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Paracerella Imadaté in China: the description of a new species and the analysis of genetic differences between populations (Protura, Acerentomata, Nipponentomidae)

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Abstract

The genus *Paracerella* Imadaté, 1980 is recorded from China for the first time, with the description of a new species, *Paracerella sinensis* **sp. n.** *Paracerella sinensis* is characterized by four pairs of *A*-setae on tergite I, the presence of setae *Pc* and *P3a* on tergite VII, eight *A*-setae on tergite VIII, the presence of seta *Pc* on both sternites VI and VII, and 4/2 setae on sternite VIII, which are different from all other members of the genus. The key to the four species of the genus is updated. In addition, DNA barcodes of four populations are sequenced and their genetic differences are analyzed.

Keywords

DNA barcodes, genetic divergences, identification key, sensillum, taxonomy

Introduction

The genus *Paracerella* Imadaté, 1980 is separated from *Verrucoentomon* Rusek, 1974 by the parallel position of the foretarsal sensilla *d* and *a'* to *t2*. It is characterized by having a distinct calyx with racemose appendices on its surface, three pairs of *A*-setae on meso- and metanota, filiform foretarsal sensillum *t1*, three *A*-setae on sternites I–VII, posterior position of setae *P3* on tergites II–VI, well-developed labial palps, two subequal setae on abdominal legs II and III and well-developed striate band on segment VIII.

As a small genus in Protura, *Paracerella* has only three known species: *P. shiratki* (Imadaté, 1964) recorded from Japan (Imadaté 1964, 1980), *P. americana* Imadaté, 1980, and *P. monterey* Shrubovych, 2012 from USA (Imadaté 1980; Shrubovych and Smykla 2012).

During field work in Inner Mongolia and Heilongjiang Provinces, northeast China, plenty of proturan specimens of *Paracerella* were found. They were identified as a new species and are described in the present paper, and an updated key to the genus was also provided. In addition, the DNA barcodes of the new species from four localities were sequenced and analyzed, the morphological identification was confirmed, and the genetic differences between different populations were revealed.

Materials and methods

Specimens were collected by Tullgren funnels. All specimens were mounted on slides in Hoyer's medium and dried at 60 °C. Specimens were identified and drawn with the aid of a NIKON E600 phase contrast microscope. The photos were taken by digital camera Nikon DXM1200. Type specimens are deposited in the Shanghai Entomological Museum (SEM), Institute of Plant Physiology & Ecology, Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences, and Shanghai Natural History Museum (SNHM).

Abbreviations used in the text follow the paper of Bu and Yin (2007). Head setae and pores are marked according to Rusek et al. (2012). Body setae are marked following Imadaté (1974) and Yin (1999). Terminology of body porotaxy follows Szeptycki (1988) and Shrubovych (2014). Arrangements of the taxa follow the system proposed by Yin (1999).

For the analysis of genetic differences, genomic DNA was extracted from each individual separately by means of a non-destructive method (Gao and Bu 2014). After the DNA extraction, the cuticles of proturans were retrieved and mounted on the slides as voucher specimens. DNA barcoding sequences of mitochondrial COI gene were amplified and sequenced by primer pair LCO/HCO (Folmer et al. 1994). The barcoding sequences are deposited in GenBank. The nucleotide composition and the genetic divergence based on the Kimura-2-parameter (K2P) model were calculated using MEGA 6 (Tamura et al. 2013).

Taxonomy

Paracerella sinensis sp. n.

