies have shown that *P. cembra* is clearly separated from the closely related *P. koraiensis*, *P. parviflora* and *P. pumila* which form a distinct clade (Liston et al. 1999; Wang et al. 1999; Gugerli et al. 2001).

Detailed morphological and biometric analysis of the sexual morphs of the studied species, including type material of *E. cembrae* designated by Börner, supported by biological data, definitely distinguish the studied species as separate taxa.

Key to oviparous females of *E. cembrae* and *E. pumilae*.

1. Ant. segm. VI/ant. segm. III 0.38–0.53. ARS without accessory setae. Hind tibiae with 32–58 pseudosensoria *E. cembrae* Börner
- Ant. segm. VI/ant. segm. III 0.58–0.61. ARS with two accessory setae. Hind tibiae with 100–105 pseudosensoria *E. pumilae* Inouye

Key to alate males of *E. cembrae* and *E. pumilae*.

1. Antennae length/body length 0.78–0.81. ARS without accessory setae. Ant. segm. IV with 29–42 accessory rhinaria *E. cembrae* Börner
- Antennae length/body length 0.69–0.71. ARS with two accessory setae. Ant. segm. IV with 55–64 accessory rhinaria ... *E. pumilae* Inouye

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References

- Barbagallo S, Patti I (1994) Appunti faunistici sugli Afidi (Homoptera, Aphidoidea) dell'Italia nord - orientale. Bollettino di Zoologia Agraria e di Bachicoltura (Ser. II) 25: 213–243.
- Binazzi A (1978) Contributi alla conoscenza degli afidi delle conifere. I. Le specie del genn. *Cinara* Curt., *Schizolachnus* Mordv., *Cedrobium* Remaud. ed *Eulachnus* d. Gu. presenti in Italia (Homoptera, Aphidoidea, Lachnidae). Redia 61: 291–400.
- Binazzi A (1984) Chiave per le specie afidiche più note delle conifere in Europa. Redia 67: 547–557.
- Blackman RL, Eastop VF (1994) Aphids on the World's Trees. CAB International, Wallingford, 987 pp.
- Blackman RL, Eastop VF (2014) Aphids on the World's Plants. An online information and information guide. <http://www.aphidson-worldsplants.info> [01.06.2014]
- Börner C (1950) Neue europäische Blattlausarten. Naumburg, 19 pp. (privately published)
- Börner C (1952) Europae Centralis Aphides. Die Blattläuse Mitteleuropas. Namen, Synonyme, Wirtspflanzen, Generationszyklen. Mitteilungen der Thüringischen Botanischen Gesellschaft, Beiheft 3(I - II) (Weimar), 484 pp.

- Börner C, Franz H (1956) Die Blattläuse des Nordostalpengebietes und seines Vorlandes. Österreichische Zoologische Zeitschrift 6: 297–411.
- Chumak V (2004) Blattläuse der Ukrainischen Karpaten. Ushhorod "Mystez'ka Linija", 160 pp.
- Ghosh AK (1982) Homoptera: Aphidoidea. Part 2. Subfamily Lachninae. In: The Fauna of India and the Adjacent Countries. Zoological Survey of India, Calcutta, 167 pp.
- Goffova K, Wojciechowski W (2013) Checklist of Aphidomorpha (Hemiptera: Sternorrhyncha) known from Slovakia. Folia Faunistica Slovaca 18(3): 275–300.
- Gugerli F, Senn J, Anzidei M, Madaghiele A, Büchler U, Sperisen C, Vandramin GG (2001) Chloroplast microsatellites and mitochondrial *nad 1* intron 2 sequences indicate congruent phylogenetic relationships among Swiss stone pine (*Pinus cembra*), Siberian stone pine (*Pinus sibirica*), and Siberian dwarf pine (*Pinus pumila*). Molecular Ecology 10: 1489–1497. doi: 10.1046/j.1365-294X.2001.01285.x
- Heie OE (1995) The Aphidoidea of Fennoscandia and Denmark VI. Aphidinae. Part 3 of Macrosiphini and Lachnidae. Fauna Entomologica Scandinavica 31, 222 pp.
- Heinze K (1962) Pflanzenschädliche Blattlausarten der Familien Lachnidae, Adelgidae und Phylloxeridae, eine systematisch-faunistische Studie. Deutsche Entomologische Zeitschrift 9(I/II): 143–227.
- Hille Ris Lambers D (1966) Polymorphism in Aphididae. Annual Review of Entomology 11: 47–78. doi: 10.1146/annurev.en.11.010166.000403
- Holman J (2009) Host Plant Catalog of Aphids, Palaearctic Region. Springer Science + Business Media B.V., 1216 pp.
- Holman J, Pinter A (1977) Aphidoidea. Acta Faunistica Entomologica Musei Nationalis Pragae. Supplement 4: 101–116.
- Inouye M (1939) On eight conifer aphids occurring in Hokkaido. Insecta matsumarana XIII: 132–142.
- Inouye M (1970) Revision of the Conifer Aphid fauna of Japan (Homoptera, Lachnidae). Bulletin of Government Forest Experimental Station Meguro 228: 57–102.
- Kanturski M, Wieczorek K (2014) Nowe stanowiska rzadko spotykanych mszyc z rodzaju *Eulachnus* Del Guercio, 1909 (Homoptera: Aphididae: Lachninae) w Południowej Polsce. Wiadomości Entomologiczne 33(1): 15–20.
- Lee WK, Seo HY, Hwang CY (1994) A taxonomic study on Lachnidae (Homoptera, Aphidoidea) of Korea. Korean Journal of Systematic Zoology 10: 157–187.
- Liston A, Robinson WA, Piñero D, Alvarez-Buylla ER (1999) Phylogenetics of *Pinus* (Pinaceae) based on nuclear ribosomal DNA internal transcribed spacer region sequences. Molecular Phylogenetics and Evolution 11: 95–109. doi: 10.1006/mpev.1998.0550
- Mamontova WA (2011) Tablicy dla opredelenija tlej semejstwa Lachnidae (Homoptera, Aphidoidea, Lachnidae) fauny Wostocznoj Ewropy i sopedelnych territorij. Ukrainiskij Entomologičnyj Žurnal 2(3): 3–39.
- Mamontova WA (2012) Tli semejstwa Ljachnid (Homoptera, Aphidoidea, Lachnidae) Fauny Wostocznoj Ewropy i Sopedelnych Territorij. Nacjonalnaja Akademia Nauk Ukrainy, Naukowa Dumka, Kiw, 390 pp.
- Nieto Nafria JM, Andreev AV, Binazzi A, Mier Durante MP, Pérez Hidalgo N, Rakauskas R, Stekolshchikov AV (2014) Fauna Europaea: Aphidoidea. Fauna Europaea, version 2.6.2, [WWW document]. <http://www.faunaeur.org>
- Pašek V (1952) Československé vošky čelade Lachnidae. Faunistický prehľad. Biologický Sborník Slovenskej Akademie Vied a Umeni 7: 91–99.
- Pašek V (1954) Vošky našich lesných drevín (Homoptera - Aphidoidea). Vydavateľstvo Slovenskej Akademie Vied, Bratislava, 322 pp.
- Pashchenko NF (1988) Podotriat, Aphidinea - Tli. In: Lehr PA (Ed.) Apriedietel Nasiekomnych Dalniego Wostoka SSR. Tom (II) rawn-okrytyje, polyžjestkokrytyje, Nauka, Leningrad, 546–686.
- Pinter A (1968) Aphids from the subtribe Schizolachnina (Homoptera: Lachnidae) in Middle Europe. Acta Entomologica Bohemoslavica 65: 100–111.
- Remaudière G, Remaudière M (1997) Catalogue des Aphididae du monde Homoptera Aphidoidea. Institut national de la Recherche scientifique, Paris, France, 474 pp.
- Roberti D (1993) Gli Afidi d'Italia (Homoptera - Aphidoidea). Entomologica 25–26: 3–387.
- Szelegiewicz H (1962a) Materiały do poznania mszyc (Homoptera, Aphididae) Polski. 1. Podrodzina Lachninae. Fragmenta faunistica 10: 63–98.
- Szelegiewicz H (1962b) Materiały do znajomości mszyc (Homoptera, Aphidina) Tatr i Podhala. Acta Zoologica Cracoviensia VII(10): 157–174.
- Szelegiewicz H (1968) Katalog Fauny Polski. Część XXI, zeszyt 4 Mszyce Aphidodea. Państwowe Wydawnictwo Naukowe, Warszawa, 316 pp.
- Szelegiewicz H (1974) A list of aphids from the Democratic People's Republic of Korea. Part I. Adelgidae to Chaitophoridae (Homoptera). Fragmenta Faunistica 19: 455–466. doi: 10.3161/00159301F1974.19.18.455
- Szelegiewicz H (1978) Klucze do oznaczania owadów Polski. XVII, Homoptera, 5a, Mszyce-Aphidodea, 1, Lachnidae, 107 pp.
- Tashev DG (1985) A catalogue of host plants of the Bulgarian Aphids. Annual of University of Sofia 76: 85–124.
- Wang XR, Tsumura Y, Yoshimaru H, Nagasaka K, Szmidt AE (1999) Phylogenetic relationships of Eurasian pines (*Pinus*, Pinaceae) based on chloroplast *rbcL*, *matK*, *rpl20-rps18* spacer, and *trnV* intron sequences. American Journal of Botany 86: 1742–1753. doi: 10.2307/2656672
- Wieczorek K, Plachno BJ, Świątek P (2011) Comparative morphology of the male genitalia of Aphididae (Insecta, Hemiptera)-part 1. Zoomorphology 130: 289–303. doi: 10.1007/s00435-011-0134-z
- Wieczorek K, Plachno BJ, Świątek P (2012) Comparative morphology of the male genitalia of Aphididae (Insecta, Hemiptera)-part 2. Zoomorphology 131(4): 303–324. doi: 10.1007/s00435-012-0163-2
- Wieczorek K, Kanturski M, Junkiert Ł (2013a) The sexuales of giant black bark aphid *Pterochloroides persicae* (Cholodkovsky) (Homoptera: Aphidoidea: Lachninae). Zootaxa 3626(1): 094–098.
- Wieczorek K, Kanturski M, Junkiert Ł (2013b) *Shenahweum minutum* (Hemiptera, Aphidoidea: Drepanosiphinae)-taxonomic position and description of sexuales. Zootaxa 3731(3): 324–330. doi: 10.11646/zootaxa.3731.3.2

A new species of *Onychotrechus* Kirkaldy, 1903 (Hemiptera, Heteroptera, Gerridae) from Dooars, West Bengal, India, and a key to males of all species

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Buxa Tiger Reserve

Jalpaiguri

A new species of hygropetric water strider, *Onychotrechus dooarsicus* **sp. n.** is described from Buxa Tiger Reserve, Dooars, West Bengal, India. Representatives of the new species were collected from a stream with boulders and rocks splashed by water, with slow current, situated at an altitude of 630 m a.s.l. This is the seventh species of *Onychotrechus* confirmed for India. The new species is closely related with *O. robustus* Andersen, 1980 from northwestern India and *O. jaechi* Zettel & Tran, 2007 from Bhutan. An identification key to males of all species of *Onychotrechus* species is also provided.

Introduction

The hygropetric water striders of the genus *Onychotrechus* Kirkaldy, 1903 are members of the subfamily Eotrechinae and chiefly distributed on the Indian subcontinent and Sri Lanka (11 species, including the new one), but two species inhabit southeastern Asia (Andersen 1980). They can be recognized by the small size (body length less than 7.4 mm); middle and hind legs with subequal lengths, first tarsomere shorter than second, long pre-apically inserted claws, and ventral row of stout spine-like setae; and genital segments of males small, with relatively simple structure.

Species of *Onychotrechus* are mostly found resting, walking, running or jumping on the wet seeping rock faces covered with algae or splashed by water of small mountainous streams. Both nymphs and adults, including copulating individuals, can be encountered in their typical habitats. Although their coloration appears vivid, it is cryptic and makes them difficult to recognize in the dark

wet rocks. The hygropetric way of life is a secondary adaptation evolved from life on water surface in this group (Andersen 1980).

Hitherto, six species of *Onychotrechus* have been recorded from India (Thirumalai 2002), namely *O. major* Andersen, 1980 (Kerala, Maharashtra), *O. robustus* Andersen, 1980 (Himachal Pradesh, Uttar Pradesh), *O. rupestris* Andersen, 1980 (Karnataka), and *O. spinifer* Andersen, 1980 (Karnataka, Kerala, Maharashtra), *O. baijali* Gupta, 1982 (Tamil Nadu), *O. rhexenor* Kirkaldy, 1903 (Karnataka, Kerala, Maharashtra, Rajasthan, Tamil Nadu). The record of a seventh species, *O. sakuntala* (Kirkaldy, 1901), from Tripura (Bal and Basu 2000) needs confirmation, because it is considered to be endemic of Sri Lanka (Andersen 1980).

In a recent expedition to the Buxa Tiger Reserve, near the Indo-Bhutan border of West Bengal, the second author collected a specimen, that is herein described and named as *Onychotrechus dooarsicus* **sp. n.**

Material and method

Specimens were collected by a short-handled aquatic net and preserved in 70% ethyl alcohol (C₂H₅OH). Samples were identified using a binocular microscope Leica M205A and body parts were photographed. Male genitalia was dissected and kept in 10% KOH for 30 minutes to clear the hard sclerotized structure and drawings were prepared using a camera lucida attached to the Leica M205A binocular microscope. Identified specimens were deposited in the National Zoological Collections of Zoological Survey of India, Kolkata. All measurements are given in millimetres.

Onychotrechus dooarsicus sp. n.

<http://zoobank.org/9B857E19-8FE4-4B25-85D8-19872CC26B5C>

Figs 1–19

Holotype (apterous male): INDIA: West Bengal; Jalpaiguri; Buxa Jhora near Buxa fort; Buxa Tiger Reserve, 26.76223° N, 89.59968° E, 630 m a. s. l., 19.IV.2013, Srimoyee Basu (**Reg. No.: 3130/H15**). **Paratypes**: one apterous male, one apterous female, same data as holotype (**Reg. No.: 3131/H15**).

Type locality. INDIA: West Bengal; Jalpaiguri; Buxa Jhora near Buxa fort; Buxa Tiger Reserve; stream with large rocks, stones in forested areas.

Description of apterous male (Fig. 1). *Size*: Body length (from head tip to tip of proctiger) of apterous male holotype 3.30, male paratype 3.27; maximum width of body across mesoacetabula 1.12 (holotype), 1.07 (paratype).

Colour: Body dorsally black with yellow markings. Head with a median yellow longitudinal stripe, which ends in a blunt arrow head (Fig. 3); head anteriorly and along medial and posterior eye margins yellow. Antenna and leg segments yellowish brown. Pronotum with two broad yellow sub-lateral stripes, a thin median yellow stripe, and two yellow curved lateral stripes. Meso- and metanotum (Fig. 4) with two thin lateral stripes, two broad sub-lateral stripes and an indistinct short yellow median line. Abdominal tergites completely black (Figs 4, 12). Forefemur yellow with one broad dark band on dorsal side and one very slender dark brown band on extensor side. Venter yellow. Mesosternum (Fig. 6) with paired black patches behind forecoxae and metasternum posteriorly with an almost W-shaped broad dark region. Abdominal sternites pale yellowish brown (Fig. 13).

Structural characteristics (measurements refer to holotype). Head length 0.64, width 0.89. Interocular width 2 times as large as eye width (0.45 : 0.22). Eye length 0.44. Length of antennal segments 1-4: 0.96, 0.94, 0.89, 1.38; first antennomere with three spines distally, being two long, and a small one arising near base of first spine. Rostrum reaching up to mid-way of mesosternum, length 1.50.

Pronotum 0.84 mm in width; pronotum length 0.53, width 0.79. Combined length of mesonotum and meta-

notum 1.12, width 0.98. Mesosternum (Fig. 6) modified, with narrow median groove slightly widened posteriorly; depression with black, scattered setae directed to its centre; posterior swelling with densely arranged long stout black setae covering base of mesosternum. Forefemur (Fig. 8) slender, widened basally, but almost evenly tapering apically; length of forefemur 1.17, width 0.25; forefemur apically with a few setae and with short dark stiff setae distributed throughout. Foretibia (Fig. 9) strongly curved, basally with patch of few short setae on flexor side; a soft spinous structure protruded outwards from base of curvature; apical region with two prominent black spines that diverge from almost touching bases (forming a 'V'), and with four black spines and a row of short setae towards extensor side. Mid and hind femora slender, each about 1.1 times as long as body; both with distinct rows of short spines arranged equidistantly. Foreclaws (Fig. 11) sharply bent and slightly longer than mid and hind claws. Measurements of leg segments provided in Table 1.

Abdomen (Figs 12, 13) short, only about one third of body length. Length of abdominal sternites 1.01, width 0.90. Sterna II-VI visible as very narrow curved strips; sternum VII (Fig. 13) much longer; sterna II-VII without median groove. Segment VIII broad, with median depression, posterior part with several setae, bluntly ending.

Genitalia (Figs 16-19): Pygophore sub-oval, slightly elongated, widened basally. Proctiger (Fig. 17) short, widened distally, gradually tapering towards basal part, with long setae and medially with numerous punctures. Endosomal sclerites as in Fig. 18. Paramere (Fig. 19) short, simple and with a distinct median notch.

Description of apterous female (Figs 2, 7). *Size*: Body length 4.4; maximum body width across mesoacetabula 1.38.

Colour: Almost identical to male, with the following exceptions: posterior yellow mid-line lacking from metanotum (Fig. 5). Venter yellow, with two broad markings on mesosternum. Metasternum brownish yellow. Abdominal sterna II-VI yellowish brown, paler at mid-line and sides; sternum VII black anteriorly, yellowish posteriorly.

Structural characteristics: Length of head 0.75, width 0.91. Interocular width 0.52. Eye length 0.42, width 0.23. Length of pronotum 0.51, width 0.85. Length of antennal segments 1-4: 1.10, 1.08, 1.04, 1.48. Combined length of meso- and metanotum 1.38, width 1.36. Forefemur slender (Fig. 10). Foretibia less curved, without spinous protrusion from curvature. Measurements of leg segments provided in Table 1. Abdominal tergites (Fig. 14) elongated, densely covered by setae. Abdominal sterna II-VI with median groove; sternum VII (Fig. 15) broad, trapezoidal, concave towards end, partly concealing genitalia. Proctiger acuminate.

Macropterous male and female. Unknown.

Comparative notes. *Onychotrechus dooarsicus* sp. n. is probably a close relative of *O. jaechi*, recently described from Bhutan. They share some common characters: males have almost identical pro-, meso- and metasternal



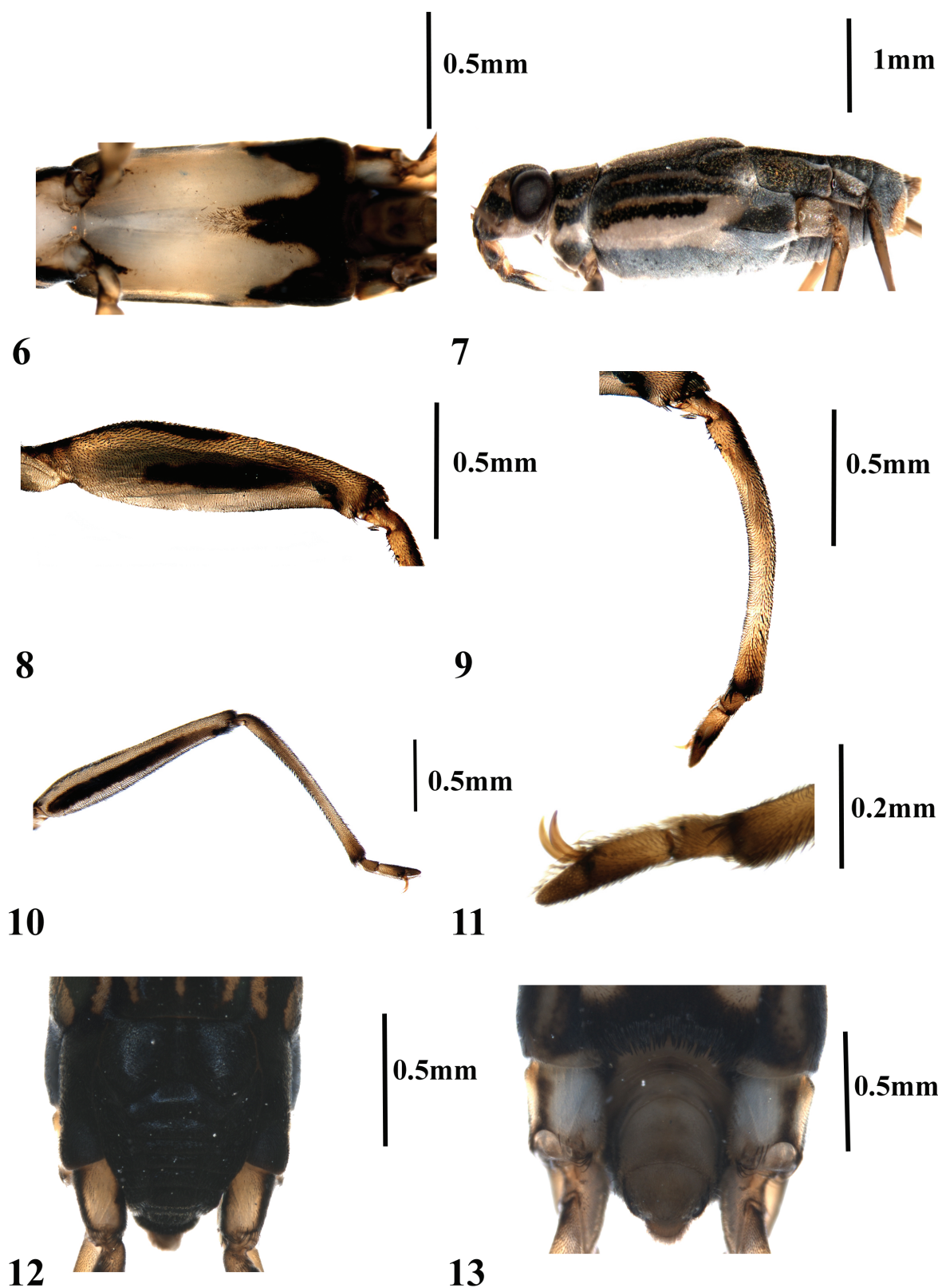
Figures 1–5. *Onychotrechus dooarsicus* sp. n. 1. Dorsal view of apterous male. 2. Dorsal view of apterous female. 3. Head and pronotal marking pattern in male. 4. Meso- and metanotal marking pattern in male. 5. Marking pattern in female.

Table 1. Measurements (value in mm) of leg segments of apterous males and female of *Onychotrechus dooarsicus* sp. n.