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Figs 1–3, Tables 1–2

Material examined. Holotype, female (No. LM6-12D) (SEM), **CHINA**, Inner Mongolia Province, Balin town, Lama Hill, extracted from the soil samples under some small pine trees, 48°19.969'N, 122°19.160'E, elev. 562 m, 12-VIII-2014, coll. W.J. Chen, C.W. Huang, Y. Ma, Y.X. Luan, and M. Potapov. Paratypes, 4 females (nos. LM6-10, LM6-11, LM6-13D, LM6-14D) (SEM), same data as holotype; 3 females (nos. HH1-1D, HH1-3D, HH1-4D) (SEM), **CHINA**, Heilongjiang Province, Heihe City, from the soil samples under some black birches of Tree Farm 727, 50°15.491'N, 126°48.434'E, elev. 410 m, 15-VIII-2014; 11 females (nos. WHS4-2D, WHS5-2D, WHS6-2D, WHS4-6-1, WHS4-6-2, WHS5-3-2, WHS5-4-1, WHS5-4-3 in SEM, nos. WHS4-5-1, WHS4-5-2, WHS4-5-3 in SNHM), **CHINA**, Heilongjiang Province, Wudalianchi City, from three soil samples of Wohu Hill, 48°39.252'N, 126°02.281'E, elev. 480 m, 17-VIII-2014; 5 females (nos. DZH2-1D, DZH2-2D, DZH2-3, DZH2-12D, DZH2-16) (SEM), **CHINA**, Heilongjiang Province, Wudalianchi City, from the soil sample under some larches in Dazhanhe National Forest Park, 48°41.726'N, 127°40.556'E, elev. 327 m, 18-VIII-2014. Other materials,1 maturus junior (no. HH7-1) (SEM), **CHINA**, Heilongjiang Province, Heihe City, from the soil samples under some black oaks of Tree Farm 733, 50°13.909'N, 126°51.887'E, elev. 517 m, 15-VIII-2014; 1 maturus junior (no. WHS6-3-2) (SEM), **CHINA**, Heilongjiang Province, Wudalianchi City, from three soil samples of Wohu Hill, 48°39.252'N, 126°02.281'E, elev. 480 m, 17-VIII-2014; 3 maturi juniores (nos. DZH2-18, DZH 2-19, DZH2- 20) (SEM), 2 larvae II (nos. DZH2-4, DZH2-17) (SEM), **CHINA**, Heilongjiang Province, Wudalianchi City, from the soil sample under some larches in Dazhanhe National Forest Park, 48°41.726'N, 127°40.556'E, elev. 327 m, 18-VIII-2014. All specimens are collected by W. J. Chen, C.W. Huang, Y. Ma, Y.X. Luan, and M. Potapov. Twelve specimens (nos. LM6-12D, LM6-13D, LM6-14D, HH1-1D, HH1-3D, HH1-4D, WHS4-2D, WHS5-2D, WHS6-2D, DZH2-1D, DZH2-2D and DZH2-12D) are voucher specimens retrieved after DNA extraction.

Diagnosis. *Paracerella sinensis* sp. n. is characterized by four pairs of *A*-setae on tergite I, the presence of seta *Pc* and *P3a* on tergite VII, 8 *A*-setae on tergite VIII, the presence of seta *Pc* on sternites VI and VII, 4/2 setae on sternite VIII, which are different to any other members of the genus, foretarsal sensillum *a* extremely long, surpassing base of sensillum *e*, sensilla *d* and *a'* located in subequal level with *t2*, acrostyli of female squama genitalis each with two fine flaps.

Description. Adult body length 1150–1450 μm (n = 24), body yellow-brown color (Fig. 2A).