Leg	Femur	Tibia	Tarsus 1	Tarsus 2
Foreleg: ♂♂	1.15, 1.17	0.99, 1.1	0.07, 0.08	0.19, 0.22
♀	1.36	1.17	0.12	0.28
Mid leg: ♂♂	3.71, 3.72	2.54, 2.56	0.15, 0.16	0.26, 0.28
♀	4.03	2.70	0.19	0.29
Hind leg: ♂♂	3.80, 3.81	2.62, 2.63	0.13, 0.15	0.34, 0.36
♀	4.36	3.09	0.24	0.41

markings, basally incrassate forefemora, similar mesosternal modifications and short abdominal segments. However, the male of *O. dooarsicus* sp. n. distinctly

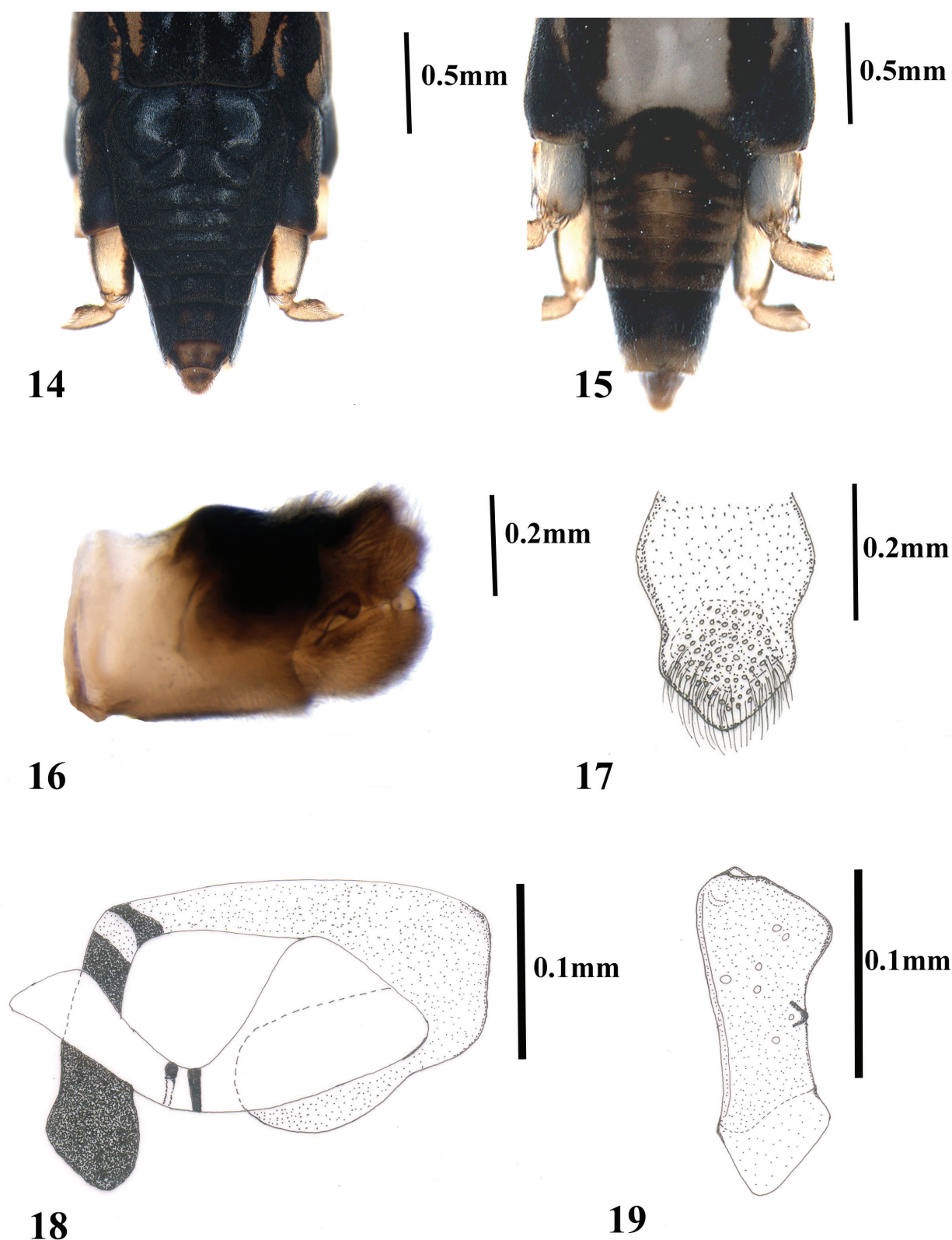
differs from *O. jaechi* by the following characteristics: 1) The foretibia of *O. dooarsicus* sp. n. bears a patch of few short setae basally on flexor side, and a soft spinous structure protruding outwards from the base of the curvature; its apical region bears two prominent black spines (forming a 'V'), four black spines and a row of short setae towards extensor side; whereas, in *O. jaechi* its base bears a patch of long hairs on the flexor side and the distal modifications are absent. 2) The mesosternum of *O. dooarsicus* sp. n. has a median narrow groove that is slightly widened posteriorly, whereas *O. jaechi* has a strongly modified mesosternum, with a medial, posteriorly widened depression and a prominent transverse swelling



Figures 6–13. *Onychotrechus dooarsicus* sp. n. 6. Mesosternum of male, ventral view. 7. Lateral view of female. 8. Forefemur of male. 9. Foretibia and tarsi of male. 10. Foreleg of female. 11. Foreleg claws in male. 12. Abdominal tergites of male. 13. Abdominal sternites with genital segments in male.

at its hind margin. 3) In *O. dooarsicus* sp. n., the paramere has a notch at mid-length, that is absent from *O. jaechi*. The female of *O. jaechi* is unknown.

Etymology. The specific epithet ‘*dooarsicus*’ comes from its place of occurrence, ‘Dooars’ of West Bengal. Dooars is a large region, forming the gateway from India



Figures 14–19. *Onychotrechus dooarsicus* sp. n. 14. Abdominal tergites of female. 15. Abdominal sternites of female. 16. Dissected genital segments of male. 17. Proctiger of male. 18. Endosoma, lateral view. 19. Left paramere, lateral view.

to Bhutan and stretching from the plains of Darjeeling District, Jalpaiguri District, and the upper regions of Cooch Behar District of West Bengal to some parts of Assam. This part mainly consists of Himalayan foothills.

Habitat. Representatives of this species have been found in the shallow zone between the rocks, splashed by a slow-flowing stream (630 m), known as Buxa Jhora, located near Buxa fort of Buxa Tiger Reserve Range.

Key to *Onychotrechus* species (males)

Note: The authors were able to study male specimens of most species, but not of *O. baijali* and *O. singalensis*. For these species characters were taken from the original descriptions.

- 1 Forefemur at flexor side with one or two prominent spine-like structures usually consisting of densely-packed setae 2
- Forefemur at flexor side without prominent spine-like structures..... 4
- 2 Forefemur at flexor side with two spine-like structures, one sub-apically and another one at mid-length. (India: Tamil Nadu) *O. baijali*
- Forefemur at flexor side with one spine-like structure sub-apically 3
- 3 Forefemur at flexor side between base and spine-like group of setae with row of long flexible setae; at extensor side basally with a few short spiny setae. (India: Karnataka)..... *O. rupestris*
- Forefemur at flexor side without long flexible setae; at extensor side basally without spiny setae; spine-like group of setae on a tubercle. (India: Karnataka, Kerala, Maharashtra) *O. spinifer*
- 4 Forefemur strongly incrassate (Fig. 8), about 4 times as long as wide 5
- Forefemur relatively slender, more than 6 times as long as wide..... 7
- 5 Foretibia weakly curved, chiefly in basal third. Mesosternum posteriorly with short black pegs. Middle femur with row of relatively long, erect spines near base. (India: Himachal Pradesh, Uttar Pradesh) *O. robustus*
- Foretibia strongly curved (Fig. 9). Mesosternum posteriorly with dense brush of long black hairs (Fig. 6) that cover metasternum. Middle femur only with a few short spines at base 6
- 6 Flexor side of foretibia basally with patch of long hairs and apically without prominent spines. Mesosternum with median groove posteriorly strongly widened and posterior margin with strong, transverse swelling. Paramere without median notch. (Bhutan)..... *O. jaechi*
- Flexor side of foretibia basally with patch of few short hairs and apically with two prominent black spines (Fig. 9). Mesosternum with median groove posteriorly slightly widened and posterior margin without swelling. Paramere with median notch (Fig. 19). (India: West Bengal) *O. dooarsicus* sp. n.
- 7 Large species; body length (from apex of head to tip of proctiger) 5.8 mm or more. (India: Kerala, Maharashtra) *O. major*
- Small species; body length (from apex of head to tip of proctiger; excluding wings) 5.2 mm or less 8
- 8 Dark markings of body much reduced; colour chiefly pale..... 9
- Dark markings of body prominent 10
- 9 Middle and hind claws shorter than first tarsomeres. (Sri Lanka) *O. singalensis*
- Middle and hind claws longer than first tarsomeres. (Malaysia: Penang, Selangor) *O. pallidus*
Note: Besides colour, *O. pallidus* differs from *O. esakii* (couplet 12), which is common in southeastern Asia, by the more slender forefemur and by small shiny areas on thoracic nota (often completely absent from pronotum and metanotum), whereas these areas are much expanded in *O. esakii* (in macropterous morph prominent on pronotum, but absent from pronotal lobe).
- 10 Metasternum laterally with one pair of round tubercles. (Sri Lanka) *O. tuberculatus*
- Metasternum without pair of tubercles 11
- 11 Forefemur relatively slender, almost evenly tapering from base to sub-apex, width at midlength less than 2 times maximum width of foretibia; its flexor side at base with conspicuous and long patch of black pegs surpassing midlength. (India: Karnataka, Kerala, Maharashtra, Rajasthan, Tamil Nadu)..... *O. rhexenor*
- Forefemur distinctly thickened in basal two thirds, width at midlength clearly more than 2 times maximum width of foretibia; its flexor side with inconspicuous patch of pale or minute pegs not surpassing midlength of femur..... 12
- 12 Forefemur suddenly narrowed sub-apically (more distinct in apterous morph); its flexor side with patch of minute black pegs. Distal part of paramere relatively slender, apically rounded. (widely distributed in southeastern Asia: Myanmar, southern China, Thailand, Vietnam, West Malaysia) *O. esakii*
- Forefemur evenly narrowed in distal third; its flexor side with indistinct patch of pale pegs. Distal part of paramere relatively wide, with distinct apex. (Sri Lanka)..... *O. sakuntala*

Discussion

The genus *Onychotrechus* shows its maximum diversity in southern India (Kerala, Karnataka, Tamilnadu) (Andersen 1980). In contrast, *Onychotrechus dooarsicus* sp. n. is the first species reported from north-eastern India. This new species was collected from the banks of a stream at an altitude of c 630 m in the Buxa Tiger Reserve Forest, which falls within the Jalpaiguri subregion of the Himalayas. It

is expected that the Eastern Himalayan states of India – including the Darjeeling Himalayas and the Himalayan foot-hills – harbor further undiscovered species of *Onychotrechus* and other eotrechine water striders that could be described if an extensive faunal survey was carried out. Due to their cryptic habits, specialized collecting is necessary to find the hygropetric species of *Onychotrechus* or *Eotrechus* that are usually overlooked when doing general surveys of aquatic insects.

Species identification of eotrechine water striders is usually based on the strongly modified genitalia of the males (see, e.g., Andersen 1982 for *Eotrechus* and *Chimarrhometra*; Polhemus and Andersen 1984 for *Amemboa* and *Amemboides*), whereas the identification of females is often extremely difficult or – as in *Amemboa* – even impossible so far. In contrast with related genera, in males of *Onychotrechus* male genitalia is relatively simple and provide few differentiating characters (Andersen 1980). For *Onychotrechus*, Andersen (1980) provided one key to both sexes, although characteristics of males forelegs and abdomen are dominating. However, the starting couplet of his key using the relative lengths of claws and tarsal segments – proved to be problematic, because the differences are small and subject to intraspecific variation. For this reason, and also because some additional species were described afterwards (Gupta 1982; Zettel and Tran 2007; this paper), we present a new key only for males, but with the advantage of a clearer discrimination of the species. Special attention is recommended to the inexperienced researcher who wants to identify females not associated with males.

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References

- Andersen NM (1980) Hygropetric water striders of the genus *Onychotrechus* Kirkaldy with description of a related genus (Insecta, Hemiptera, Gerridae). *Steenstrupia* 6: 113–146.
- Andersen NM (1982) Semiterrestrial water striders of the genera *Eotrechus* Kirkaldy and *Chimarrhometra* Bianchi (Insecta, Hemiptera, Gerridae). *Steenstrupia* 9: 1–25.
- Bal A, Basu RC (2000) Insecta: Hemiptera: Water-bugs. Fauna of Tripura. State Fauna Series, Zoological Survey of India 7(2): 427–443.
- Gupta YC (1982) Description of a new species of *Onychotrechus* Kirkaldy (Heteroptera: Gerridae) from India. *Entomon* 7(2): 205–208.
- Polhemus JT, Andersen NM (1984) A revision of *Amemboa* Esaki with notes on the phylogeny and ecological evolution of eotrechine water striders (Insecta, Hemiptera, Gerridae). *Steenstrupia* 10: 65–111.
- Thirumalai G (2002) A checklist of Gerromorpha (Hemiptera) from India. *Records of the Zoological Survey of India* 100(1–2): 55–97.
- Zettel H, Tran AD (2007) On Gerridae (Insecta: Heteroptera) from Bhutan, with description of a new species of *Onychotrechus* Kirkaldy, 1903. *Zootaxa* 1467: 43–49.

Species of the pleasing lacewing genus *Dilar* Rambur (Neuroptera, Dilaridae) from islands of East Asia

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Abstract

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Six species of the pleasing lacewing genus *Dilar* Rambur, 1838, are recorded from several islands of East Asia, including Hainan, Taiwan, and Japan. Five species, i.e. *Dilar formosanus* (Okamoto & Kuwayama, 1920), *Dilar hikosanus* Nakahara, 1955, *Dilar japonicus* McLachlan, 1883, *Dilar pallidus* Nakahara, 1955 and *Dilar taiwanensis* Banks, 1937, are herein redescribed. *Dilar distinctus* Nakahara, 1955, and *Dilar kanoi* Nakahara, 1955, are synonymized with *Dilar taiwanensis* Banks, 1937. *Dilar insularis* sp. n. from Hainan and Taiwan is described as new to science. A key to these insular species of *Dilar* is also provided.

Introduction

The Dilaridae, a small neuropteran family comprising about 80 valid species, are sorted in five genera of two subfamilies, i.e. Dilarinae (only occur in the Old World) and Nallachiinae (mainly occur in the New World, with two species recorded from Vietnam and southern Africa) (Engel 1999; Monserrat 1988, 1989, 2005; Oswald 1998, 2013). The genus *Dilar* Rambur, 1838 is the most species rich genus of Dilaridae, belonging to the subfamily Dilarinae, with 52 described species (Oswald 1998; Oswald and Schiff 2001; Yang 1992, 1999, 2001; Aspöck et al. 2001; Zhang et al. 2014a). Majority of *Dilar* species occur in the Eurasia continent, while a few species are distributed in some islands of Asia and Europe. For instance, Sri Lanka harbours an endemic

species, *Dilar nietneri* Hagen, 1858, and two species, i.e. *Dilar grandis* (Banks, 1931) and *Dilar macleodi* Oswald & Schiff, 2001 only occur in Borneo. In East Asia, there are many islands along the coast, including Hainan (second largest island of China), Taiwan (the largest island of China), Ryukyus, and Japanese archipelago. Hitherto, seven species of *Dilar* have been recorded from some of these islands (McLachlan 1883; Okamoto and Kuwayama 1920; Banks 1937; Nakahara 1955a, b). Among these species, two of them are distributed in Japan, while, remarkably, five species were described and endemic to Taiwan. However, all these seven *Dilar* species were poorly described and lack a clear, modern redescription and illustrations. In this paper, we revise the insular species of *Dilar* from East Asia. Six valid species are herein recorded and

described from Hainan, Taiwan, and Japan, with one new species. A key to the insular species of *Dilar* from East Asia is also given.

Material and methods

Specimens for the present study are deposited in the Natural History Museum (BMNH), London, U.K.; the Entomological Museum of China Agricultural University (CAU), Beijing, China; the Museum of Comparative Zoology (MCZ), Cambridge, U.S.A.; Museum für Naturkunde, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin (MNB), Berlin, Germany; National Museum of Natural History (NMNH), Smithsonian Institutions, Washington, D.C., U.S.A.; the National Museum of Nature and Science (NSMT), Tsukuba, Japan; the National Institute for Agro-Environmental Sciences (NIAES), Tsukuba, Japan; and the Entomological Collection of Hokkaido University Museum (SEHU), Sapporo, Japan. Genitalic preparations were made by clearing the apex of the abdomen in a cold, saturated KOH solution for 3–4 h. After rinsing the KOH with acetic acid and water, the apex of the abdomen was transferred to glycerin for further dissection and examination. Habitus photos of adults were taken by using a Nikon D90 digital camera with Nikon MICRO NIKKOR 105 mm lens, and the genitalic figures were made by hand drawing under a Motic SMZ168 stereo microscope. The terminology of the genitalia generally follows U. Aspöck and H. Aspöck (2008).

Taxonomy

Genus *Dilar* Rambur

Dilar Rambur, 1838: 9. Type species: *Dilar nevadensis* Rambur, 1838 (monotypy).

Cladocera Hagen, 1860: 56. Nomen nudum.

Lidar Navás, 1909: 153. Type species: *Dilar meridionalis* Hagen, 1866: 295, original designation.

Fuentenus Navás, 1909: 154. Type species: *Dilar campes-tris* Navás, 1903: 380, original designation.

Nepal Navás, 1909: 661. Type species: *Nepal harmandi* Navás, 1909: 661, original designation.

Rexavius Navás, 1909: 664. Type species: *Dilar nietneri* Hagen, 1858: 482, subsequent designation by Navás, 1914: 10.

Didar Navás, 1913: 6. An incorrect subsequent spelling of *Dilar*.

Lider Kuwayama, 1962: 376. An incorrect subsequent spelling of *Lidar*.

Diagnosis. Male antennae pectinate, except 2 proximal and more than 3 distal simple antennomeres, branch of 1st flagellomere short, with only one dentate process. Wings broad, generally with numerous dark markings; costal area broad with crossveins simple except several ones forked; subcostal area obviously narrower than costal area, having several crossveins; more than 5 crossveins between R and Rs, MA fused with R at wing base, proximally with no crossvein connecting to MP, and arising from R prior to separation between R and Rs; MP with 2 main branches; nygmata present; trichosors present along wing margin. Male ninth tergite in dorsal view with a truncate or arcuate anterior incision and a deeply V- or U-shaped posterior incision, leaving a pair of broad hemitergites, which are obtuse distally and densely haired. Male ninth sternite generally much shorter than ninth tergite. Male ectoproct highly specialized, largely covered by ninth tergite, without callus cerci and any macrosetae. Male gonocoxite complexes 9, 10 and 11 comprising two pairs of sclerites (i.e. ninth and tenth gonocoxites) and a transverse sclerite (i.e. gonarcus = eleventh gonocoxites); gonarcus laterally connecting to bases of ninth gonocoxites. Hypandrium internum generally trapezoidal, with lateral margins slightly arcuate.

Distribution. This genus ranges from northern Africa, through Europe, to Asia, and is recorded in the following countries: Afghanistan, Algeria, Andorra, Bulgaria, China, France, Greece, India, Iran, Italy, Japan, Korea, Kyrgyzstan, Lebanon, Malaysia, Nepal, Pakistan, Portugal, Russia, Spain, Sri Lanka, Tajikistan, Thailand, Turkey, Turkmenistan, Vietnam all countries of former Yugoslavia.

Key to males of insular *Dilar* species from East Asia¹

- 1 Forewings nearly hyaline, with no obviously markings *D. pallidus* Nakahara
- Forewings yellowish brown, with distinct brown markings 2
- 2 Male (Fig. 24, 26) with ninth tergite in dorsal view with posteromedial portion protruding into a projection *D. insularis* **sp. n.**
- Male with ninth tergite in dorsal view without projection posteromedially 3
- 3 Male (Fig. 17) with ectoproct in dorsal view with a strong sclerotized projection at tip and with gonarcus beam-shaped, which is bifid on both ends *D. taiwanensis* Banks
- Male with gonarcus beam-shaped, which is not bifid on both ends 4
- 4 Male (Fig. 13) with ectoproct in dorsal view with a pair of parallel prolongations which are truncatus and serrate at tip *D. hikosanus* Nakahara
- Male (Fig. 7) with ectoproct in dorsal view with three projections at tip which is sparsely haired *D. japonicus* McLachlan

¹ *Dilar formosanus* (Okamoto & Kuwayama) is not included in this key because the male of this species is unknown. Moreover, the specific identity of *D. formosanus* is still unclear (see remarks of *D. formosanus*).

***Dilar japonicus* McLachlan, 1883**

Figs. 1, 7–12

Dilar japonicus McLachlan, 1883: 220. Type locality: Japan (Fukushima).

Dilar nohirae Nakahara, 1914: 297. Type locality: Japan (Nara).

Dilar japonicus var. *gracilis* Kuwayama, 1921: 71. Type locality: Japan (Fukushima).

Diagnosis. This species is characterized by the forewings with numerous pale brown markings, and the male ectoproct in dorsal view with three projections at tip which is sparsely haired.

Description. Male. Body length 4.3–5.3 mm; forewing length 10.0–11.4 mm, hindwing length 8.8–9.4 mm.

Head pale yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 29 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal seven flagellomeres simple.

Prothorax pale yellow, pronotum pale yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slightly darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly smoky brown, with numerous brown spots. Forewing ~2.1 times as long as wide, densely spotted, with markings on proximal half much darker, arranging as transversely arcuate pattern, a broad immaculate area present on either side of median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.0 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown, crossveins much paler than longitudinal veins. Forewing with trichosors present along wing margin between R and CuA; Rs with three main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellow, pregenital segments dorsally yellowish brown. Ninth tergite in dorsal view with an arcuate anterior incision and a deeply V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, truncately posteriad. Ectoproct in dorsal view with three projections at tip which is sparsely haired, posteroventrally with a pair of subsemicircular and flattened projections, a pair of bifid unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite with anterior

half broadly spoon-shaped and with posterior half slenderly elongate and curved posteroventrally; tenth gonocoxite slenderly elongate, much longer ninth gonocoxite, with incurved base and spinous tip, medially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, slightly expanded on both ends, laterally connecting to base of ninth gonocoxites. Hypandrium internum nearly trapezoidal, with lateral margins slightly arcuate.

Female. Body length 6.5 mm; forewing length 14.0 mm, hindwing length 12.7 mm.

Seventh sternite (Fig. 11) in lateral view subtrapezoidal, in ventral view nearly rectangular and slightly convex on posterior margin. Eighth abdominal segment ventrally without subgenitale. Bursa copulatrix (Fig. 11) with colleterial gland tubular and elongate, sinuate medially; basal part of bursa copulatrix sac-like in lateral view and nearly ovoid in ventral view, posteriorly slightly sclerotized on both sides; bursal accessory gland not observed. Ectoproct rather small, ovoid.

Materials examined. Holotype ♂, “Japan, Fukushima [37°44’N, 140°28’E]/28.7.[18]81/Type/*japonicus* McL[achlan]” (BMNH). JAPAN: 1♂, Aomori, Tsuta-onsen [40°13’N, 140°30’E], 6.VIII.1953, K. Sadanaga (NIAES); 1♀, Gunma, Kuni-mura [36°38’N, 138°38’E], 10.VIII.1992, K. Konishi (NIAES); 1♂, Gunma [36°23’N, 139°03’E], 3.VIII.1960, K. Fujimoto (NIAES); 1♂, Shikoku, Mt. Sara [33°45’N, 133°30’E], 27.VII.1955, Toshiro Yano (NIAES); 1♂, Yamanashi, Shojiko [35°29’N, 138°36’E], 23.VII.1969, P. H. Hasegawa (NIAES); 1♂, Fukushima, Yokomuki Onsen [37°53’N, 140°33’E], 26.VII.1964, H. Kobayashi (NIAES).

Distribution. Japan (Honshu, Kyushu, Shikoku).

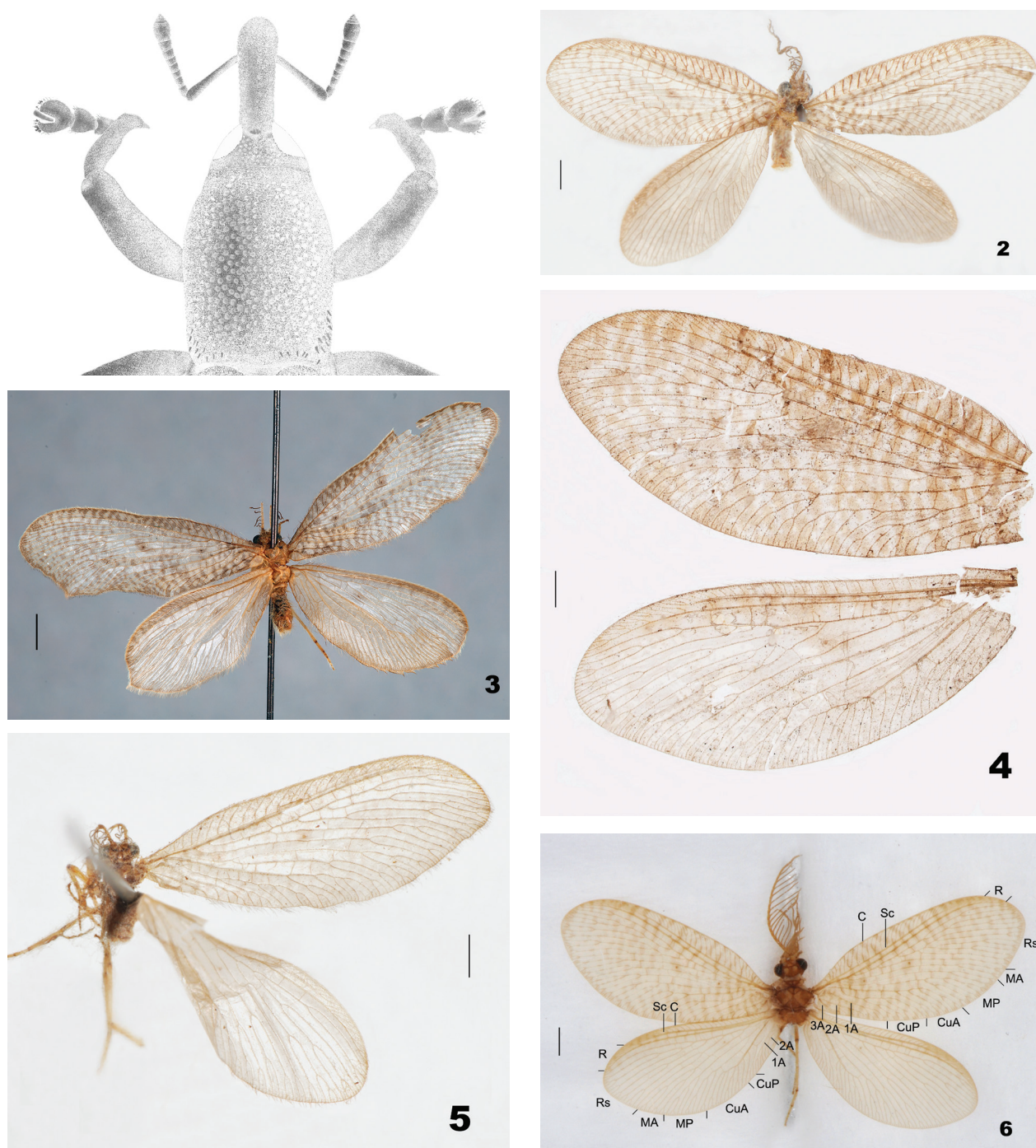
Remarks. This species appears to be very closely related to *D. hikosanus* Nakahara in having similar wing marking patterns and male genitalia. The only difference between these two Japanese species refers to the male ectoproct. In *D. japonicus*, the male ectoproct distally bears three projections which are sparsely haired. However, in *D. hikosanus* the ectoproct has a pair of parallel projections which are truncate and serrate at tip. Primarily we even suspected *D. hikosanus* to be conspecific with *D. japonicus* due to the remarkable similarity of the external morphological and genitalic characters. Nevertheless, we examined several males of both species, and the difference of the male ectoproct mentioned above is stable. Therefore, we consider *D. hikosanus* and *D. japonicus* to be different species. *Dilar japonicus* is a widely distributed species in Honshu, Kyushu and Shikoku, while *D. hikosanus* seems to be endemic to Kyushu, and more exactly to the Mt. Hikosan.

***Dilar hikosanus* Nakahara, 1955**

Figs. 2, 13–16

Dilar hikosanus Nakahara, 1955b: 137. Type locality: Japan (Fukuoka).

Diagnosis. This species is characterized by the forewings with numerous brown stripes, and the male ectoproct in



Figures 1–6. Adults of *Dilar* spp. **1.** *D. japonicus* McLachlan, holotype male; **2.** *D. hikosanus* Nakahara, male; **3.** *D. taiwanensis* Banks, holotype male; **4.** *D. formosanus* (Okamoto & Kuwayama), holotype female, fore- and hindwing; **5.** *D. pallidus* Nakahara, holotype male; **6.** *D. insularis* sp. n., holotype male. Scale bars: 1.0 mm.

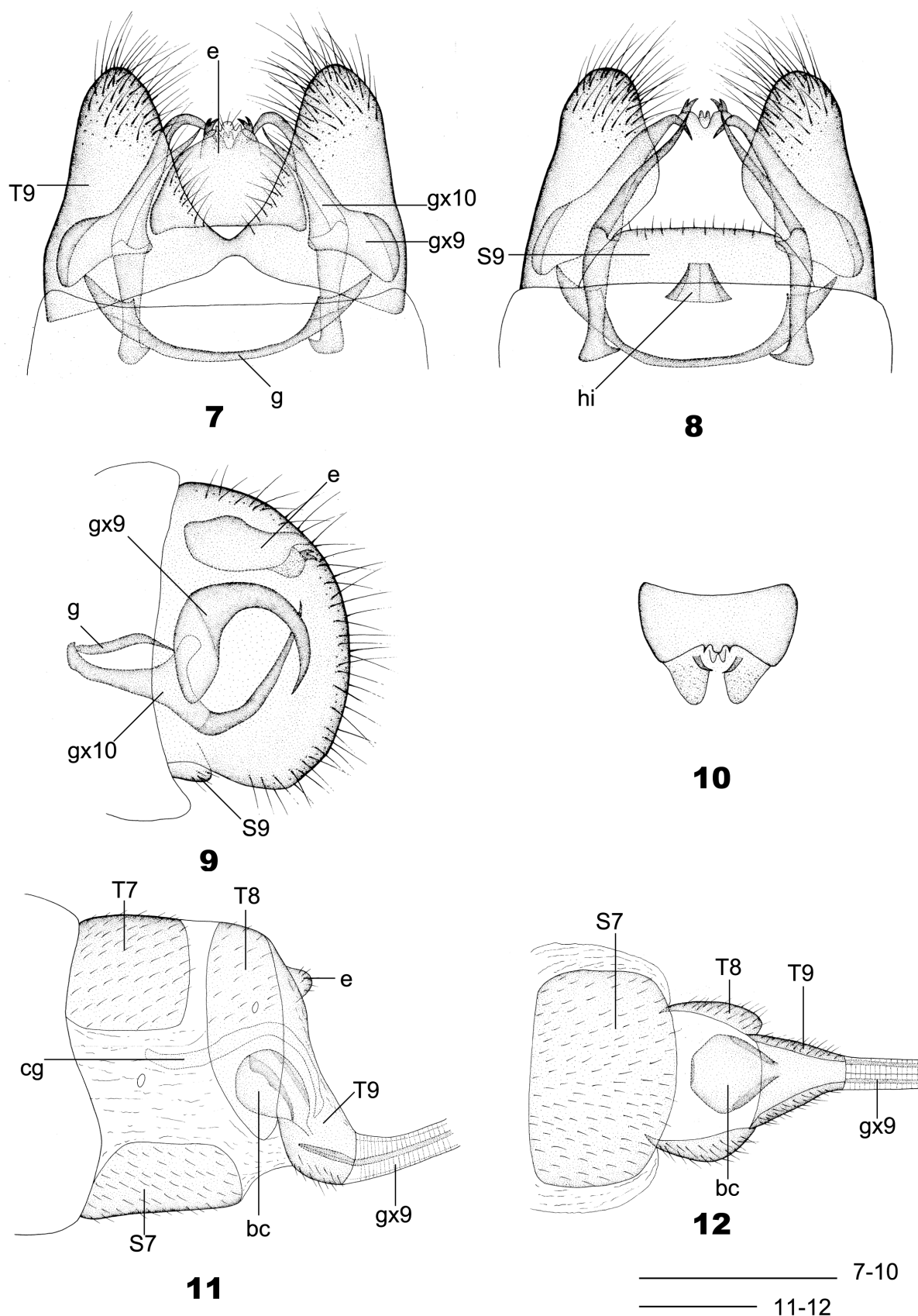
dorsal view with a pair of parallel prolongations which are truncate and serrate at tip.

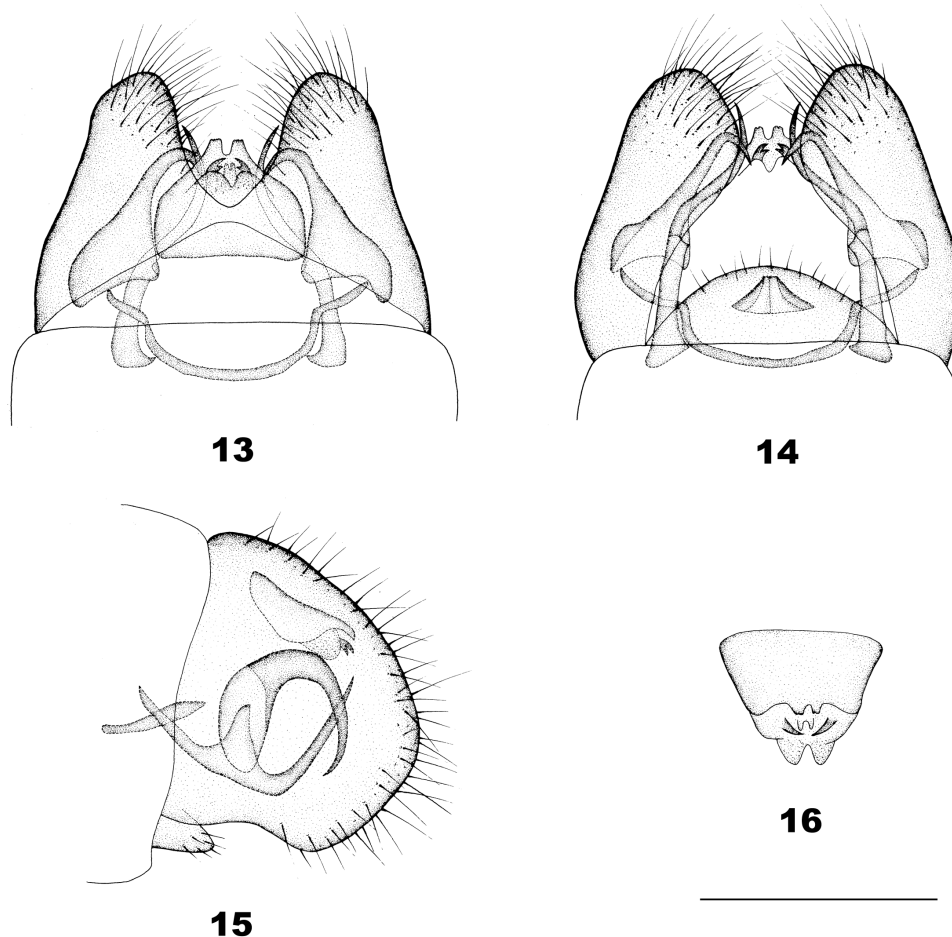
Description. Male. Body length 4.7 mm; forewing length 8.3 mm, hindwing length 6.8 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 29 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant

flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

Prothorax pale yellowish brown, pronotum yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slightly darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown, with numerous brown





Figures 13–16. *Dilar hikosanus* Nakahara. **13.** Male genitalia, dorsal view; **14.** Male genitalia, ventral view; **15.** Male genitalia, lateral view; **16.** Male ectoproct, caudal view. Scale bars: 0.5 mm.

spots. Forewing ~2.2 times as long as wide, densely spotted, with markings on proximal half much darker, most markings connected with each other, generally arranging into several arcuate transverse stripes, an immaculate area present distal to median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Rs with four main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellowish brown, pregenital segments dorsally brown. Ninth tergite in dorsal view with an arcuate anterior incision and a nearly V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, arcuately convex posteriad. Ectoproct in dorsal view with a pair of

parallel prolongations which are truncate and serrate at tip, posteroventrally with a pair of subsemicircular and flattened projections, a pair of bifid unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite with anterior half broadly spoon-shaped and with posterior half slenderly elongate and curved posteroventrally; tenth gonocoxite slenderly elongate, much longer ninth gonocoxite, with incurved base and spinous tip which is curved outward, medially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, laterally connecting to base of ninth gonocoxites. Hypandrium internum nearly trapezoidal, with lateral margins slightly arcuate.

Female. Unknown.

Materials examined. Holotype ♂, “HIKOSAN [33°01’N, 131°01’E], Kyushu, Aug. 3, 1934, S. Hiroyama/*Dilar hikosanus* n.sp. (Type) W. NAKAHARA/Waro Nakahara Collection II/*Dilar hikosanus* n.sp. W. NAKAHARA (Holotype)/NSMT-I-Nr No. 4302” (NSMT). 2♂, JAPAN: Kyushu, Hikosan, Buzen, 19.VII.1963, H. Kuroko (NIAES).

Distribution. Japan (Kyushu).

Remarks. See Remarks under *Dilar japonicus* McLachlan, 1883.

***Dilar taiwanensis* Banks, 1937**

Figs. 3, 17–20

Dilar taiwanensis Banks, 1937: 276. Type locality: China (Taiwan: Jiayi).

Dilar distinctus Nakahara, 1955b: 139. Type locality: China (Taiwan: Tattaka). **syn. n.**

Nepal kanoi Nakahara, 1955a: 6. Type locality: China (Taiwan: Tattaka). **syn. n.**

Diagnosis. This species is characterized by the male ninth gonocoxite with anterior half broadly spoon-shaped and with posterior half slenderly elongate and curved posteroventrally, and by the slenderly elongate tenth gonocoxite which has a lobe connecting to ninth gonocoxite medially.

Description. Male. Body length 3.4–5.5 mm; forewing length 6.4–9.0 mm, hindwing length 5.5–7.6 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 29 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

Prothorax pale yellowish brown, pronotum yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slight darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown, with numerous dark spots. Forewing ~2.2 times as long as wide, densely spotted, with markings on proximal half much darker, most markings fused with each other, generally arranging into several arcuate transverse stripes, an immaculate area present distal to median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Rs with four main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellowish brown, pregenital segments dorsally brown. Ninth tergite in dorsal view with an arcuate anterior incision and a nearly V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, arcuately convex posteriorly. Ectoproct in dorsal view with a strong sclerotized projection medially, which is bifid at tip, posteroventral-

ly with a pair of short and flattened projections, a pair of bifid unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite strongly inflated and spoon-shaped on anterior half, with posterior half slenderly elongate and curved posteroventrally, which is with a slenderly short projection extended subterminally; tenth gonocoxite slenderly elongate, much longer than ninth gonocoxite, with incurved base and spinous tip which is curved outward, medially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, bifid on both ends, laterally connecting to base of ninth gonocoxites. Hypandrium internum nearly trapezoidal, with lateral margins slightly arcuate.

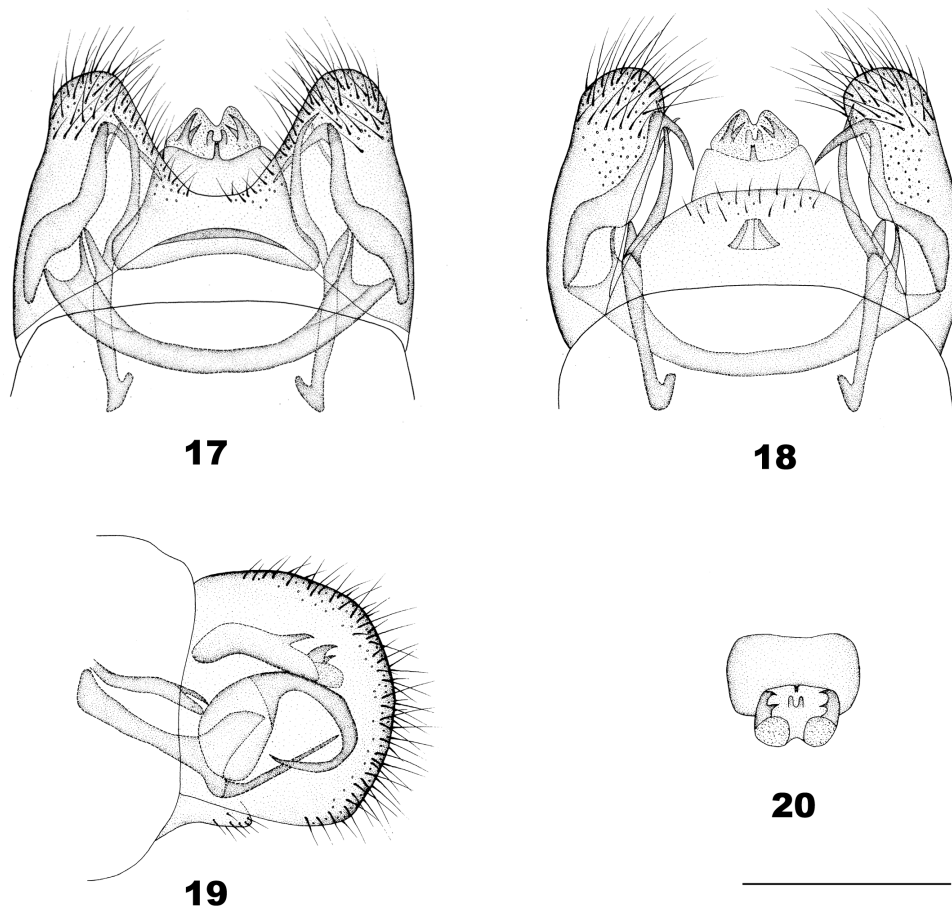
Female. Forewing length 12.5 mm, hindwing length 11.5 mm.

Abdomen yellow, ovipositor yellowish brown, seventh sternite ruptured during maceration, eighth abdominal segment without subgenitale. Colleterial gland apparently also ruptured, not visible. Bursa copulatrix sac-like in lateral view, with an elongated bowl-like sclerite and a paired sclerotized domed structure distally behind it; bursal accessory gland not observed. Ectoproct rather small, ovoid.

Materials examined. Holotype ♂, “Formosa, Arizan [= Mt. Alishan, Taiwan, 23°31’N, 120°48’E], June 4, Gressitt, Type, M.C.Z. No. 20229” (MCZ). CHINA: 2♂, Taiwan, Taoyuan, Mt. Tamanshan [24°42’N, 121°27’E], 1600 m, 11.VI.2013, Feiyang Liang (CAU); 1♂, Taiwan, Taipei, Mt. Yangmingshan, Datun Park [25°09’N, 121°32’E], 900 m, 17.VI.2012, Lihua Wang (CAU); 2♂, Taiwan, Taipei, Mt. Yangmingshan, Datun Park, 900 m, 17.VI.2012, Luxi Liu (CAU); 5♂1f#, Taiwan, Nantou, Tayuling [23°55’N, 120°40’E], 2500 m, 8–18.VI.1998, D. R. Davis (NMNH); 1♂, “Formosa, Taihorin [Taiwan: Chiayi County, Dalin (= Taihorin), 23°35’N, 120°28’E], VI.10. [= June 1910], H. Sauter” (MNB); 2♂ [Holotype and a paratype of *Dilar distinctus*], “Formosa, T. Kano/*Dilar distinctus* n.sp. (Type) W. NAKAHARA/Waro Nakahara Collection II” (NSMT); 1♂ [Holotype of *Dilar kanoi*], “Formosa, T. Kano/*Dilar kanoi* n.sp. (Type) W. NAKAHARA/Waro Nakahara Collection II/NSMT-I-Nr No. 4340” (NSMT); 1♂, CHINA: Taiwan, 29.VII.1928, T. Kano (NSMT); JAPAN: 1♂, Iriomote Island, Upper Nakara River [24°20’N, 123°49’E], 12.III.1964, Y. Miyatake (NSMT).

Distribution. China (Taiwan), Japan (Iriomote Island).

Remarks. This species was originally described by Banks (1937) based on external morphology only. After our examination of the holotype of this species, we found that this species is identical with *Dilar distinctus* Nakahara and *Dilar kanoi* Nakahara based on the comparison of its male genitalia with the original genitalic illustrations of the latter two species. Therefore, we treat *D. distinctus* and *D. kanoi* as junior synonyms of *D. taiwanensis*. Nevertheless, it should be noted that the collecting labels of the primary types of *D. distinctus* and *D. kanoi* lack the information of the precise data of the collecting sites and dates, which however were indicated in the original descriptions (Nakahara 1955a, b).



Figures 17–20. *Dilar taiwanensis* Banks. **17.** Male genitalia, dorsal view; **18.** Male genitalia, ventral view; **19.** Male genitalia, lateral view; **20.** Male ectoproct, caudal view. Scale bars: 0.5 mm.

It is interesting that this species is polymorphic. Some individuals (See Figs. 28, 30) have dark wings, while some individuals (See Figs. 29, 31) have much paler wings. Therefore, it is difficult to identify the Taiwanese *Dilar* species only based on external morphology because of its significant intraspecific variations. Possibly, *D. formosanus* and *D. pallidus* are individual variations of *D. taiwanensis*, which, however, needs further clarification.

Considering the distribution, this species is firstly recorded in Iriomote Island, which is the southernmost island of Ryukyus, Japan.

***Dilar formosanus* (Okamoto & Kuwayama, 1920)**

Figs. 4, 21–22

Lidar formosanus Okamoto & Kuwayama, 1920: 341.

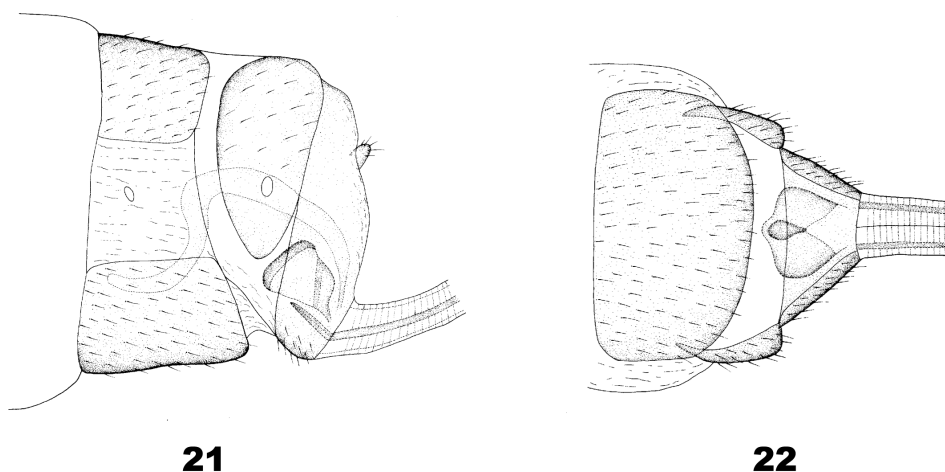
Type locality: China (Taiwan: Jiayi).

Diagnosis. This species is characterized by the forewings with numerous brown markings, and the basal part of bursa copulatrix, which is subtrapezoidal, with anteromedial portion slightly prominent and sclerotized in ventral view.

Description. Female. Body length 8.5 mm; forewing length 14.0 mm, hindwing length 12.0 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 25 segments, pale yellowish brown, medial flagellomeres much longer than those on both ends, distal eight flagellomeres short, nearly moniliform.

Prothorax pale yellowish brown, pronotum dark brown, with eight yellowish tubercles clothed with yellowish hairs; mesothorax and metathorax pale yellowish brown. Legs pale yellowish brown, with each segment blackish brown at tip. Wings hyaline, slightly pale brown, with numerous brownish spots. Forewing ~2.5 times as long as wide, densely spotted, most spots expanded and fused with each other, with markings on costal area and proximal half much darker, arranging as transversely arcuate pattern, an immaculate area present distal to median nygmata; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins brown. Forewing with 13 crossveins between Sc and R; Sc just touching R in pterostigmatic region; 12 crossveins between R and Rs; Rs with five main branches; MP with two main branches. Hindwing subcostal area slightly widened on distal half, with four crossveins; Rs with six main branches.