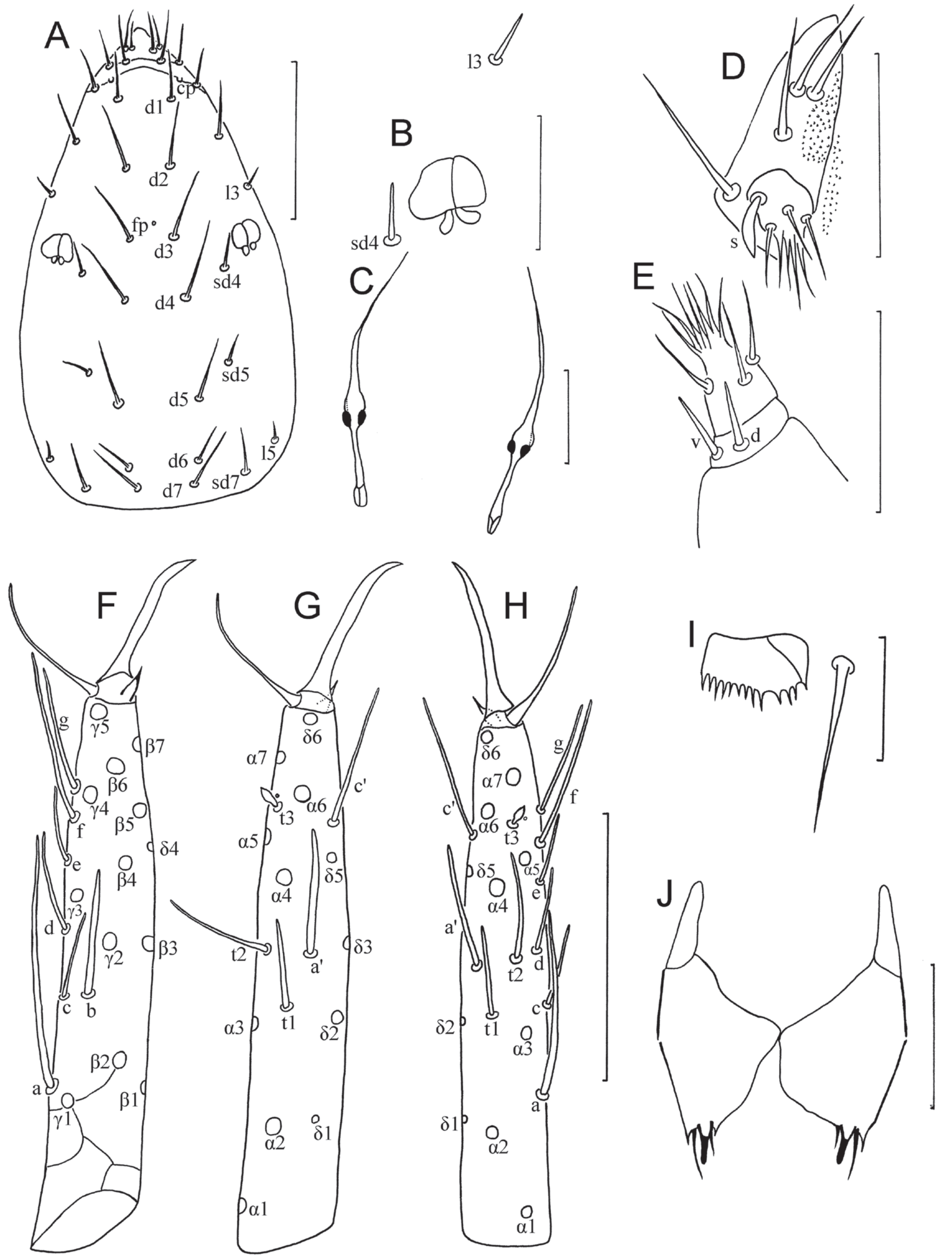

Figure 1. *Paracerella sinensis* sp. n. holotype. **A** Head, dorsal view (*cp* = clypeal pore, *fp* = frontal pore) **B** pseudoculus **C** canal of maxillary gland **D** labial palpus **E** maxillary palpus (d = dorsal sensillum, v = ventral sensillum) **F** foretarsus, exterior view **G** foretarsus, interior view **H** foretarsus, interolateral view (paratype No. LM6-14D) **I** comb **J** female quama genitalis. Scale bars: (**A, F–H**) 50 μm; others, 20 μm.