Figures 21–22. *Dilar formosanus* (Okamoto & Kuwayama). **21.** Female genitalia, lateral view; **22.** Female genitalia, ventral view. Scale bars: 0.5 mm.

Abdomen yellow, pregenital segments dorsally brown. Ovipositor yellowish brown, much longer than abdomen. Seventh sternite in lateral view subtrapezoidal, with slightly convex posterior margin in ventral view. Eighth abdominal segment without subgenitale. Bursa copulatrix with colleterial gland tubular and elongate, strongly curved medially; basal part of bursa copulatrix sac-like in lateral view, subtrapezoidal in ventral view with anteromedial portion slightly prominent and sclerotized; bursal accessory gland not observed. Ectoproct rather small, ovoid.

Male. Unknown.

Material examined. Holotype f#, “Mt. Ari [23°26'N, 120°46'E], Taiwan, 2.IV.1907. S. Matsumur[a] leg./*Lidar formosanus* n. sp. 1920 Det. HANJIRO OKAMOTO SATORO KUWAYAMA (HOLOTYPE)/*Lidar formosanus* OKAMOTO et KUWAYAMA 1920 Holotype ♀” (SEHU).

Distribution. China (Taiwan).

Remarks. This species was originally described based on a single female by Okamoto and Kuwayama (1920). Due to the phenomenon that remarkable intraspecific variation of wing marking patterns is present in Dilaridae (see Zhang et al. 2014b and the remarks on *D. taiwanensis*), it is difficult to clarify the specific identity of *D. formosanus* based on the external morphology with the other Taiwanese *Dilar* species, of which the females are unknown. Nevertheless, it is highly possible that *D. formosanus* is conspecific with one of the other three *Dilar* species from Taiwan, i.e. *D. pallidus*, *D. taiwanensis*, and *D. insularis*. This may be clarified by DNA barcoding, when fresh material is available.

Dilar pallidus Nakahara, 1955

Figs. 5, 23

Dilar pallidus Nakahara, 1955b: 140. Type locality: China (Taiwan: Tattaka).

Diagnosis. This species is characterized by the forewings with no obvious markings, and the male ectoproct in dor-

sal view with a subrectangular projection terminating in three sharply pointed processes of about equal length.

Description. Male. Body length 3.5 mm; forewing length 10.5 mm, hindwing length 8.5 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 24 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 3.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

Prothorax pale yellowish brown, pronotum yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum dark brown on anterior and lateral margins; metanotum pale yellowish brown, slight darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown. Forewing ~2.3 times as long as wide, with numerous very indistinct markings, and with a yellowish brown spot on median nygma; two nygmata present on proximal and median portion of forewing, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Rs with four main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with three main branches.

Abdomen pale yellowish brown, pregenital segments dorsally brown. Ectoproct in dorsal view with a subrectangular projection which terminating in three sharply pointed processes of about equal length, posteroventrally with a pair of large, bifid, unguiform projections and a subrectangular, feebly sclerotized projection. Ninth gonocoxite with anterior half slightly inflated and with posterior half slenderly elongate and strongly incurved;



Figures 23. *Dilar pallidus* Nakahara, male genitalia, ventral view. Reproduced from Nakahara (1955b).

tenth gonocoxite slenderly elongate, with incurved base and spinous tip, submedially with a lobe connecting to ninth gonocoxite; gonarcus beam-shaped, laterally connecting to base of ninth gonocoxites. Hypandrium internum unknown.

Female. Unknown.

Material examined. Holotype ♂, “Formosa, T. Kano/*Dilar pallidus* n.sp. (Type) W. NAKAHARA/*pallidus* n.sp./Waro Nakahara Collection II/NSMT-I-Nr No. 4301/Type of *Dilar pallidus*?” (NSMT).

Distribution. China (Taiwan).

Remarks. This species is known only from the holotype male, whose genitalia have been unfortunately lost. The present redescription of the male genitalia is based on the original illustration from Nakahara (1955b). Considering the wing marking patterns, *D. pallidus* has very pale wings without distinct dark markings, while the other Taiwanese species of *Dilar* have much darker markings on forewings. Considering the male genitalia, it is obvious that *D. pallidus* is closely related to *D. taiwanensis* by having similar male gonocoxite complexes 9, 10, 11. However, in *D. pallidus* the male ectoproct differs in some details, e.g. the presence of a rectangular dorsomedian projection, and the presence of a pair of posteroventral lobes each with two widely separated claw-like projections, from *D. taiwanensis*. Nevertheless, the specific identity of *D. pallidus* needs further clarification when more materials will be available.

***Dilar insularis* Zhang, Liu & U. Aspöck sp. n.**

<http://zoobank.org/721BA7E1-F9DF-4967-822B-E46BE6AA0C96>
Figs. 6, 24–27

Diagnosis. This species is characterized by the forewings with numerous yellowish brown stripes, and the male

gonarcus/ninth gonocoxite complex with rather inflated ninth gonocoxites and slenderly elongate tenth gonocoxites which are angulately curved anteriorly.

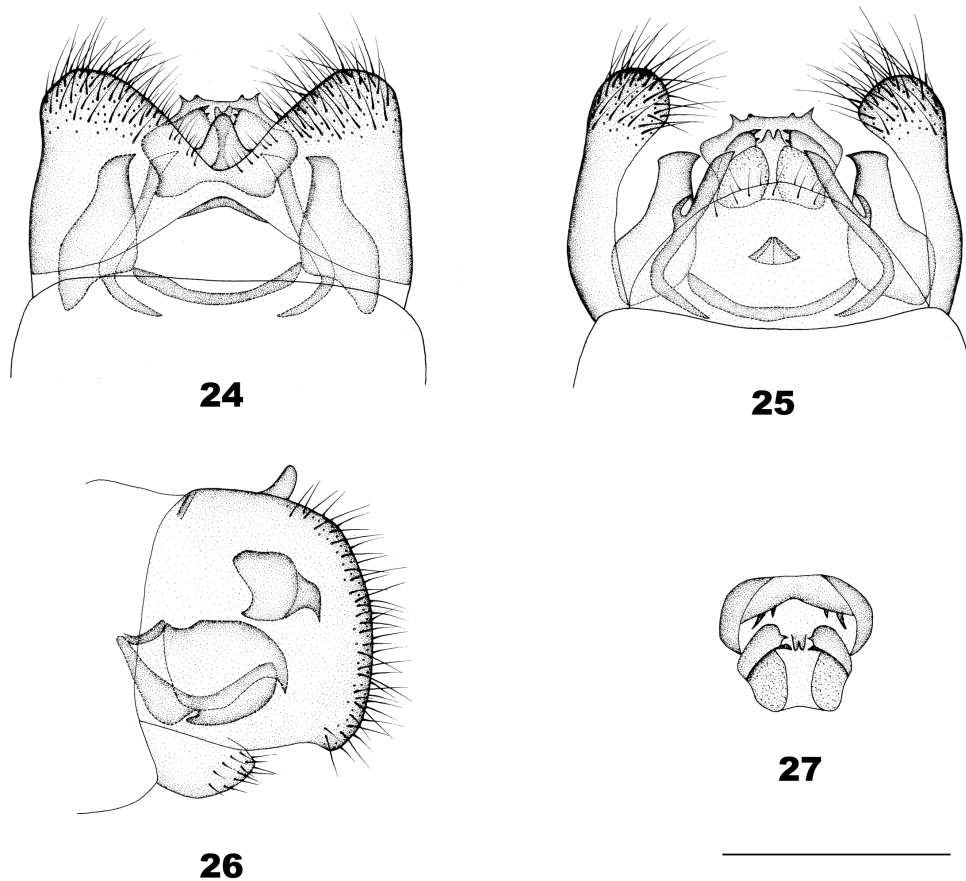
Description. Male. Body length 3.7–5.5 mm; forewing length 6.0–8.9 mm, hindwing length 5.2–7.5 mm.

Head yellowish brown, with pale yellow setose tubercles. Compound eyes blackish brown. Antenna with ca. 28 segments, pale yellowish brown, pedicel with brown annular stripes, flagellum unipectinate on most flagellomeres, medial branches much longer than those on both ends, longest branch nearly 7.0 times as long as relevant flagellomere, but branch of 1st flagellomere short and dentate, distal eight flagellomeres simple.

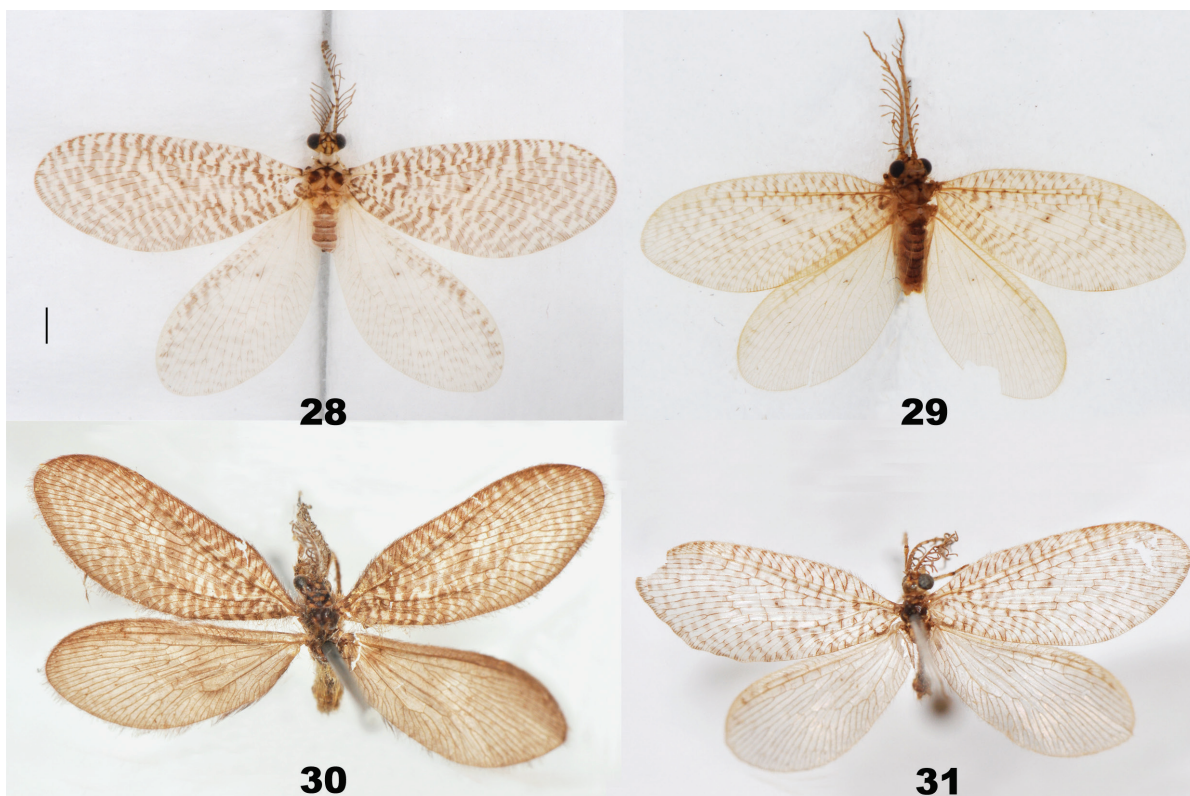
Prothorax pale yellow, pronotum pale yellowish brown, with anterior margin and posterolateral corners pale yellow, medially with a pair of ovoid markings; mesothorax pale yellowish brown, mesonotum yellowish brown on anterior and lateral margins; metanotum yellowish brown, slightly darker on lateral margins. Legs pale yellowish brown, femora blackish brown at tip. Wings hyaline, slightly yellowish brown, with numerous yellowish brown stripes. Forewing ~2.2 times as long as wide, proximal stripes slightly darker, arranging as transversely arcuate pattern, an immaculate area present distal to median nygma; two nygmata present on proximal and median portion, median one much larger than proximal one. Hindwing ~2.1 times as long as wide, slightly paler than forewing, with similar marking pattern; one nygma present at middle. Veins pale brown. Forewing with trichosors present along wing margin between R and CuP; Sc just touching R in pterostigmatic region, terminally leaving several weak veinlets; Rs with four or five main branches; MP with two main branches; two gradate crossveins present at middle. Hindwing with trichosors present along wing margin between R and CuA; Rs with four main branches.

Abdomen pale yellowish brown, pregenital segments dorsally dark brown. Ninth tergite in dorsal view with an arcuate anterior incision and a nearly V-shaped posterior incision, leaving a narrow median portion and a pair of subtriangular hemitergites, which are obtuse distally and densely haired; posteromedial portion protruding into a projection; in lateral view broad, with straight ventral margin and arcuate posterior margin. Ninth sternite obviously shorter than ninth tergite, arcuately convex posteriorly. Ectoproct in dorsal view nearly truncate distally, with two pairs of claw-like projections, in ventral view posteroventrally with two pairs of unguiform projections and a pair of short, feebly sclerotized, digitiform projections. Ninth gonocoxite rather short and robust with acutely tapering tip; tenth gonocoxite slenderly elongate, slightly longer than ninth gonocoxite, angulately curved anteriorly, posteriorly with obtuse tip, medially with a lobe connecting to ninth gonocoxite; gonarcus slenderly beam-shaped, laterally connecting to base of ninth gonocoxites. Hypandrium internum subtriangular, with lateral margins slightly arcuate.

Female. Unknown.



Figures 24–27. *Dilar insularis* sp. n. 24. Male genitalia, dorsal view; 25. Male genitalia, ventral view; 26. Male genitalia, lateral view; 27. Male ectoproct, caudal view. Scale bars: 0.5 mm.



Figures 28–31. Individual variations of *Dilar* spp. 28, 30. *D. taiwanensis* Banks, male with dark wings; 29, 31. same species, male with bright wings. Scale bars: 1.0 mm.

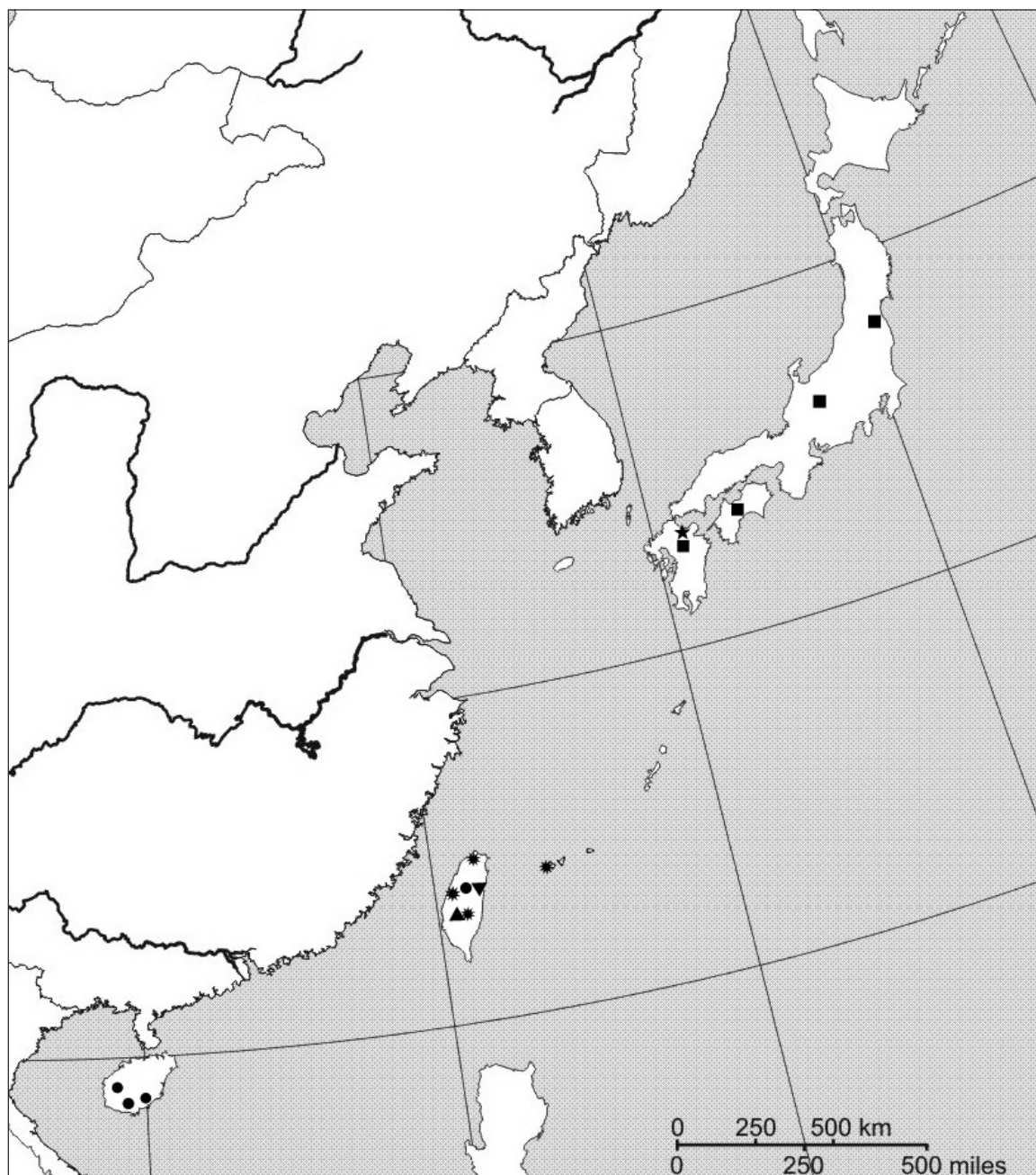


Figure 32. Geographic distribution of the species of *Dilar*. ▲ *Dilar formosanus* (Okamoto & Kuwayama); ★ *Dilar hikosanensis* Nakahara; ● *D. insularis* sp. n.; ■ *Dilar japonicus* McLachlan; ▼ *Dilar pallidus* Nakahara; ★ *Dilar taiwanensis* Banks.

Type materials. Holotype ♂, “CHINA, Hainan, Mt. Wuzhishan [18°46’N, 109°30’E], 1800 m, 23.V.1964, Sikong Liu” (CAU). Paratypes 1♂, CHINA, Hainan, Baisha, Bawangling [19°08’N, 109°15’E], 1300 m, 24.V.2007 (CAU); 1♂, CHINA, Hainan, Lingshui, Mt. Diaoluoshan [18°39’N, 109°54’E], 27.III.1964, Sikong Liu (CAU); 1♂, CHINA, Taiwan, Nantou [23°55’N, 120°40’E], 10.VII.1961, T. Shirogu (NSMT).

Distribution. China (Hainan, Taiwan).

Etymology. The specific epithet “*insularis*” refers to the fact that the new species is endemic to the islands of East Asia: Hainan and Taiwan. It is an adjective in the nominative masculine singular.

Remarks. This species can be easily distinguished from the other *Dilar* species from Taiwan by the male ninth tergite with a posteromedial projection, the male gonocoxite complex 9, 10, 11 with rather inflated and short ninth gonocoxites, and the male ectoproct distally with two pairs of claw-like projections. First, we discovered this new species in several localities on Hainan Island, but subsequently found one specimen of this species in Taiwan, which indicates that this species might be diverged much earlier than the other Taiwanese *Dilar* species when these two large islands were parts of the East Asian mainland.

Discussion

Among the presently described *Dilar* species, the two Taiwanese species (i.e. *D. pallidus* and *D. taiwanensis*) and the two Japanese species (i.e. *D. hikosanus* and *D. japonicus*) are morphologically similar and probably closely related because of the similar structure of the male gonocoxite complex 9, 10, 11, which has a strongly ventrally curved gonocoxite 9 and a proximally bifurcated gonocoxite 10. Based on these characters, the above four insular species appear to be closely related to the mainland species *Dilar septentrionalis* Navás, 1912, which is distributed in northeastern Asia (northeastern China, Korea, and Russia Far East) (Monserrat 1988a, Zhang et al. 2014a). Whether the common ancestor of these four species from the islands invaded the islands and diversified there afterwards or whether the island species result from several invaders remains open at present. Hypotheses on the separation of the islands offshore Eastern Asia have been discussed in the context of several taxa, e.g. Raphidioptera (Liu et al. 2010). The subsequent southern dispersal of the ancestral species from Japan through Ryukyus to Taiwan might account for further separation and the modern distribution of these four insular species.

Dilar insularis sp. n. is remarkably different from the other insular species from Japan and Taiwan, and it seems to be somewhat related to the *Dilar* species ranging in the Himalayas (Zhang et al. 2014b) by having the posteromedial projection of male ninth tergite, suggesting that the speciation of *D. insularis* sp. n. might be correlated with a different vicariance event, possibly the separation of Hainan and Taiwan from the southeastern Chinese mainland.

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References

- Aspöck H, Hölzel H, Aspöck U (2001) Kommentierter Katalog der Neuropterida (Insecta: Raphidioptera, Megaloptera, Neuroptera) der Westpaläarkt. *Denisia* 2: 1–606.
- Aspöck U, Aspöck H (2008) Phylogenetic relevance of the genital sclerites of Neuropterida (Insecta: Holometabola). *Systematic Entomology* 33: 97–127. doi: 10.1111/j.1365-3113.2007.00396.x
- Banks N (1937) Neuropteroid insects from Formosa. *Philippine Journal of Science* 62: 255–291.
- Engel MS (1999) The first fossil of a pleasing lacewing (Neuroptera: Dilaridae). *Proceedings of the Entomological Society of Washington* 101: 822–826.
- Liu XY, Aspöck H, Hayashi F, Aspöck U (2010) New species of the snakefly genus *Mongoloraphidia* (Raphidioptera: Raphidiidae) from Japan and Taiwan, with phylogenetic and biogeographical remarks on the Raphidiidae of eastern Asia. *Entomological Science* 13: 408–416. doi: 10.1111/j.1479-8298.2010.00401.x
- McLachlan R (1883) *Dilar japonicus*, n. sp. *Entomologist's Monthly Magazine* 19: 220–221.
- Monserrat VJ (1988a) Revisión de la obra de L. Navás, I: EL genero *Dilar* Rambur, 1842 (Neuropteroidea, Planipennia: Dilaridae). *Neuroptera International* 5: 13–23.
- Monserrat VJ (1988b) Revisión de los diláridos ibéricos (Neuropteroidea, Planipennia: Dilaridae). *EOS: Revista Española de Entomología* 64: 175–205.
- Monserrat VJ (1989) Algunos Neuropteros del Museo de Basilea (Insecta, Neuropteroidea, Planipennia). *Entomologica Basiliensis* 13: 417–428.
- Monserrat VJ (2005) Nuevos datos sobre algunas pequeñas familias de neuropteros (Insecta: Neuroptera: Nevrothidae, Osmylidae, Sisyridae, Dilaridae). *Heteropterus: Revista de Entomología* 5: 1–26.
- Nakahara W (1955a) Formosan Neuroptera collected by the late Dr. T. Kano. *Kontyû* 23: 6–12.
- Nakahara W (1955b) The Dilaridae of Japan and Formosa (Neuroptera). *Kontyû* 23: 133–142.
- Nakahara W (1957) A new species of *Dilar* from north China (Neuroptera: Dilaridae). *Mushi* 30: 31–33.
- Okamoto H, Kuwayama S (1920) *Lidar formosanus* sp. n., the first species to the extreme Oriental fauna of the genus. *Zoological Magazine* 32: 341–345.
- Oswald JD (1998) Annotated catalogue of the Dilaridae (Insecta: Neuroptera) of the world. *Tijdschrift voor Entomologie* 141: 115–128. doi: 10.1163/22119434-99900008
- Oswald JD, Schiff NM (2001) A new species of the genus *Dilar* Rambur (Neuroptera: Dilaridae) from Borneo. *Proceedings of the Entomological Society of Washington* 103: 74–80.
- Oswald JD (2013) Dilaridae. Neuropterida Species of the World. Version 2.0. <http://lacewing.tamu.edu/Species-Catalogue/>
- Yang CK (1992) Neuroptera. In: Chen S (Ed.) *Insects of the Hengduan Mountains Region*. Science press, Beijing, 438–454.
- Yang CK (1999) Dilaridae. In: Huang BK (Ed.) *Fauna of Insects Fujian Province of China*. Fujian Science and Technology Press, Fuzhou, 94–95.
- Yang CK (2001) Neuroptera: Mantispidae and Dilaridae. In: Wu H, Pan CW (Eds) *Insects of Tianmushan National Nature Reserve*. Science press, Beijing, 305–307.
- Zhang W, Liu XY, Aspöck H, Aspöck U (2014a) Revision of Chinese Dilaridae (Insecta: Neuroptera) (Part I): Species of the genus *Dilar* Rambur from northern China. *Zootaxa* 3753: 10–24. doi: 10.11646/zootaxa.3753.1.2
- Zhang W, Liu XY, Aspöck H, Aspöck U (2014b) Revision of Chinese Dilaridae (Insecta: Neuroptera) (Part II): Species of the genus *Dilar* Rambur from Tibet. *Zootaxa*, 3878: 551–562. doi: 10.11646/zootaxa.3878.6.3

Beaded lacewings – a pictorial identification key to the genera, their biogeographics and a phylogentic analysis (Insecta: Neuroptera: Berothidae)

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Abstract

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Key Words

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The present paper comprises the first illustrated key for the genera of the Berothidae. Distribution maps for all genera are provided and distribution areas are discussed. A phylogenetic analysis based on the matrix of morphological characters of Aspöck and Nemeschkal (1998) using additional taxa and a modified approach concerning the homology of the genital sclerites (Aspöck and Aspöck 2008) yielded the following conflicting results: (i) The Trichomatinae are nested within the Nosybinae – which is considered an implausible position. (ii) Within the Berothinae, the genus *Podallea* appeared as the sister group of *Asadetevea* + *Nodalla*, whereas previously it was the sister group of the *Isoscelipteron* clade. In addition, the phylogenetic relevance of a peculiar phenomenon concerning the sclerites of the seventh abdominal segment of the females is discussed.

Introduction

The Berothidae Handlirsch, 1908, are a small neuropteran family that comprises about 110 known species in 24 genera. The adults superficially resemble hemerobiids (Fig. 1) but can clearly be distinguished from them by a pair of large haired tubercles on the vertex and the long “running” CuA of the hindwing (Tjeder 1959). The term beaded refers to the encrusted appearance of the setae on the wings of females that is caused by a secretion (Penny et al. 1997).

The fossil record of Berothidae dates back as far as the Middle Jurassic, but the family is assumed to be much older (Makarkin et al. 2011). Most of the fossil material was described from the Cretaceous e.g. in Lebanese amber (Whalley 1980), Burmese amber (Engel and Grimaldi 2008), New Jersey amber (Grimaldi 2000) and Canadian

amber (Klimaszewski and Kevan 1986). The fossil record from the Tertiary is comparatively poor, and only a few berothids are known from Baltic and English ambers (Krüger 1923, Wedmann et al. 2013). A list of known fossil Berothidae is provided in Makarkin et al. (2011).

The biology of the family is poorly documented. Since the adults are almost exclusively collected at light they are assumed to be nocturnal (Aspöck 1986, Oswald et al. 2002). However, *Lomamyia* Banks, 1904, has been collected by sweeping bushes (Toshi 1964) and was observed to sit inactive on the stems or undersides of leaves (New 1986). Also numerous adults of *Nyrma kervillea* Navás, 1933 were observed feeding in the daytime (Dobosz and Górski 2008), and species of the genera *Nosybus* Navás, 1910, and *Podallea* Navás, 1933, were frequently observed in cocoa plantations and on other vegetation on a field trip in Ghana in 2007



Figure 1. *Nodalla* sp., ♀ (Photo: Harald Bruckner).

(U. Aspöck, H. Aspöck, Duelli and Hölzel unpublished). Berothidae are polyphagous, their gut usually contains pollen, fragments of small arthropods and fungal hyphae (Monserrat 2006). Pollen is consumed from various inflorescences, e.g. *Podallea manselli* U. Aspöck & H. Aspöck, 1988, feeds on Rosaceae and Fabaceae, and *Nyrma kervillea* on Compositae type *Bellis* and Umbelliferae (Monserrat 2006, Dobosz and Górski 2008). Even pollen of Monocotyledonae is utilized since *Nodalla* (*Nodalla*) *saharica* (Esben-Petersen, 1920) feeds on Liliaceae (Monserrat 2006).

Larvae are known only from four genera of the subfamily Berothinae (*Lomamyia*, *Isoscelipteron* Costa, 1863, *Podallea*, *Spermophorella* Tillyard, 1916) and from two genera of the subfamily Nyrminae (*Nyrma* Navás, 1933, *Berothimerobius* Monserrat & Deretsky, 1999) (Tillyard 1916, Gurney 1947, Toschi 1964, Tauber and Tauber 1968, Brushwein 1987, Minter 1990, Möller 2003, Möller et al. 2006, Monserrat 2006, Dobosz and Górski 2008, Komatsu 2014). Their whole life cycle is largely obscure. Larvae of *Lomamyia*, *Podallea* and *Isoscelipteron* are associated with termites in their larval stage (Tauber and Tauber 1968, Brushwein 1987, Minter 1990, Möller et al. 2006, Komatsu 2014), but it is doubtful, whether this is a general strategy of the family or of the subfamily Berothinae only (Wedmann et al. 2013) as no data on the larvae of the other subfamilies are available.

The first modern treatment of the family Berothidae was completed by MacLeod and Adams (1967); it replaced the traditional typological classification and recognized four subfamilies: Cyrenoberothinae MacLeod & Adams, 1967, Rhachiberothinae Tjeder, 1959 (recently raised to family status, see below), Nosybiniae MacLeod & Adams, 1967, and Berothinae Handlirsch, 1908. Aspöck (1989) erected an additional subfamily, Nyrminae Navás, 1933, to contain the highly specialized species *Nyrma kervillea*, which was previously placed in the Hemerobiidae.

The first computerized cladistic analysis of the Berothidae (Aspöck and Nemeschkal 1998) yielded two additional subfamilies: Protobiellinae Aspöck & Nemeschkal, 1998, and Trichomatinae Tillyard, 1916. However, a basal trichotomy of *Nyrma*, *Manselliberotha* U. Aspöck & H. Aspöck, 1988, and *Cyrenoberothesa* MacLeod & Adams, 1967, remained unresolved and

failed to corroborate recognition of the subfamilies Nyrminae and Cyrenoberothinae, which were however retained as a working hypothesis.

The Rhachiberothinae were primarily described as a subfamily of the Berothidae (Tjeder 1959, 1968), later interpreted to be a subfamily of the Mantispidae (Willmann 1990), and finally elevated to family rank as sister group of the Berothidae within the clade Dilaridae + (Mantispidae + (Berothidae + Rhachiberothidae)) (Aspöck and Mansell 1994). Although this arrangement could not be re-established in a molecular analysis of the Neuropterida (Haring and Aspöck 2004), the sister group relationship Berothidae + Rhachiberothidae was corroborated in the phylogenetic analyses of morphological characters by Aspöck et al. (2001), Beutel et al. (2010), Zimmermann et al. (2011), Randolph et al. (2013, 2014) and in the treatment of genital sclerites by Aspöck and Aspöck (2008).

The present approach is based on the matrix of Aspöck and Nemeschkal (1998), amended by a new homologization of male and female genital sclerites (Aspöck and Aspöck 2008) and the data for three additional genera: *Ormiscocerus* Blanchard, 1851, which was rediscovered by Penny and Winterton (2007), *Berothimerobius*, which was newly described by Monserrat and Deretsky (1999) and *Tanzanberotha* U. Aspöck & Hynd, 1995. *Tanzanberotha* was not included in the analysis of Aspöck and Nemeschkal (1998) because females were unknown, but it was suggested to be part of Nosybiniae (Aspöck and Nemeschkal 1998). Females are still unknown, but the genus was included in the present analysis to test if male characters corroborate *Tanzanberotha* as part of the Nosybiniae.

Berothidae occur throughout most biogeographical regions. Cyrenoberothinae are known from southern South America and southern Africa, Nosybiniae from the Afro-tropical region and South America, Berothinae from most parts of the world with a high diversity in Australia and Africa (Grimaldi and Engel 2005). Nyrminae are known from Anatolia (Aspöck 1989) and Chile (Penny and Winterton 2007, Monserrat and Deretsky 1999). In the present paper the Berothimerobiinae with the single genus *Berothimerobius* are interpreted to be part of the Nyrminae [nov. syn.!). The Protobiellinae are restricted to New Zealand and Australia, and the Trichomatinae to Australia (Aspöck and Nemeschkal 1998, Grimaldi and Engel 2005).

Until now the only identification keys available are for the species of a single genus (e.g. Ardila-Camacho 2013, Winterton 2010) or for the genera or species of a single geographic region (e.g. Aspöck et al. 2013). The present work gives an identification key for all known genera of the Berothidae for the first time. In addition, distribution maps of the genera based on data from literature are provided.

Material and methods

Key

Figures 2–46 and 56–57 were drawn with Adobe Illustrator CS 11.0.0. For the figures in the identification keys

already published figures served as template (Tab. 1, Supplementary file 1) except Figures 19, 22 and 23, which were drawn from photographs of the material in the collection of the Natural History Museum Vienna. The identifying characteristics used in the key are highlighted in grey and/or marked with an arrow.

Distribution maps

Localities were taken from original literature (Supplementary file 2) and listed continuously with a number for each locality in MS Excel 2010 (Supplementary file 3). Plausible locations were set in MS Encarta Professional 2004 (version 13.0.0.0531) and then transferred to copies of Encarta maps with Photoshop Elements 8 (version 8.0) since these cannot be illustrated in Encarta directly. Some of the location marks are super-imposed due to the vicinity of the localities.

Cladistic analyses

The phylogenetic analysis comprises 50 characters for 24 genera and 5 outgroup taxa. The character matrix of As-

pöck and Nemeschkal (1998) was amended to account for newly available data: the homologized characters of the genital sclerites (Aspöck and Aspöck 2008) and data for *Ormiscocerus*, *Berothimerobius* and *Tanzanberotha* from the literature (Penny and Winterton 2007, Monserrat and Deretsky 1999, Aspöck and Hynd 1995). The matrix is consistent on the genus level (Supplementary file 4).

Only informative characters were included in the data matrix. The cladistic analyses were performed with TNT (Goloboff et al. 2008). Space for 500000 trees was reserved in the memory. Analyses were performed under equal and implied weights. For implied weighting (Goloboff 1993), the concavity constant K was set from 3 – 15. For each weighting scheme, traditional analyses with 10 000 replications and TBR saving 20 trees per replication were conducted. The root was *Nallachius* (Dilaridae). Bootstrap values and the Bremer support values were calculated with heuristic search (100 000 replications, 1000 TBR branch swapping replications). For character optimization Winclada (Nixon 2002) was used.

A list of the currently known valid genera and species of Berothidae is provided (Supplementary file 5).

Results

Key to the genera of Berothidae

AUSTRALIA and NEW ZEALAND (Figs 2–16, 47, 48, 54, 55)

1	New Zealand	<i>Protobiella</i>
–	Australia + Barrow Island	2
2	Wings slender, proximally hardly smaller than distally (Fig. 2)	<i>Stenobiella</i>
–	Wings proximally clearly smaller than distally (Figs 3, 4, 5)	3
3	Forewings heavily falcate, gradate row in hindwings with 9–10 cross veins (Fig. 3)	<i>Isoscelipteron</i>
–	Forewings sinuate (Fig. 4) or rounded (Fig. 5), posterior part of the hindwings without gradate row (Fig. 3) or with a few cross veins only (Fig. 5)	4
4	Both fore and hindwings sinuate (Fig. 4)	<i>Trichoma</i> ♂
–	Both fore and hindwings not sinuate	5 ♀, 10 ♂
5	Tergite 9 in ♀ with pseudohypocaudae (Fig. 6)	<i>Austroberothella</i>
–	Tergite 9 in ♀ without pseudohypocaudae	6
6	Gonocoxites 9 in ♀ lacking hypocaudae (Fig. 7)	<i>Trichoberotha</i>
–	Gonocoxites 9 in ♀ with hypocaudae (Figs 8, 9)	7
7	Gonocoxites 9 in ♀ with short hypocaudae (Fig. 8)	<i>Trichoma</i>
–	Gonocoxites 9 in ♀ with long hypocaudae (Fig. 9)	8
8	Pronotum in ♀ with brush of scales (Fig. 10)	<i>disseminata</i> group of <i>Spermophorella</i>
–	Pronotum in ♀ without brush of scales	9
9	Bursa copulatrix in ♀ with coiled basal element (Fig. 11)	<i>Quasispermophorella</i>
–	Bursa copulatrix in ♀ without coiled basal element (Fig. 12)	<i>goobita</i> group of <i>Spermophorella</i>
10	Sternite 9 in ♂ with spectacular spines (Fig. 13)	<i>Austroberothella</i>
–	Sternite 9 in ♂ without spectacular spines	11
11	Gonocoxite complex 10 in ♂ without loops (Fig. 14)	<i>Trichoberotha</i>
–	Gonocoxite complex 10 in ♂ with loops (Figs 15, 16)	12
12	Gonocoxite complex 10 in ♂ with few loops (Fig. 15)	<i>Spermophorella</i>
–	Gonocoxite complex 10 in ♂ with up to 8 screwed loops (Fig. 16)	<i>Quasispermophorella</i>

OLD WORLD

Oriental region (Figs 17–19, 49, 54, 55)

1	Forewing falcate (e.g. Fig. 3) or sinuate (e.g. Fig. 4)	2
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- Forewing not falcate or sinuate 3
- 2 Forewing: pterostigma inconspicuous (e.g. Fig. 3) *Isoscelipteron*
- Forewing: pterostigma dark, distally enlarged (Fig. 17) *Berotha*
- 3 Postocular region globular (Fig. 18) *Lekrugeria*
- Postocular region not globular (Fig. 19) *Nodalla*

OLD WORLD

Palearctic region (Figs 20–24, 50, 54, 55)

- 1 Frons elongated (Fig. 20), forewing venation reticulate (Fig. 21) *Nyrma*
- Frons not elongated (Fig. 22), forewing venation not reticulate 2
- 2 Forewings falcate (e.g. Fig. 3) 4
- Forewings not falcate 3
- 3 Postocular region globular (Fig. 18) *Lekrugeria*
- Postocular region not globular (Fig. 19) *Nodalla*
- 4 Length of scapus 7–10 flagellomeres (Fig. 22) *Podallea*
- Length of scapus 4–5 flagellomeres (Fig. 23) 5
- 5 Hindwings: gradate row with up to 10 cross veins (e.g. Fig. 3) *Isoscelipteron*
- Posterior part of the hindwings without gradate row (e.g. Fig. 4) or with a few cross veins only (Fig. 24) *Asadeteve*

OLD WORLD

Afrotropical region (Figs 22–34, 51, 52, 55)

- 1 Forewings falcate (e.g. Fig. 3) 2
- Forewings not falcate 3
- 2 Scapus length 7–10 flagellomeres (Fig. 22) *Podallea*
[females: spectacular spermatheca complex (Fig. 25); males: spectacular gonocoxit complex 10 (Fig. 26)]
- Scapus length 4 flagellomeres (Fig. 27) *Berlekrumyia*
[females: spermatheca complex simple (Fig. 28); males: gonocoxit complex 10 simple (Fig. 29)]
- 3 Frons elongated (Fig. 30) *Manselliberothera*
- Frons not elongated (Fig. 31) 4
- 4 Postocular region not globular (Fig. 19) *Nodalla*
- Postocular region globular (e.g. Fig. 18) 5
- 5 Costal field of forewing not enlarged (Fig. 32) *Tanzanberothera*
- Costal field of forewing enlarged (Figs 33, 34) 6
- 6 Forewing with gradate row (Fig. 33) *Lekrugeria*
- Forewing without gradate row (Fig. 34) *Nosybus*

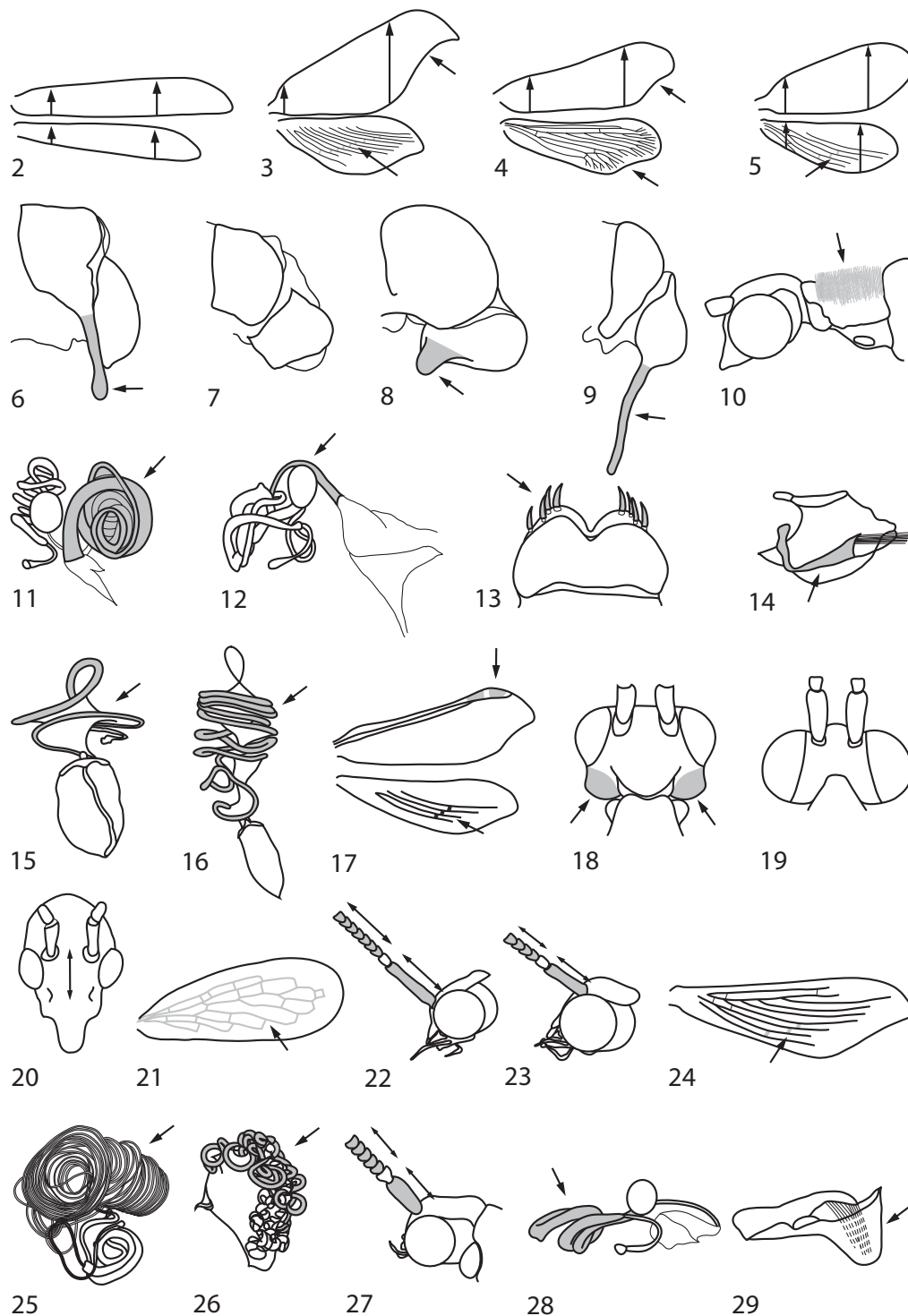
NEW WORLD

Nearctic region, Neotropical region (Figs 35–46, 53, 55)

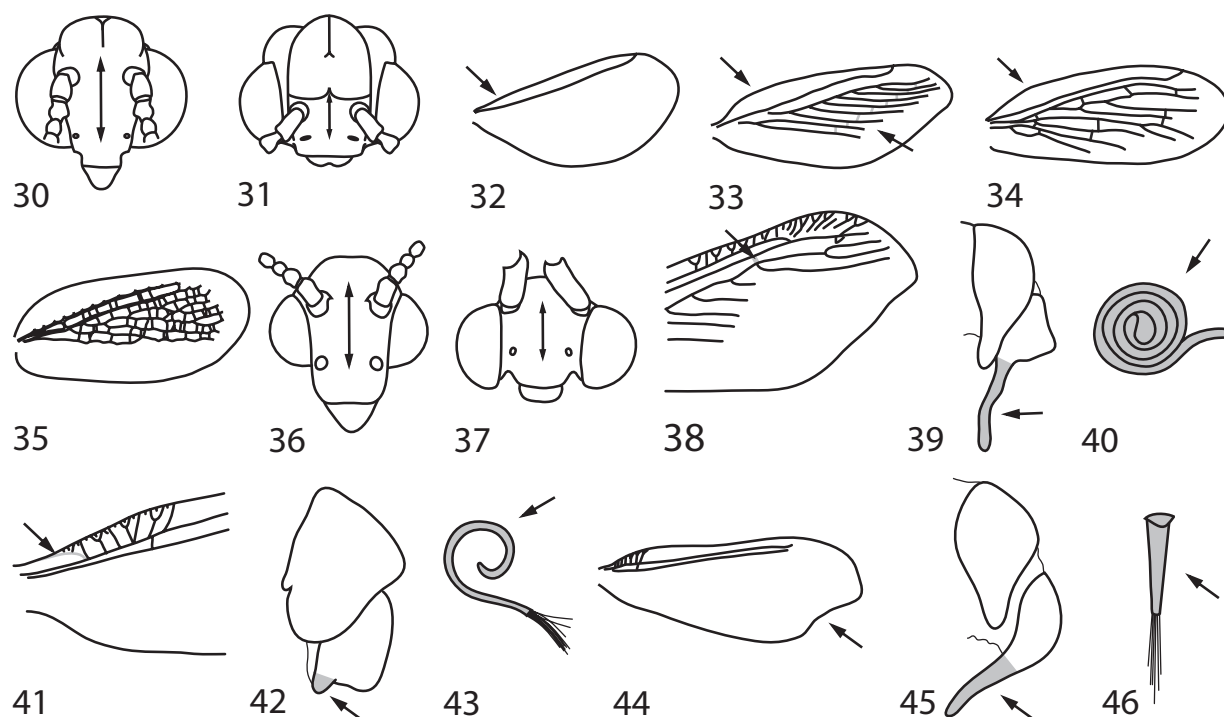
- 1 Forewing venation reticulate (Fig. 35) *Ormiscocerus/Berothimerobius*
- Forewing venation not reticulate 2
- 2 Frons elongated (Fig. 36) *Cyrenoberothera*
- Frons not elongated (Fig. 37) 3
- 3 Forewing with 1 radial crossvein (Fig. 38) *Spiroberothera*
[female: hypocaustae long, finger like (Fig. 39); male: gonocoxite complex 10 coiled (Fig. 40)]
- Forewing with more than 1 radial crossvein 4
- 4 Forewing humeral vein recurrent, apex not falcate (Fig. 41) *Naizema*
[female: hypocaustae short, wart like (Fig. 42), male: gonocoxit complex 10 coiled (Fig. 43)]
- Forewing humeral vein not recurrent, apex falcate (Fig. 44) *Lomamyia*
[female: hypocaustae long, finger like (Fig. 45), male: gonocoxit complex 10 not coiled (Fig. 46)]

Phylogenetically relevant characters

1. *Frons*: short (0), elongate (1), see Aspöck and Nemeschkal (1998, char. 0).
2. *Mouthparts*, position: external (0), sunken into concavity of head (1), see Aspöck and Nemeschkal (1998; char. 1).
3. *Mouthparts*, shortening: no shortening (0), shortening (1), see Aspöck and Nemeschkal (1998; char. 2).
4. *Galea*, elongation: not longer than stipes (0), longer than stipes (1), see Aspöck and Nemeschkal (1998; char. 3).