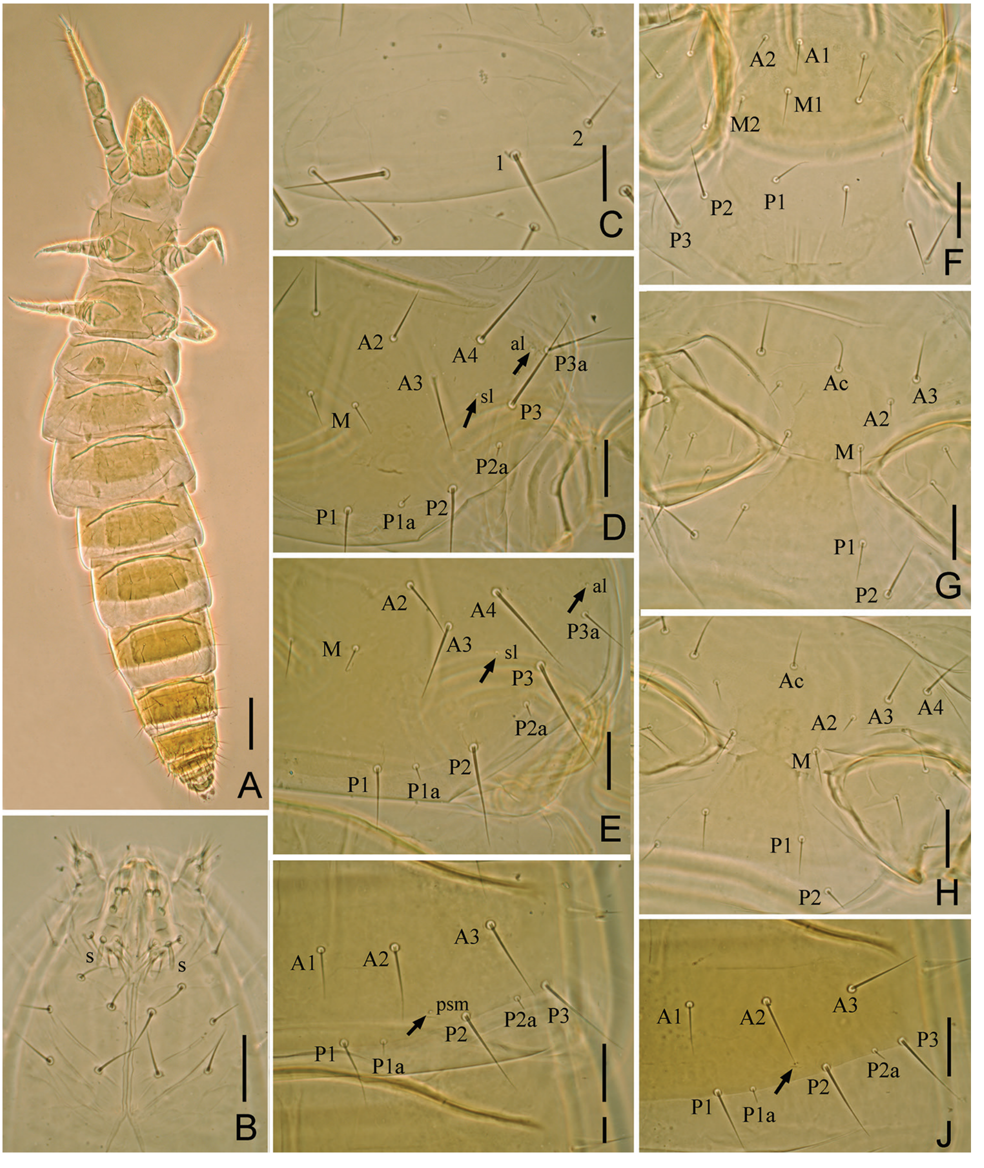

Figure 2. *Paracerella sinensis* sp. n. holotype. **A** Habitus **B** ventral side of head (s=sensillum) **C** pronotum **D** mesonotum **E** metanotum **F** prosternum **G** mesosternum **H** metasternum **I** tergite I, right side **J** tergite III, right side. Arrows indicate pores. Scale bars: (**A**)100 µm, others, 20 µm.

Head (Fig. 1A). Ovate, length 140–150 µm, width 85–90 µm. Setae *d6* present, *sd4* and *sd5* short, sensilliform. Setae *d6* 14–15 µm, *d7* 17–18 µm. Clypeal pore *cp* and frontal pore *fp* present. Pseudoculus round, length 8–10 µm, with short posterior extension, PR = 15–19 (Fig. 1B). Maxillary gland large, calyx with lateral racemose appendices and one helmet-like dorsal appendix, and bilobed posterior dilation, posterior filament length 15–17 μm, CF = 8–10 (Fig. 1C). Labial palpus well-developed, with tuft and one leaf-shaped basal sensillum (7–8 μm) (Figs 1D, 2B). Maxillary palpus with two tapering sensilla, subequal in length (8–9 μm) (Fig. 1E).

Foretarsus (Fig. 1F, G, H). Length 100–107 μm, claw length 20–25 μm, TR = 4.2–5.2; empodium length 5 μm, EU = 0.2–0.25. Dorsal sensilla *t1* filiform, BS = 0.75–0.85, *t2* slender and long (25 μm), *t3* lanceolate and short. Exterior sensilla *a* broad and long (35–55 μm), surpassing base of *d*, *b* broader and longer than *c*, *c* short and slender, *d* filiform, same level to *t2* and *a'*, *e* short, *f* and *g* filiform and long. Interior sensilla *a'* broad and long, surpassing base of *δ5*, *b'* absent, *c'* slender and surpassing base of claw. Relative length of sensilla: *t3* < *e* < *c* < *d* < *t1*< (*b* = *g* = *t2*)< *a'* < *c'* < *f* < *a*. Setae *β1* (9 μm) and *δ4* (13 μm) setiform. Pores close to sensilla *c* and *t3* present. Length of middle tarsus 50 μm, claw length 23–25 μm. Length of hind tarsus 55 μm, claw length 25 μm.