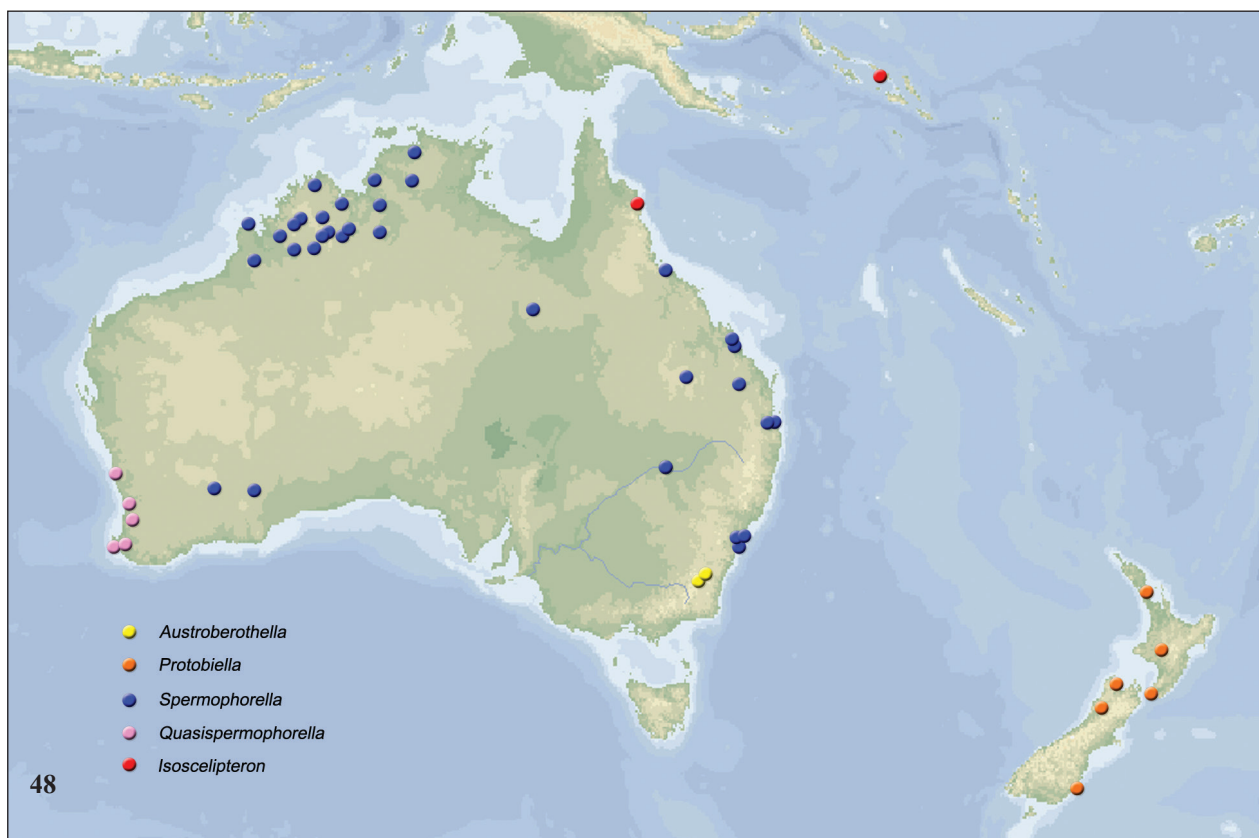
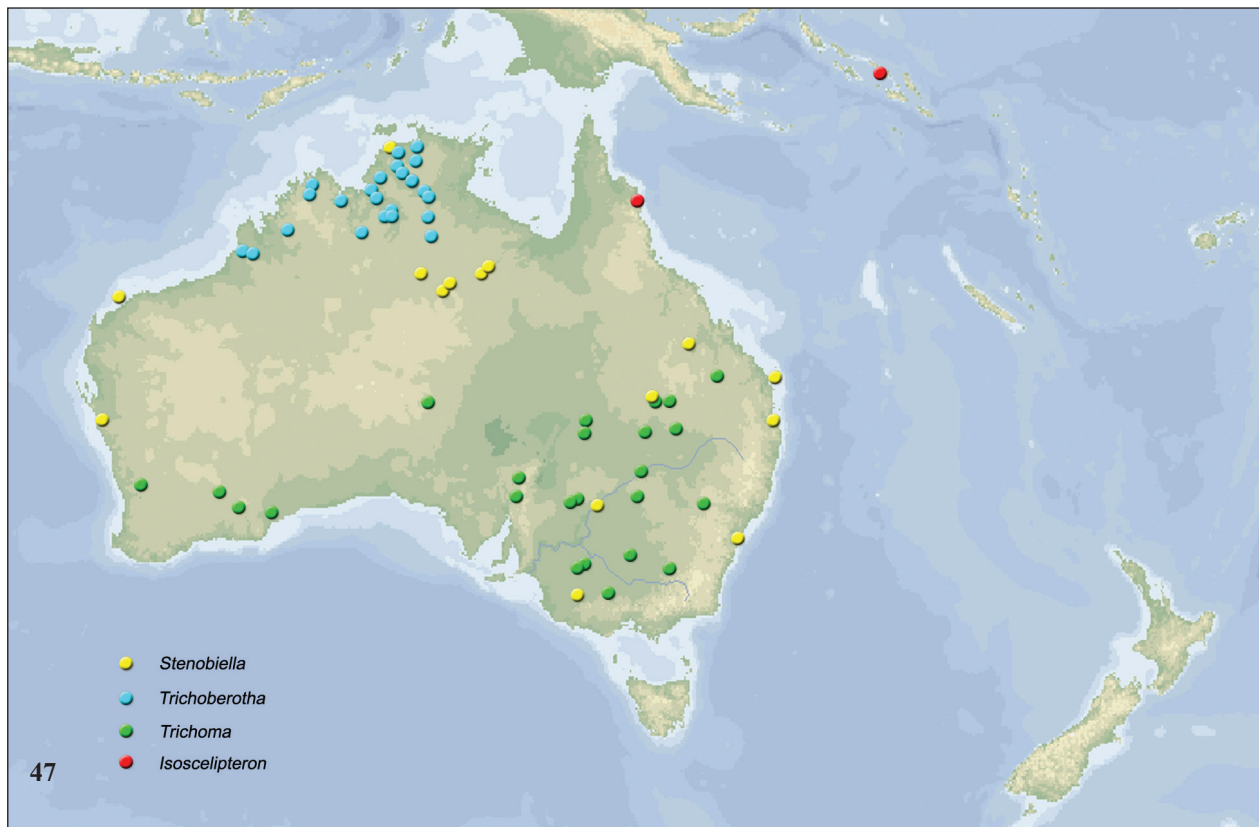


Figures 2–29. Schematic drawings with the identifying characteristics in the key. **2.** *Stenobiella cardaleae* ♂, fore and hind wing; **3.** *Isoscelipteron rufum* ♂, fore and hind wing; **4.** *Trichoma gracilipenne* ♂, fore and hind wing; **5.** *Austroberothella rieki* ♀, fore and hind wing; **6.** *Austroberothella rieki* ♀, genital sclerites, lateral; **7.** *Trichoberotha ferruginea* ♀, genital sclerites, lateral; **8.** *Trichoma gracilipenne* ♀, genital sclerites, lateral; **9.** *Spermophorella goobita* ♀, genital sclerites, lateral; **10.** *Spermophorella* sp. ♀, head and pronotum lateral; **11.** *Quasispermophorella ingwa* ♀, complex of bursa copulatrix and spermatheca; **12.** *Spermophorella goobita* ♀, complex of bursa copulatrix and spermatheca; **13.** *Austroberothella rieki* ♂, sternite 9 ventral; **14.** *Trichoberotha ferruginea* ♂, gonocoxite complex 10; **15.** *Spermophorella kurtbaueri* ♂, gonocoxite complex 10; **16.** *Quasispermophorella ingwa* ♂, gonocoxite complex 10; **17.** *Bertha indica* ♀, fore and hind wing; **18.** *Lekrugeria koenigi* ♀, head dorsal; **19.** *Nodalla saharica*, head dorsal; **20.** *Nyrma kervillea* ♀, head frontal; **21.** *Nyrma kervillea* ♂, forewing; **22.** *Podallea vasseana*, ♀, head lateral; **23.** *Isoscelipteron fulvum*, ♀, head lateral; **24.** *Asadetea vartianorum* ♂, hind wing; **25.** *Podallea arabica* ♀, complex of bursa copulatrix and spermatheca; **26.** *Podallea squamulata* ♂, gonocoxite complex 10; **27.** *Berlekrumyia africanella* ♂, head lateral; **28.** *Berlekrumyia africanella* ♀, complex of bursa copulatrix and spermatheca; **29.** *Berlekrumyia africanella* ♂, gonocoxite complex 10.

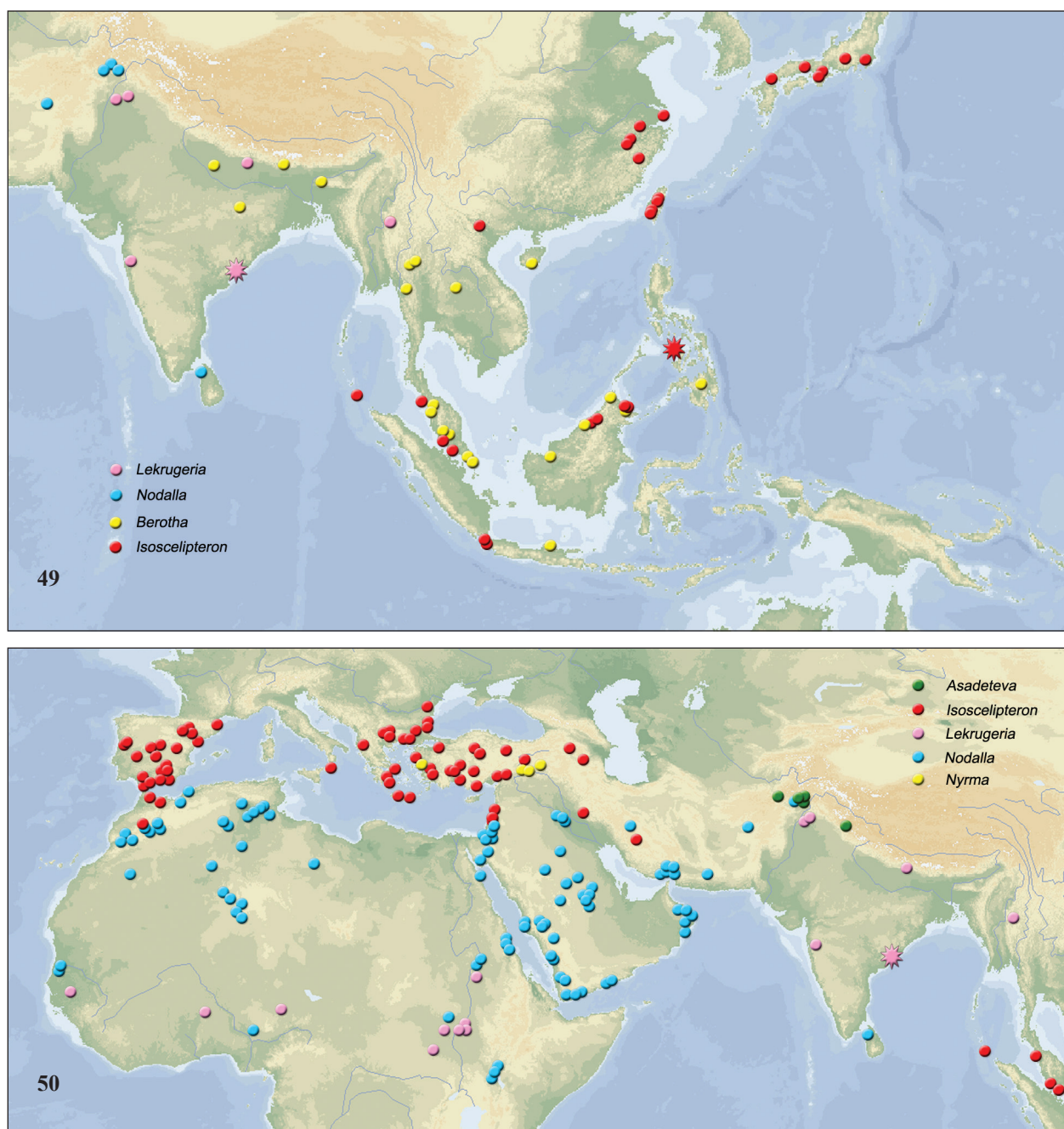


Figures 29–46. Schematic drawings with the identifying characteristics in the key. **30.** *Manselliberothera neuropterologorum* ♀, head frontal; **31.** *Nosybus minutus* ♀, head frontal; **32.** *Tanzanberothera hirsuta*, ♂, fore wing; **33.** *Lekrugeria koenigi* ♀, fore wing; **34.** *Nosybus nobilis* ♂, forewing; **35.** *Ormiscocerus nitidipennis* ♂, forewing; **36.** *Cyrenoberothera penai*, head frontal; **37.** *Spiroberothera sanctarosae* ♂, head frontal; **38.** *Spiroberothera sanctarosae* ♀, forewing; **39.** *Spiroberothera sanctarosae* ♀, genital sclerites, lateral; **40.** *Spiroberothera sanctarosae* ♂, gonocoxite complex 10; **41.** *Naizema mendozina* ♂, forewing; **42.** *Naizema mendozina* ♀, genital sclerites, lateral; **43.** *Naizema mendozina* ♂, gonocoxite complex 10; **44.** *Lomamyia flavicornis*, forewing; **45.** *Lomamyia latipennis* ♀, genital sclerites, lateral; **46.** *Lomamyia latipennis*, ♂, gonocoxite complex 10.

5. Antennal scape, length: at most twice the length of the pedicellus (0), about four times the length of the pedicellus (1), about six times the length of the pedicellus (2), see Aspöck and Nemeschkal (1998; char. 4).
6. Pronotum, transverse furrows: present (0), absent (1), see Aspöck and Nemeschkal (1998; char. 5).
7. Pronotum, number of transverse furrows: one (0), two (1), see Aspöck and Nemeschkal (1998; char. 5).
8. Pronotum, length: about as long as broad (0), shortened (1), elongate (2), see Aspöck and Nemeschkal (1998; chars 6, 7).
9. Thorax, scales: absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 9).
10. Forelegs: cursorial (0), raptorial (1), see Aspöck and Nemeschkal (1998; char. 10).
11. Wings, apex: rounded (0), subfalcate to slightly falcate (1), strongly falcate (2), see Aspöck and Nemeschkal (1998; char. 11).
12. Pterostigmal region: distinct (0), absent (1), see Aspöck and Nemeschkal (1998; char. 13).
13. Forewing, recurrent humeral vein: present (0), absent (1), see Aspöck and Nemeschkal (1998; char. 14).
14. Forewing, stems of R and M: separate to base (0), fused at or before base (1), see Aspöck and Nemeschkal (1998; char. 15).
15. Forewing, vein "b", proximal of MP fork: present (0), absent (1), see Aspöck and Nemeschkal (1998; char. 16).
16. Forewing, number of sc-r crossveins: 0–2 (0), 3–5 (1), see Aspöck and Nemeschkal (1998; char. 17).
17. Forewing, number of CuA branches: one (0), two or more (1), see Aspöck and Nemeschkal (1998; char. 18).
18. Forewing, A1 vein, distal branching: with simple dichotomous marginal branching (0), additional marginal branching (1), "creeping" (=pectinate, with only short veinlets along wing margin) (2), no branching (3), see Aspöck and Nemeschkal (1998; char. 19).
19. Hindwing, stems of R and M: free (0), fused at base (1), see Aspöck and Nemeschkal (1998; char. 20).
20. Hindwing, vein "b" (free basal part of MA): sinuate (0), crossvein-like (1), absent (2), see Aspöck and Nemeschkal (1998; char. 21).
21. Hindwing, base of CuP: present (0), absent (1), see Aspöck and Nemeschkal (1998; char. 22).
22. Hindwing, distal part of CuP: simply forked (0), "creeping" (=pectinate, with only short veinlets along wing margin) (1), absent (2), see Aspöck and Nemeschkal (1998; char. 23).
23. Female: wings, scales: absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 24).
24. Male: tergite 9 and ectoproct: free, not fused (0), fused (1), see Aspöck and Nemeschkal (1998; char. 26).
25. Male: sternite 9, caudal region: unpaired (0), paired (1).



Figures 47–48. Distribution maps of the genera of Berothidae from Australia and New Zealand.



Figures 49–50. Distribution maps of the genera of Berothidae from **49.** Oriental and **50.** Palearctic region. Asterisks indicate specimens with imprecise locality.

26. Male: size of sternit 9 compared with sternite 8: of similar length (0), reduced (1), enlarged (2), see Aspöck and Nemeschkal (1998; chars 28, 29).
27. Gonocoxit complex 11, dorsocaudal protrusion: absent (0), present (slender) (1), present (prominent) (2), see Aspöck and Nemeschkal (1998; char. 30).
28. Gonocoxit complex 11, fusion with gonocoxites 9: gonocoxite complex 11 associated with gonocoxites 9, but clearly separate (0), gonocoxite complex 11 partially fused with gonocoxites 9 (1), gonocoxite complex 11 amalgamated with gonocoxites 9 (2), gonocoxite complex 11 associated with ectoproct (3), see Aspöck and Nemeschkal (1998; chars 31, 32).
29. Male: ninth gonocoxites, anterior apodeme: absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 33).
30. Gonocoxit complex 10, lateral sclerites: absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 34).
31. Gonocoxit complex 10, bristles: absent (0), present (1), see Aspöck and Nemeschkal (1998; chars 35, 36).
32. Gonocoxit complex 10, length and arrangement of bristles: short and scattered (0), long and bundled (1), see Aspöck and Nemeschkal (1998; chars 36, 37).
33. Gonocoxit complex 10, formations of bristles: simple bow (0), looped (1), thread-like (2), straight (3), see Aspöck and Nemeschkal (1998; chars 38, 39).

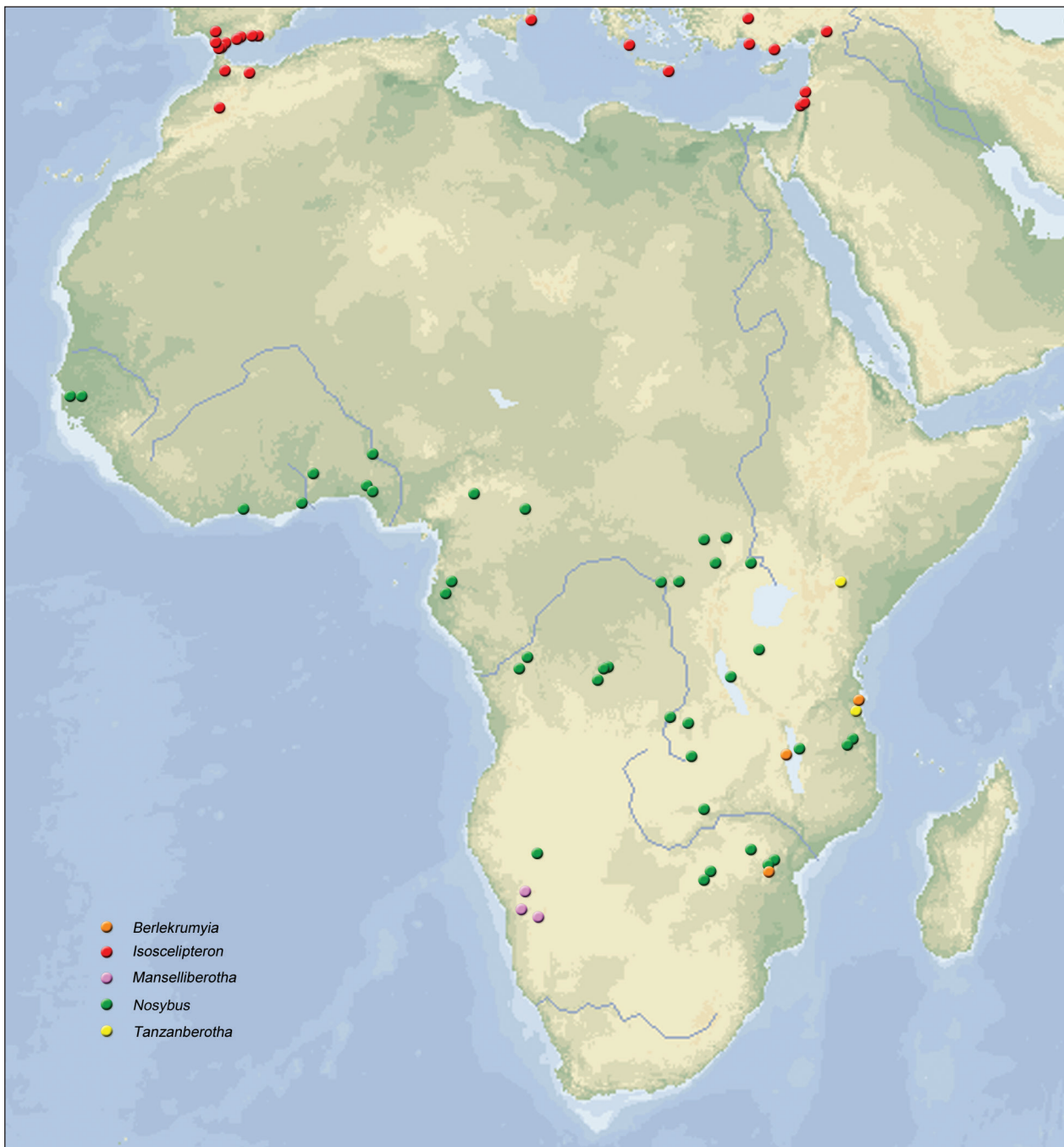


Figure 51. Distribution map of the genera of Berothidae from Afrotropical region and the westernmost records of *Isoscelipteron*.

34. *Torulus* (sclerite dorsally above the gonocoxite complex 11): absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 41).
35. Female: tergite 9 and ectoproct: separate (0), fused, see Aspöck and Nemeschkal (1998; char. 42).
36. Female: tergite 9, ventral extremities: continuous with dorsal arch (0), divided from dorsal arch (1), see Aspöck and Nemeschkal (1998; char. 43).
37. *Pseudohypocaudae*: absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 44).
38. *Hypocaudae*: absent (0), short (1), long (2), extremely long (3), see Aspöck and Nemeschkal (1998; char. 45).
39. Female: sternite 7: semiannular, posterior margin transverse (0), bilobed, posterior margin distinctly emarginate (1), consisting of a pair of lateral sclerites (gonocoxites 7) (2), see Aspöck and Nemeschkal (1998; char. 46).
40. Female: posterior region of sternum 7, pair of sclerite disks (gonapophyses 7): absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 47).
41. Female: sternite 8: well developed, reaching tergite 8 laterally (0), reduced, not reaching tergite 8 laterally (1), obliterated (2), see Aspöck and Nemeschkal (1998; char. 48).