Thorax. Thoracic chaetotaxy given in Table 1. Setae *1* and *2* on pronotum 31 μm and 21 μm length respectively (Fig. 2C). Mesonotum and metanotum with eight pairs of *P*-setae, accessory setae short sensilliform, 6–8 μm in length; setae *P1*, *P1a*

Table 1. Adult chaetotaxy of *Paracerella sinensis* sp. n.

Segment		Dorsal		Ventral	
		Formula	Setae	Formula	Setae
Th.	I	4	1, 2	(4 + 4)/6	A1, 2, M1, 2 P1, 2, 3
	II	8/16	A2, 3, 4, M P1, 1a, 2, 2a, 3, 3a, 4, 5	(5 + 2)/4	Ac, 2, 3, M P1, 2
	III	8/16	A2, 3, 4, M P1, 1a, 2, 2a, 3, 3a, 4, 5	(7 + 2)/4	Ac, 1, 2, 3, M P1, 2
Abd.	I	8/12	A1, 2, 3, 5 P1, 1a, 2, 2a, 3, 4	3/4	Ac, 2 P1, 1a
	II–III	10/16	A1, 2, 3, 4, 5 P1, 1a, 2, 2a, 3, 4, 4a, 5	3/5	Ac, 2 Pc, 1a, 2
	IV–V	10/16	A1, 2, 3, 4, 5 P1, 1a, 2, 2a, 3, 4, 4a, 5	3/8	Ac, 2 P1, 1a, 2, 3
	VI	10/16	A1, 2, 3, 4, 5 P1, 1a, 2, 2a, 3, 4, 4a, 5	3/9	Ac, 2 Pc, 1, 1a, 2, 3
	VII	10/19	A1, 2, 3, 4, 5 Pc,1, 1a, 2, 2a, 3,3a, 4, 4a, 5	3/9	Ac, 2 Pc, 1, 1a, 2, 3
	VIII	8/15	A1, 2, 4, 5 Mc, 2, 3, 4, P2, 3, 4, 5	4/2	1, 2 1a
	IX	12	1, 1a, 2, 2a, 3, 4	4	1, 2
	X	10	1, 2, 2a, 3, 4	4	1, 2

and *P2* on mesonotum 21–25 μm, 5–6 μm and 35–36 μm respectively (Fig. 2D, E). Prosternum with two pairs of anterior seta, and setae *A2* and *M2* sensilliform, 6–7 μm (Fig. 2F). Mesosternum and metasternum with 5 and 7 *A*-setae respecitvely, and setae *A2* on mesosternum and metasternum sensilliform, 6–7 μm (Fig. 2G, H). Pronotum without pores. Mesonotum and metanotum with pores *sl* and *al*. Sterna without pores.

Abdomen. Abdominal chaetotaxy given in Table 1. Tergite I with four pairs of anterior setae (*A1*, *A2*, *A3*, *A5*) (Fig. 2I). Tergites II–VI with five pairs of anterior setae and eight pairs of posterior setae (Fig. 2J). Tergite VII with five pairs of anterior setae and 19 posterior setae, *Pc* and *P3a* present (Fig. 3A). Accessory setae on tergites I–VI short sensilliform, 6–7 μm on tergites I–III, 7–9 μm on tergite IV–VI, and on VII setiform (13–16 μm). Tergite VIII with seta *Mc* (Fig. 3B). Sternites IV–V each with eight posterior setae (Fig. 3E). Sternites VI–VII each with nine posterior setae, *Pc* present (Fig. 3F, G). Sternite VIII with two rows of setae (4/2) (Fig. 3J). Hind margin of tergites IX–XI and sternites IX–X with distinct denticles.