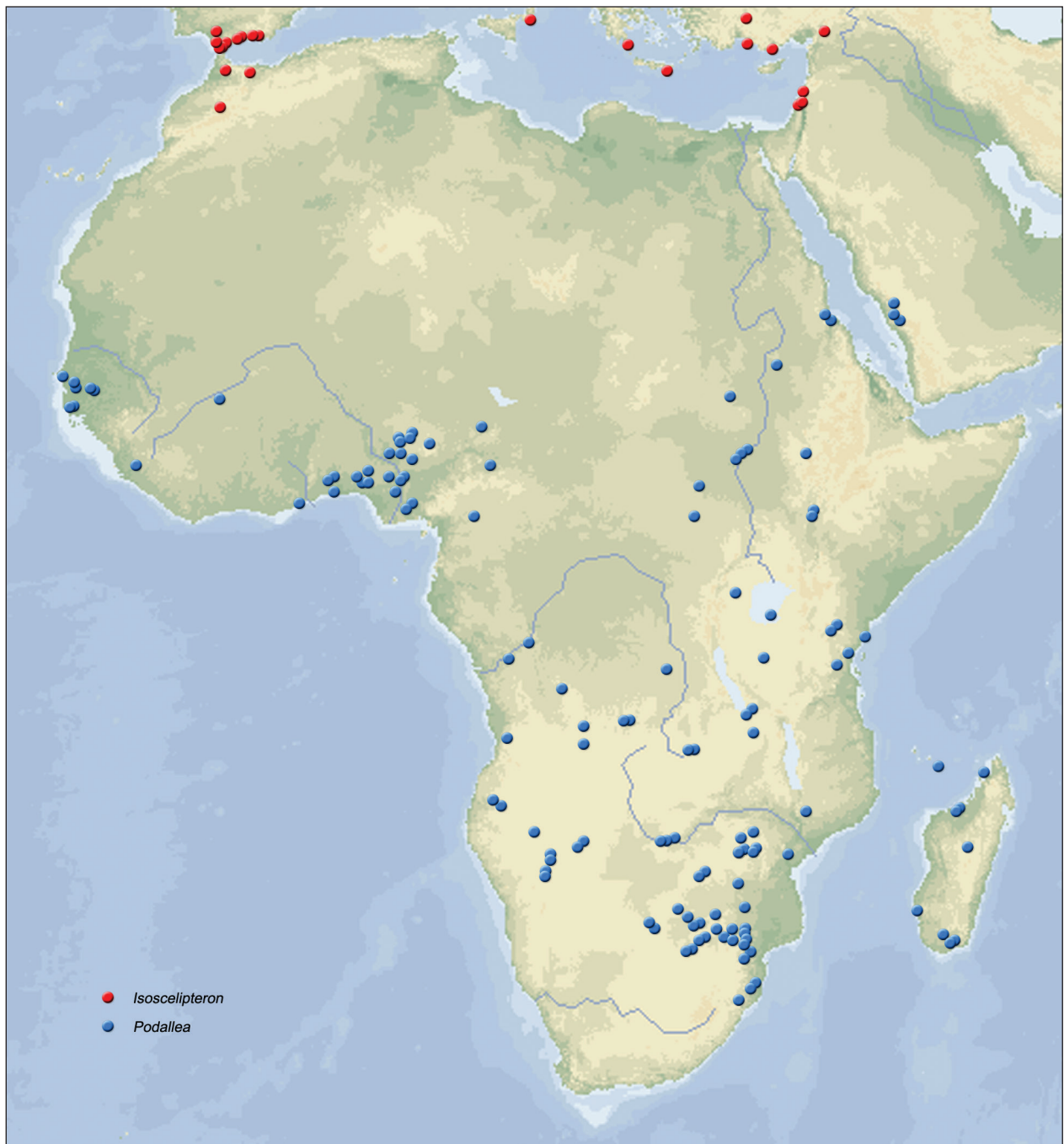


Figure 52. Distribution map of *Podallea* from Afrotropical region and the westernmost records of *Isoscelipteron*.

42. Female: sternite 8, ventral processus: absent (0), present, one pair processus (1), present, one median processus (2), see Aspöck and Nemeschkal (1998; char. 49).

43. Pudiculum: absent (0), present, well developed (1), present, reduced (2), see Aspöck and Nemeschkal (1998; char. 50).

44. Bursa copulatrix, size: small (0), large (1), see Aspöck and Nemeschkal (1998; char. 51).

45. Bursa copulatrix, sclerotization: membranous (0), sclerotized (1), see Aspöck and Nemeschkal (1998; char. 51).

46. Receptaculum seminis, globular element: globular (0), elongate (1), see Aspöck and Nemeschkal (1998; char. 52).

47. Ductus receptaculi: short (0), elongate (1), coiled (2), see Aspöck and Nemeschkal (1998; char. 53).

48. Foretarsus, male/female: 5-segmented in male and female (0), 4-segmented in male, 5-segmented in female (1), 4-segmented in male and female (2), see Aspöck and Nemeschkal (1998; char. 55).

49. Long ovipositor: absent (0), present (1), see Aspöck and Nemeschkal (1998; char. 56).

50. Forecoxae of males: not inflated (0), inflated (1).



Figure 53. Distribution map of the genera of Berothidae from Nearctic and Neotropical region.

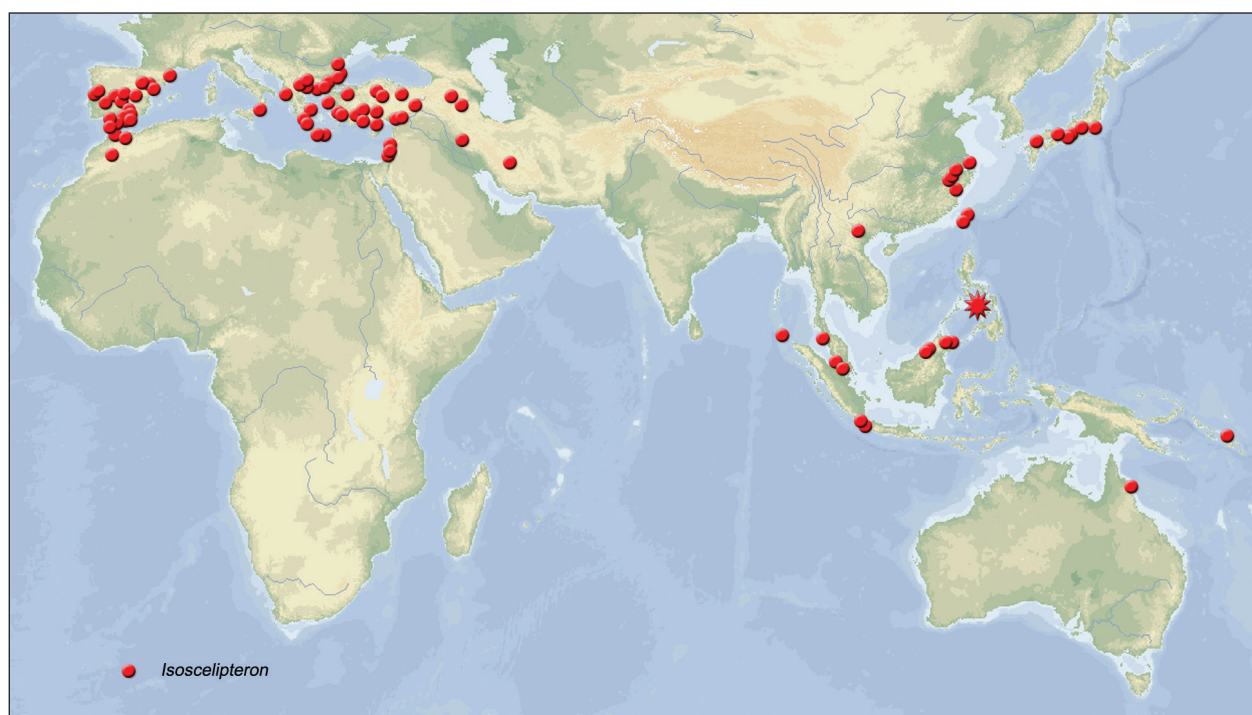


Figure 54. Distribution map of the genus *Isoscelipteron* worldwide. Asterisk indicates specimen with imprecise locality.

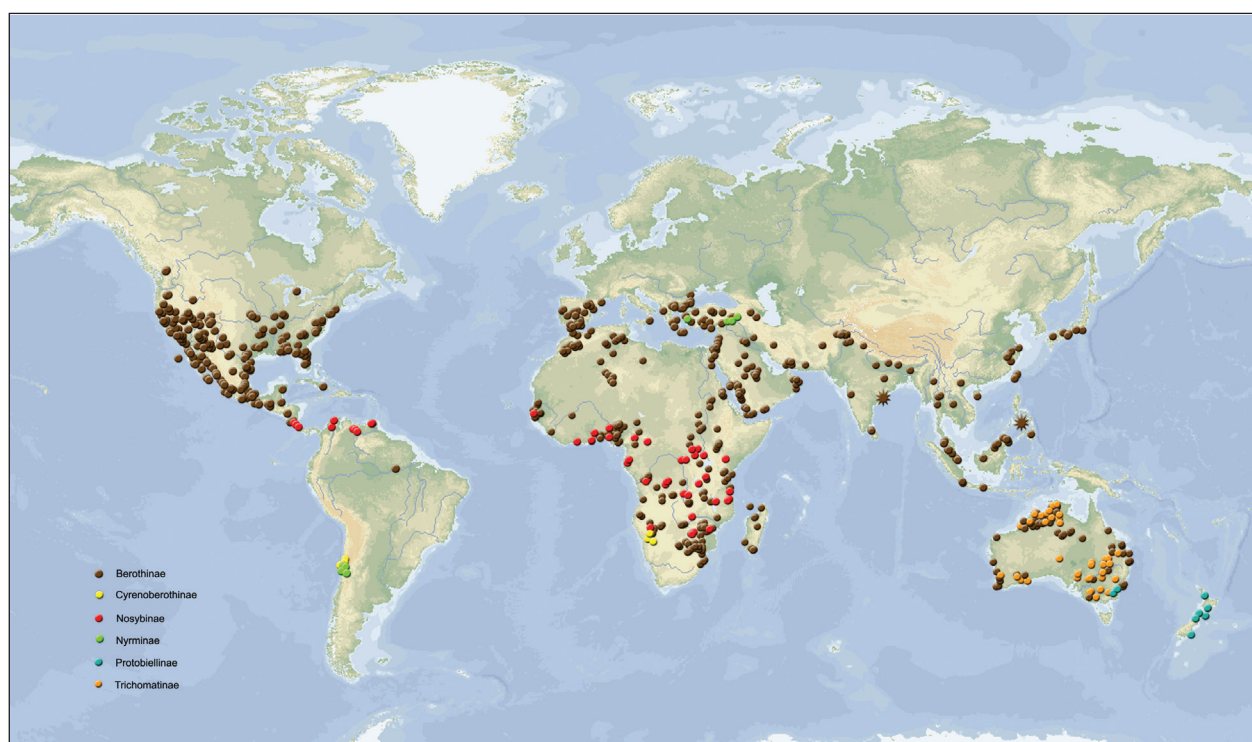


Figure 55. Distribution map of the subfamilies of Berothidae worldwide. Asterisks indicate specimens with imprecise locality.

Cladistic analyses

The analysis using equal weights yielded twenty most parsimonious trees (MPTs) with a length of 209 steps, a consistency index (CI) of 0.34, and a retention index (RI) of 0.6. Bremer Support values and Bootstrap values are indicated in Fig. 57. In the MPTs the position of *Nyrma*

is very unstable: it took any possible position within the Nyrminae, and in two trees the genus was sister group to the Cyrenoberothinae. *Naizema*, belonging to the Nosybinae, consistently resulted as sister group of the Trichomatinae in the MPTs. *Spiroberotha*, another

nosybinae genus, switched between a position as sister group of *Nosybus* + *Tanzanberotha* within the Nosybinae, and a position as sister group of *Naizema* + Trichomatinae. Within the Berothinae, *Stenobiella* switched between being sister to all except *Berlekrumyia* and sister to all except *Berlekrumyia* plus the clade (*Podallea* + (*Nodalla* + *Asadeteva*)).

Three different topologies were retrieved by implied weighting with K3-15, none of which represents a MPT. Weighting with K3-4 and K6 yielded a tree that is 212 steps long, as did weighting with K5. These two tree topologies differ only in the position of *Stenobiella* which is the sister group of *Nodalla* + *Asadeteva* under K5, and sister group of a larger clade comprising *Nodalla* + *Asadeteva* as well as *Podallea* and the *Isoscelipteron* clade. The two tree topologies are consistent in that *Podallea* is the sister group of the *Isoscelipteron* clade, and in Trichomatinae being the sister group to Nosybinae + Berothinae. Implied weighting with K7-15 yielded a tree with 210 steps. In that tree, the subfamily Nosybinae was not retrieved as monophyletic since the nosybinae genus *Naizema* was the sister group of the Trichomatinae as in all MPTs.

Discussion

Biogeography

The distribution areas of berothid genera are extremely diverse. At present they cannot be assigned to known general patterns, although they certainly contribute to an understanding of their biogeography.

The **Australian region** (Figs 47, 48) comprises 8 genera (representing 27 described species), all of them – with only one exception, *Isoscelipteron* – are endemic. Some have undergone an amazing radiation, e.g. *Stenobiella*, with 12 described species and more awaiting description. *Stenobiella* has the largest distribution area, mainly occurring in the eastern half of the continent but with two vicariant species in the west. *Trichoberotha*, comprising two species, is restricted to northwestern Australia, the vicariant monotypic sister group *Trichoma* has a much larger distribution area in the southern half of the continent. *Quasispermophorella* is characterized by vicariant distribution areas of its two species in south-western and south-eastern parts of the continent. *Spermophorella* comprises six species which are disjunctly distributed along northern, eastern and southern borders of the continent. *Isoscelipteron* is distributed in the northeast, nested between the disjunct distribution areas of *Spermophorella*. The origin of the distribution pattern is not yet understood for the monotypic *Austroberothella* with two species in the southeast of the continent and its monotypic sister group *Protobiella* from New Zealand.

The **Oriental region** (Figs 49, 54, 55) comprises four genera with altogether 16 species. The most diverse genus *Berotha* with altogether five species is endemic to the Oriental region and is scattered over large areas of this

realm. The genus *Isoscelipteron* is recorded with four species from several islands in the Oriental realm and apparently has its main diversification in this region (with only two other species in the Palearctic and one in the Australian region). *Lekrugeria* occurs in the northwestern transition-zone to the Palearctic region with two species (and another in the Afrotropical region, see below). The record of one species of *Nodalla* (predominantly distributed in Palearctic Africa, see below) from Sri Lanka might be mislabelled.

The **Palaeartic region** (Figs 50, 54, 55) comprises five genera representing 15 described species. *Nodalla* is an element of the Eremic and distributed within the West Palearctic desert belt from northwestern Africa throughout the Arabian Peninsula to Afghanistan. With eleven known species it is the most diverse Palearctic genus (Aspöck and Aspöck 1998). Whether the intra-generic differentiations date back to the Pleistocene or are much older remains speculative at present. *Isoscelipteron*, which is predominantly known from the Oriental (see above) and Australian regions (one species), is represented by a western-mediterranean and an eastern-mediterranean species. *Asadeteva* is known from two species in Pakistan and Afghanistan, respectively, both from high altitudes (1400 m – 1800 m). The species are certainly Palaeartic elements, however occupy a transition zone to the Oriental realm. The monotypic enigmatic genus *Nyrma* which is so far only known from Anatolia has a highly disjunct Neotropical sister group (*Ormiscocerus* + *Berthimerobius* Fig. 53). This vicariance pattern is not typically Gondwanan and is not yet understood.

The **Afrotropical region** (Figs 51, 52, 55) comprises six genera, representing 26 species. The most diverse genus *Podallea* is represented by 15 species. Its distribution is confined to the Afrotropical region, including the southwestern part of the Arabian Peninsula, Madagascar and the Comoro Islands. All *Podallea* species are arboreal elements. The extant distribution patterns are probably mainly the result of vicariance events apparently long before the Pleistocene (Aspöck and Aspöck 1981, 1996). The five species from Madagascar are closely related or identical with the *Podallea* species from the African mainland and are certainly the result of not very old colonizations (Aspöck et al. 2010). *Nosybus* (comprising seven species) and its monotypic sister group *Tanzanberotha* from Tanzania and Kenya are endemic to the Afrotropical region. Their common Neotropical sister group (*Spiroberotha* + *Naizema*) demonstrates a classical Gondwanan vicariance pattern (but see the above mention of the conflict with the Australian Trichomatinae). *Lekrugeria* comprises one Afrotropical species which is distributed along a sub-Saharan belt and two other species occurring in Northern India and Nepal in a small transition zone of the Palearctic and the Oriental regions. The genus represents a Palaeartic-Subsaharan-Oriental pattern, which is unique among Berothidae (Aspöck and Aspöck 1986 c). The monotypic endemic genus *Manseliberotha* from southern Africa exemplifies another

Gondwanan vicariance pattern with its sister group, the Neotropical *Cyrenoberotha*. The monotypic isolated genus *Berlekrumyia* which is recorded from southern Africa is endemic to the Afrotropical region.

Berothidae of the **Nearctic** and **Neotropical regions** (Figs 53, 55) predominantly occupy the southern parts of North America, as well as parts of Central and South America. The most common taxon is *Lomamyia*, vicariant to all other Berothinae which are restricted to other continents. The genus comprises 12 species, 10 in North America, one in Central America and one in eastern South America. All other genera of this region represent relic taxa, with one or two species only; however, they are characterized by vicariant sister groups in the Old World. The monotypic genera *Ormiscocerus* and *Berothimerobius* are endemic to Chile. The transoceanic vicariance with their joint sister group *Nyrma* from Anatolia does not fit into any of the typical Gondwanan patterns. The monotypic relic genus *Cyrenoberotha* is endemic to Chile, representing the Neotropical counterpart to *Manselliberotha* from the Afrotropical region. It may be interpreted as a typical Gondwanan pattern – however, its origin is not yet understood. *Spiroberotha* (two species) from Central America and northern South America and the vicariant *Naizema* (two closely related species or monotypic) from southern South America represent an unknown pattern (both belonging to the otherwise Afrotropical Nosybinae).

In summary, it can be stated that the distribution patterns of berothid genera are extremely heterogeneous. Their origin, biogeographic and biological backgrounds and their congruence with general patterns are far from being understood.

- 1) Two types of Gondwanan patterns are distinguishable: Neotropical / Afrotropical vicariance on the one hand, represented e.g. by *Cyrenoberotha* / *Manselliberotha* (Figs 51, 53), and Afrotropical / Australian vicariance and on the other hand, e.g. represented by *Podallea* (Fig. 52) and the *Isoscelipteron* clade (Fig. 47).
- 2) One genus, *Lekrugeria*, marks a sub-Saharan Palearctic belt which extends to the Palearctic/Oriental transgression zone (Fig. 50).
- 3) The genus with the largest and highly vicariant distribution area, *Isoscelipteron*, comprises the Palearctic, Oriental and Australian regions (Fig. 54).
- 4) Finally: Endemism is a very common phenomenon among Berothidae, with radiations of genera within biogeographic realms, on one hand, or as monotypic enigmatic locus typicus relics, on the other hand.

Phylogeny

The results of our cladistic analyses will be discussed in the context of previous results reported in Aspöck and Nemeschkal (1998), on one hand, and concerning their plausibility, on the other hand. Prima vista it can be emphasized that the Rhachiberothidae (Figs 56, 57: *Mucroberotha* + *Rhachiberoth*), which in the present

analysis was part of the out-group, is corroborated as a discrete family, which has already been advertised by Aspöck and Mansell (1994). This contrasts with the interpretation of the rhachiberothids as a subfamily of the Berothidae which was originally proposed by Tjeder (1959) and more recently advocated by Winterton et al. (2010).

Generally, it is noteworthy that the trees retrieved with strong implied weighting (K3-6) are mostly congruent with the previous analysis by Aspöck and Nemeschkal (1998), while major conflicts emerge in the MPTs and the trees with implied weighting above K7. Conflicts in the shorter trees (MPTs and K7+) concern the Trichomatinae (Fig. 56: TRI) appearing as part of the Nosybinae (Fig. 56: NOS) and the position of the genus *Podallea* as sister to *Nodalla* + *Asadeteva* within the Berothinae (Fig. 56: BER).

Within the Nosybinae the genus *Nosybus* (comprising seven species) and the monotypic *Tanzanberotha*, both from the Afrotropics (Fig. 51), emerged as the sister group of *Spiroberotha* (two species) from the Neotropical region (Fig. 53). These three genera are the sister group of the Neotropical *Naizema* (two species). Yet, the Trichomatinae appear as sister group of *Naizema* and thus within the Nosybinae in all shorter trees. However, this result lacks plausibility, since the complex of the gonocoxites 10 in the Nosybinae is highly differentiated, enlarged and rolled up, whereas in the Trichomatinae the complex is simple. In Aspöck and Nemeschkal (1998) and in the trees obtained by implied weighting with K3-6, the Trichomatinae are the sister group of Nosybinae + Berothinae. The Trichomatinae are endemic in the Australian region (Fig. 47) and comprise two genera: the monotypic *Trichoma* and *Trichoberotha* (with two species).

The Berothinae represent the largest clade of Berothidae and emerged as a monophylum in all trees (Figs 56, 57). They comprise 11 genera: *Asadeteva* (two species from Asia, Fig. 50), *Nodalla* (11 species from northern Africa, Fig. 50), *Stenobiella* (12 species endemic to Australia, Fig. 47), *Berotha* (five species, Oriental region, Fig. 49), *Lekrugeria* (three species, Sub Sahara and Asia, Fig. 49, 50), and *Lomamyia* (12 species, Neartic and Neotropical region, Fig. 53). The monotypic Afrotropical *Berlekrumyia* appears as the sister group to the rest in all MPTs, as in Aspöck and Nemeschkal (1998), but not in the trees obtained by implied weighting with K3-6, where *Lomamyia* holds this position. The *Podallea* clade comprises the Afrotropical *Podallea* (with 15 species), the *Isoscelipteron* clade with *Isoscelipteron* (Palearctic, Oriental and Australian regions with 13 species) and *Quasispermophorella* (two species) + *Spermophorella* (six species) with the latter two genera being endemic to the Australian region (Fig. 48). The monophyly of the *Podallea* clade was one of the highlights in the study by Aspöck and Nemeschkal (1998) and was a most convincing result. In the present analysis this relationship was obtained by implied weighting with K 3-6. However, it is most surprising and lacks plausibility that in the MPTs and under implied weighting with K7-15 (compare strict consensus Fig. 57), *Podallea* emerged consistently as

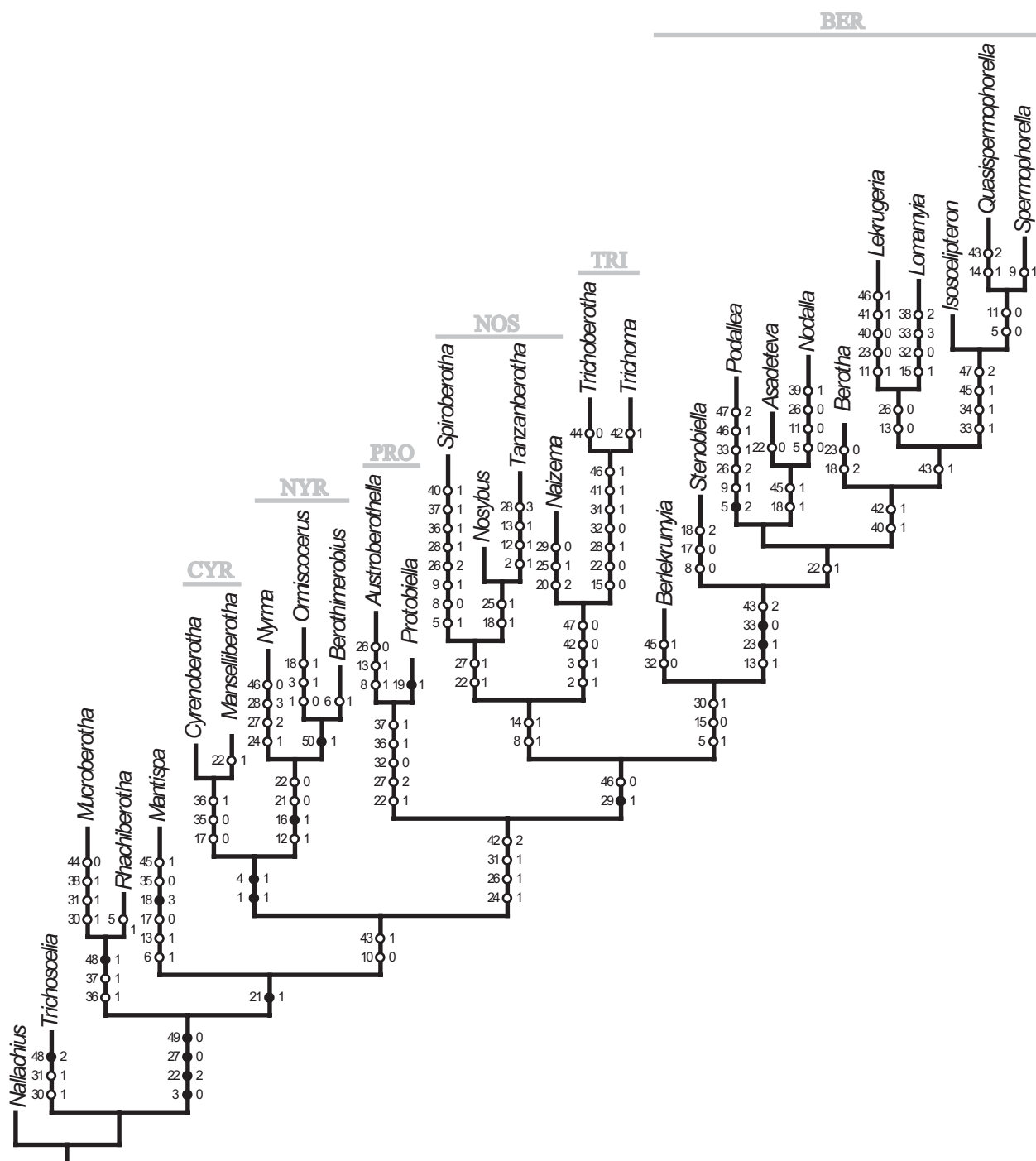


Figure 56. Preferred tree of 20 most parsimonious trees produced by exhaustive search under equal weights with unambiguous character optimization (209 steps, CI = 0.34, RI = 0.6). Black circles indicate unique synapomorphies, white circles homoplastic ones. BER – Berothinae, CYR – Cyrenoberothinae, NOS – Nosybininae, NYR – Nyrmia, PRO – Protobiellinae, TRI – Trichomatinae.

the sister group of *Asadeteve* + *Nodalla*. The characters 33.1 (male: complex of gonocoxites 10 looped) and 47.2 (female: ductus receptaculi coiled), which in our understanding are clearly synapomorphies of *Podallea* and the *Isoscelipteron* clade, occur as homoplasies in those trees.

One character complex that is highly interesting in the context of Berothinae and Nosybininae phylogeny is a conspicuous formation of the female sternal region of the abdominal segment seven (chars. 39 and 40): Hairy

domed lateral sclerites, interpreted as gonocoxites seven, accompanied by smooth and weakly sclerotized discs which are interpreted as gonapophyses seven (Aspöck and Aspöck 2008). It is present in the Nosybininae genus *Spiroberotha* and in several genera of Berothinae (*Lomamyia*, *Berotha*, *Podallea*, *Isoscelipteron*, *Quasispermophorella* and *Spermophorella*) and is unique among Berothidae. Due to the peculiarity of the structures, an independent development is rather unlikely. Thus the

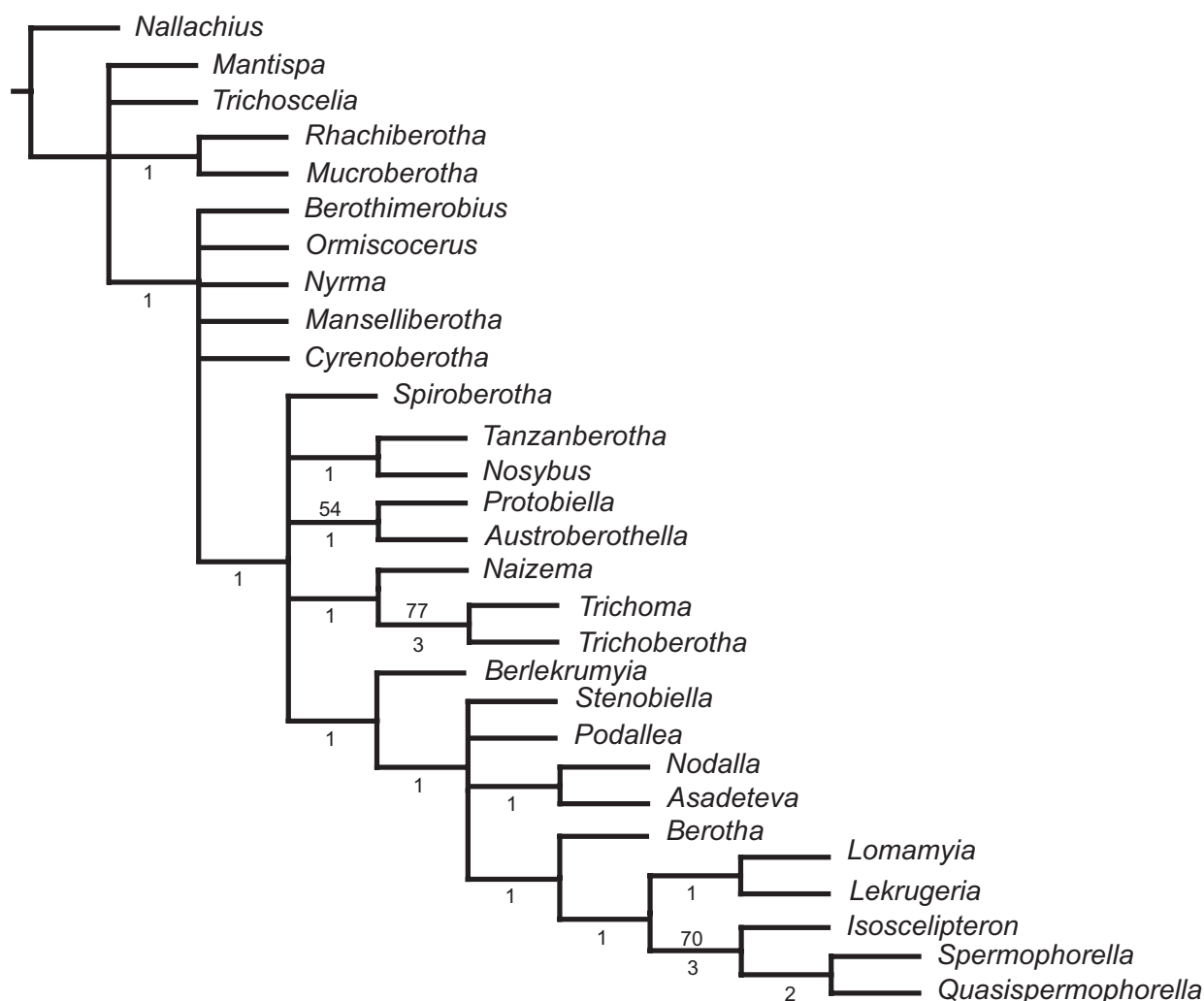


Figure 57. Strict consensus tree produced by exhaustive search under equal weights with bootstrap values over 50% (above) and Bremer support values (below).

question remains whether it is in fact a synapomorphy of Nosybinae + Berothinae with secondary reductions in some genera, or whether *Spirobertha*, a genus which also switches positions in the present analysis, might belong to the Berothinae. The condition of the seventh female abdominal segment is a phenomenon restricted to this subfamily. In a larger context it rises the question whether this differentiation of the seventh sternite is a re-expression tracing back to the combined nature of the abdominal sternites (Aspöck and Aspöck 2008).

The Nyrminae (Fig. 55, Fig. 56: NYR) comprise the hitherto monotypic *Nyrma* from Anatolia (Fig. 50) and *Ormiscocerus* + *Berothimerobius*, both monotypic genera from Chile (Fig. 53). All three genera are apparently old relics from Gondwana (although they do not show a typical Gondwanan vicariance pattern). Character 16.1 (more than three sc-r crossveins in the forewing) is a synapomorphy of *Nyrma*, *Ormiscocerus* and *Berothimerobius* (Fig. 56). The inflated forecoxae of the males (char. 50.1) of *Ormiscocerus* and *Berothimerobius* are a very striking synapomorphy of the two genera (Fig. 56) which are geographically very close together (Fig. 53).

Concluding remarks

The discussion of the distribution areas of the genera on a worldwide scale serves as a brain storming exercise for a forthcoming biogeographic analysis which would be premature at the present state of berothid phylogeny. Nevertheless, we expect a positive cybernetic aspect in presenting both approaches. That our phylogenetic tree should be understood as starting point for falsification does not need to be emphasized.

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References

(Including references for the templates of Figs 2–46)

- Adams P A (1989) A new genus of Berothidae from tropical America, with two new species. *Psyche* 96: 187–193. doi: 10.1155/1989/39647
- Ardila-Camacho A (2013) First record of Beaded Lacewings (Neuroptera, Berothidae) from Colombia. *Zootaxa* 3669(2): 159–164. doi: 10.11646/Zootaxa.3669.2.7
- Aspöck U (1983) Das Genus *Berotha* Walker (Neuropteroidea: Planipennia: Berothidae). *Annalen des Naturhistorischen Museums in Wien* 84B: 463–478.
- Aspöck U. (1986) The present state of knowledge of the family Berothidae (Neuropteroidea: Planipennia). In: Gepp J, Aspöck H, Hölzel H (Eds) Recent Research in Neuropterology. Proceedings of the 2nd International Symposium on Neuropterology. Privately printed, Graz, Austria, 87–101.
- Aspöck U (1989) *Nyrma kervillea* Navás – eine Berothide! (Neuropteroidea: Planipennia). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 41: 19–24.
- Aspöck U, Aspöck H (1979) *Nyrma kervillea* Navás – Wiederentdeckung einer systematisch isolierten Hemerobiiden-Spezies in Kleinasien. *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 31: 92–96.
- Aspöck U, Aspöck H (1981a) Das Genus *Podallea* Navás, 1936 (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 32: 81–96.
- Aspöck U, Aspöck H (1981b) Weitere Untersuchungen an Berothiden: *Berotha* Walker, *Isoscelipteron* Costa und *Asadetea* n. g. (Neuropteroidea: Planipennia). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 33: 1–14.
- Aspöck U, Aspöck H (1984) Die Berothiden Australiens I: Neue Spezies des Genus *Stenobiella* Tillyard (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 36: 17–32.
- Aspöck U, Aspöck H (1985) Die Berothiden Australiens (und Neuseelands) II: Die Genera *Trichoma* Tillyard, *Trichoberothes* Handschin, *Protobiella* Tillyard und *Austroberothella* n. g. (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 36: 65–85.
- Aspöck U, Aspöck H (1986a) Die Berothiden Australiens III: Die Genera *Spermophorella* Tillyard und *Quasispermophorella* n. g. (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 38: 17–34.
- Aspöck U, Aspöck H (1986b) Die Berothiden Australiens IV: Weitere Untersuchungen über das Genus *Spermophorella* Tillyard (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 38: 89–102.
- Aspöck U, Aspöck H (1986c) Das Genus *Lekrugeria* Navás (Neuropteroidea: Planipennia: Berothidae: Berothinae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 37: 85–98.
- Aspöck U, Aspöck H (1988a) *Berlekrumyia africanella* n. g. et n. sp. und *Podallea manselli* n. sp. – zwei neue Berothiden-Spezies aus Südostasien (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 39: 113–123.
- Aspöck U, Aspöck H (1988b) Die Subfamilie Cyrenoberothinae – ein Gondwana-Element? *Manselliberotha neuropterologorum* n. g. et n. sp. aus S.W.A./Namibia (Neuropteroidea: Planipennia: Berothidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* 40: 1–13.
- Aspöck U, Aspöck H (1988c) Die Berothiden Australiens V: Zur Systematischen Stellung von *Austroberothella rieki* U. A. and H. A. (Mit einem kurzen Überblick über die Erforschung der Berothidae Australiens) (Neuropteroidea: Planipennia). *Stapfia* 17: 135–146.
- Aspöck U, Aspöck H (1996) Revision des Genus *Podallea* Navás, 1936 (Neuroptera: Berothidae: Berothinae). *Mitteilungen der Münchner Entomologischen Gesellschaft* 86: 99–144.
- Aspöck U, Aspöck H (2008) Phylogenetic relevance of the genital sclerites of Neuropterida (Insecta: Holometabola). *Systematic Entomology* 33: 97–127. doi: 10.1111/j.1365-3113.2007.00396.x
- Aspöck U, Hynd WRB (1995) A new genus and species of Nosybinae (Neuropt., Berothidae) from eastern Africa. *Entomologist's Monthly Magazine* 131: 107–113.
- Aspöck U, Liu X, Aspöck H (2013) The Berothidae of Taiwan (Neuroptera: Neuropterida). *Deutsche Entomologische Zeitschrift* 60(2): 221–230.
- Aspöck U, Mansell MW (1994) A revision of the family Rhachiberothidae Tjeder, 1959, stat. n. (Neuroptera). *Systematic Entomology* 19: 181–206. doi: 10.1111/j.1365-3113.1994.tb00587.x
- Aspöck U, Nemeschkal HL (1998) A cladistic analysis of the Berothidae (Neuroptera). In: Panelius SP (Ed.) *Neuropterology 1997. Proceedings of the 6th International Symposium on Neuropterology* (13–16 July 1997, Helsinki, Finland). *Acta Zoologica Fennica* 209: 45–63.
- Aspöck U, Plant JD, Nemeschkal HL (2001) Cladistic analysis of Neuroptera and their systematic position within Neuropterida (Insecta: Holometabola: Neuropterida: Neuroptera). *Systematic Entomology* 26: 73–86. doi: 10.1046/j.1365-3113.2001.00136.x
- Aspöck U, Randolph S, Aspöck H (2010) The Berothidae of Madagascar (Neuropterida: Neuroptera) and Madagascar's biological exploration by the Viennese adventuress Ida Pfeiffer (1797 – 1858). In: Devetak D, Lipovšek S, Arnett AS (Eds) *Proceedings of the Tenth Symposium on Neuropterology, Piran, Slovenia, 2008, Maribor Slovenia*, 75–82.
- Beutel RG, Friedrich F, Aspöck U (2010) The larval head of Nevrothidae and the phylogeny of Neuroptera (Insecta). *Zoological Journal of the Linnean Society* 158: 533–562. doi: 10.1111/j.1096-3642.2009.00560.x
- Brushwein JR (1987) Bionomics of *Lomamyia hamata* (Neuroptera: Berothidae). *Annals of the Entomological Society of America* 80: 671–679.
- Carpenter FM (1940) A revision of the Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae and Dilaridae (Neuroptera). *Proceedings of the American Academy of Arts and Sciences* 74: 193–280. doi: 10.2307/20023398
- Dobosz R, Górski G (2008) New data on *Nyrma kervillea* (Neuroptera: Berothidae). In: Devetak D, Klenovšek T (Eds) *Tenth International Symposium on Neuropterology, 22–25 June 2008, Piran, Slovenia*. Abstract book. Faculty of Natural Sciences and Mathematics, Maribor, 33.
- Engel MS, Grimaldi DA (2008) Diverse Neuropterida in Cretaceous amber, with particular reference to the paleofauna of Myanmar (Insecta). *Nova Supplementa Entomologica* 20: 1–86.

- Faulkner D K (1992) A revision of the genus *Lomamyia* Banks (Planipennia: Berothidae) with an emphasis on the western United States species. Master's thesis. California State University, Long Beach, California, 119 pp.
- Goloboff PA (1993) Estimating character weights during tree search. *Cladistics* 9: 83–91. doi: 10.1111/j.1096-0031.1993.tb00209.x
- Goloboff PA, Farris JS, Nixon KC (2008) TNT, a free program for phylogenetic analysis. *Cladistics* 24: 774–786. doi: 10.1111/j.1096-0031.2008.00217.x
- Grimaldi DA (2000) A diverse fauna of Neuropterodea in amber from the Cretaceous of New Jersey. In: Grimaldi DA (Ed.) *Studies on Fossil in Amber, with Particular Reference to the Cretaceous of New Jersey*. Backhuys Publishers, Leiden, 259–303.
- Grimaldi D, Engel MS (2005) *Evolution of the Insects*. Cambridge University Press, New York, 755 pp.
- Gurney AB (1947) Notes on Dilaridae and Berothidae, with special reference to the immature stages of the Nearctic genera (Neuroptera). *Psyche* 54: 145–169. doi: 10.1155/1947/78317
- Haring E, Aspöck U (2004) Phylogeny of the Neuropterida: a first molecular approach. *Systematic Entomology* 29: 415–430. doi: 10.1111/j.0307-6970.2004.00263.x
- Klimaszewski J, Kevan DKMcE (1986) A new lacewing-fly (Neuroptera: Planipennia) from Canadian Cretaceous Amber, with an analysis of its fore wing characters. *Entomological News* 97: 124–132.
- Komatsu T (2014) Larvae of the Japanese termitophilous predator *Isoscelipteron okamotoi* (Neuroptera, Berothidae) use their mandibles and silk web to prey on termites. *Insectes Sociaux* 61(2): 203–205. doi: 10.1007/s00040-014-0346-6
- Krüger L (1923) *Neuroptera succinica baltica*. Die im baltischen Bernstein eingeschlossenen Neuroptera des Westpreussischen Provinzial-Museums (heute Museum für Naturkunde und Vorgeschichte) in Danzig. *Stettiner Entomologische Zeitung* 84: 68–92.
- MacLeod EG, Adams PA (1967) A review of the taxonomy and morphology of the Berothidae, with the description of a new subfamily from Chile (Neuroptera). *Psyche* 74: 237–265.
- Makarkin VN, Yang Q, Ren D (2011) Two new species of *Sinosmylites* Hong (Neuroptera, Berothidae) from the Middle Jurassic of China, with notes on Mesoberothidae. *ZooKeys* 130: 199–215. doi: 10.3897/zookeys.130.1418
- Minter LR (1990) A comparison of the eggs and first-instar larvae of *Mucroberotha vesicaria* Tjeder with those of other species in the families Berothidae and Mantispidae (Insecta: Neuroptera). In: Mansell MW, Aspöck H (Eds) *Advances in Neuropterology*. Proceedings of the Third International Symposium on Neuropterology. South African Department of Agricultural Development, Pretoria, 115–129.
- Möller A (2003) Aspects of the larval morphology and biology of South African *Podallea* species (Neuropterida: Neuroptera: Berothidae). Master of Science Thesis. School of Molecular and Life Sciences in the Faculty of Sciences, Health and Agriculture, University of the North, South Africa, 123 pp.
- Möller A, Minter LR, Olivier PAS (2006) Larval morphology of *Podallea vasseana* Navás and *Podallea manselli* Aspöck and Aspöck from South Africa (Neuroptera: Berothidae). *African Entomology* 14: 1–12.
- Monserrat VJ (2006) Nuevos datos sobre algunas especies de la familia Berothidae (Insecta: Neuroptera). *Heteropterus Revista de Entomología* 6: 173–207.
- Monserrat VJ, Deretsky Z (1999) New faunistic, taxonomic and systematic data on brown lacewings (Neuroptera: Hemerobiidae). *Journal of Neuropterology* 2: 45–66.
- New TR (1986) A review of the biology of Neuroptera Planipennia. *Neuroptera International (Supplemental Series)* 1: 1–57.
- Nixon KC (2002) WinClada. Ver. 1.00.08. Cornell University, Ithaca, NY.
- Oswald JD, Contreras-Ramos A, Penny ND (2002) Neuroptera (Neuropterida). In: Bousquets JL, Morrone JJ (Eds) *Biodiversidad, Taxonomía y Biogeografía de Artrópodos de México: hacia una síntesis de su conocimiento*. Vol. 3. Universidad Nacional Autónoma de México, Distrito Federal, 559–581.
- Penny ND, Adams PA, Stange L A (1997) Species catalog of the Neuroptera, Megaloptera, and Raphidioptera of America North of Mexico. *Proceedings of the California Academy of Sciences* 50(3): 39–114.
- Penny ND, Winterton SL (2007) Rediscovery of the unusual genus *Ormiscoceris* (Neuroptera: Berothidae: Cyrenoberothinae). *Proceedings of the California Academy of Sciences* (4)58: 1–6.
- Randolf S, Zimmermann D, Aspöck U (2013) Head anatomy of adult *Sisyr terminalis* (Insecta: Neuroptera: Sisyridae) – functional adaptations and phylogenetic implications. *Arthropod Structure and Development* 42: 565–582. doi: 10.1016/j.asd.2013.07.004
- Randolf S, Zimmermann D, Aspöck U (2014) Head anatomy of adult *Nevrorthus apatelios* and basal splitting events in Neuroptera (Neuroptera: Nevrothidae). *Arthropod Systematics and Phylogeny* 72 (2): 111–136.
- Tauber CA, Tauber MJ (1968) *Lomamyia latipennis* (Neuroptera, Berothidae) life history and larval descriptions. *Canadian Entomologist* 100: 623–629. doi: 10.4039/Ent100623-6
- Tillyard RJ (1916) Studies in Australian Neuroptera IV. The families Ithonidae, Hemerobiidae, Sisyridae, Berothidae, and the new family Trichomatidae; with a discussion of their characters and relationships, and descriptions of new and little-known genera and species. *Proceedings of the Linnean Society of New South Wales* 41: 269–332.
- Tjeder B (1959) Neuroptera-Planipennia. The Lace-wings of Southern Africa. 2. Family Berothidae. In: Hanström B, Brinck P, Rudebec G (Eds) *South African Animal Life*. Vol. 6. Swedish Natural Science Research Council, Stockholm, 256–314.
- Tjeder B (1968) The genus *Mucroberotha* TJED. and its systematic position (Neuroptera). *Entomologisk Tidskrift* 89: 3–18.
- Toschi CA (1964) Observations on *Lomamyia latipennis*, with a description of the first instar larva. *Pan-Pacific Entomologist* 40: 21–26.
- Wedmann S, Makarkin VN, Weiterschan T, Hörschemeyer T (2013) First fossil larvae of Berothidae (Neuroptera) from Baltic amber, with notes on the biology and termitophily of the family. *Zootaxa* 3716 (2): 236–258. doi: 10.11646/zootaxa.3716.2.6
- Whalley PES (1980) Neuroptera (Insecta) in amber from the Lower Cretaceous of Lebanon. *Bulletin of the British Museum of Natural History (Geology)* 33: 157–164.
- Willmann R (1990) The phylogenetic position of the Rhachiberothinae and the basal sister-group relationships within the Mantispidae (Neuroptera). *Systematic Entomology* 15: 253–265. doi: 10.1111/j.1365-3113.1990.tb00316.x
- Winterton SL (2010) A new species of *Stenobiella* Tillyard (Neuroptera, Berothidae) from Australia. *ZooKeys* 64: 1–8. doi: 10.3897/zookeys.64.403
- Zimmermann D, Randolph S, Metscher BD, Aspöck U (2011) The function and phylogenetic implications of the tentorium in adult Neuroptera (Insecta). *Arthropod Structure and Development* 40: 571–582. doi: 10.1016/j.asd.2011.06.003

Supplementary material 1

Table S1. Figure numbers in present work and in references that served as template.

Authors: Ulrike Aspöck, Susanne Randolph

Data type: references list

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Supplementary material 2

Sources of records upon which the distribution maps are based.

Authors: Ulrike Aspöck, Susanne Randolph

Data type: distribution data

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Supplementary material 3

Data table.

Authors: Ulrike Aspöck, Susanne Randolph

Data type: species data

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Supplementary material 4

NEXUS file.

Authors: Ulrike Aspöck, Susanne Randolph

Data type: NEXUS file

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Supplementary material 5

List of genera and species of Berothidae.

Authors: Ulrike Aspöck, Susanne Randolph

Data type: species list

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