Tergites I–III and VII with pores *psm* and *al*, IV–VI with pores *psm*, *al* and *psl*, VIII with pores *psm* only, IX–XI without pores, XII with single medial pore. Pores *psm* on tergite VII close to seta *P1* (Fig. 3A). Sternites I–V without pores (Fig. 3C, D, E), VI and VII each with single medial pore *spm*, on VI located close to *Pc* and on VII located in central position (Fig. 3F, G). Sternites VIII–XI without pores, XII with 1+1 *sal* pores.

Abdominal appendages I, II, III with 2, 1, 1 segments and 4, 2, 2 setae respectively (Fig. 3C, D). On appendages II and III, subapical setae 19–21 μm, apical setae 18–19 μm in length. Striate band on abdominal segment VIII well-developed (Fig. 3H, I, J). Comb on abdomen VIII rectangular, with 12–13 teeth (Fig. 1I). Female squama genitalis robust, with short basal apodeme and pointed acrostyli, each acrostylus with two fine flaps (Fig. 1J). Male unknown.

Etymology. The species is named after the Latin name of China, the place where the species was found.

Distribution. Inner Mongolia and Heilongjiang, China.

Remarks. The new species is placed in the genus *Paracerella* because of the three pairs of *A*-setae on both meso- and metanota, filiform sensillum *t1* on foretarsus, sensilla *d* and *a'* located in subequal level with *t2*, and well-developed striate band. *Paracerella sinensis* sp. n. can be easily distinguished from the other three species of the genus by the chaetotaxy of tergites I, IV and VIII, sternites VI–VIII, as well as the length of foretarsal sensillum *a*.

Among 24 adults of *P. sinensis* observed, the length of sensillum *a* is variable between individuals: in most specimens it can surpass base of *e* (holotype and most of paratypes) (Fig. 1F), in some specimens it is a little shorter, only surpassing base of *d* (nos. LM6-10, LM6-14D) (Fig. 1H), in some specimens it is extremely long as reaching or surpassing base of *f* (nos. LM6-13D, HH2-4D, WHS4-6-1), even reaching base of *g* (no. WHS4-2D). The four species of *Paracerella* can be distinguished by the following key.

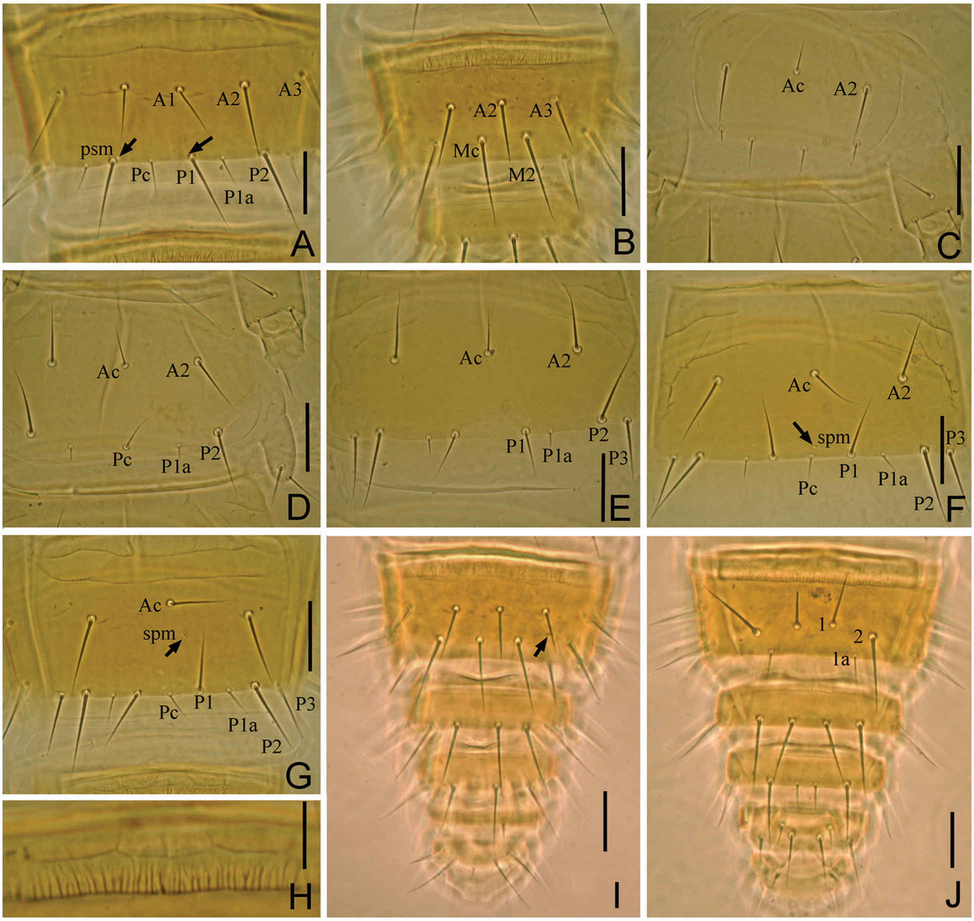

Figure 3. *Paracerella sinensis* sp. n. holotype. **A** Tergite VII (*psm*= posterosubmedial) **B** tergite VIII **C** sternite I **D** sternite II **E** sternite IV **F** sternite VI (*spm*= sternal posteromedial) **G** sternite VII **H** striate band of abdominal VIII **I** Tergite VIII–XII **J** sternites VIII–XII. Arrows indicate pores. Scale bars: 20 µm.

Key to the species of genus *Paracerella* Imadaté, 1980

1	Tergites I–VI with seta *P1a*, sternite I with 4 posterior setae	**2**
–	Tergites I–VI without seta *P1a*, sternite I with 2 posterior setae .... ***P. monterey* Shrubovych, 2012**; USA (California)	
2	Tergite VII without *Pc* and *P3a* setae, sternite VI without *Pc* seta	**3**
–	Tergite VII with *Pc* and *P3a* setae, sternite VI with *Pc* seta .... ***P. sinensis* sp. n.**; China (Inner Mongolia, Heilongjiang)	
3	Tergite VII with 8 *A*-setae and without seta *P1a*, tergite VIII with 6 *A*-setae .... ***P. americana* Imadaté, 1980**; USA (California)	
–	Tergite VII with 6 *A*-setae and with *P1a* seta, tergite VIII with 4 *A*-setae...... ***P. shiratki* (Imadaté, 1964)**; Japan (Hokkaido)	

Table 2. The K2P genetic distances of DNA barcodes (COI gene) in *Paracerella sinensis* sp. n.

	LM6-12D	**LM6-14D**	**HH1-2D**	**WHS4-2D**	**WHS5-2D**	**WHS6-2D**	**DZH2-1D**	**DZH2-2D**
LM6-12D								
LM6-14D	0.0000							
HH1-2D	0.1211	0.1211						
WHS4-2D	0.1173	0.1173	0.0046					
WHS5-2D	0.1251	0.1251	0.0346	0.0362				
WHS6-2D	0.1193	0.1193	0.0362	0.0378	0.0046			
DZH2-1D	0.1235	0.1235	0.1214	0.1214	0.1197	0.1178		
DZH2-2D	0.1254	0.1254	0.1233	0.1233	0.1216	0.1197	0.0015	

Note: The geographic distances among four populations are 397 km, 390 km, 277 km, 187 km, 185 km, and 121 km for LM-DZH, LM-HH, LM-WHS, HH-WHS, HH-DZH and WHS-DZH, respectively.

Genetic differences between populations of *Paracerella sinensis* sp. n.

The standard DNA barcoding sequences (COI genes) of eight individuals (voucher species nos. LM6-12D, LM6-14D, HH1-2D, WHS4-2D, WHS5-2D, WHS6-2D, DZH2-1D and DZH2-2D) from one locations in Inner Mongolia (LM) and three locations in Heilongjiang (HH, WHS and DZH) were sequenced and deposited in GenBank (accession numbers KU983757-KU983764). Each sequence contains 658 base pairs of nucleotides that encoding 219 amino acids. The average nucleotide composition is A = 25.2%, T = 41.5%, C = 15.9%, and G = 17.4%.

The K2P genetic divergences of nucleotides for barcode sequences are 0-3.78% between individuals within the same population, and 0.46%-12.54% between individuals from different populations. The numbers of different coded amino acids for this sequence are 0-3 between individuals within the same populations, and 1-4 between individuals from different populations. Except that the COI gene sequence of WHS4-2D is more similar to COI of HH1-2D than to COI of WHS5-2D and WHS6-2D, our data show low genetic variation within populations (LM, WHS, and DZH), but reveal high genetic differentiation among four geographic populations (Table 2).

Discussion

The intraspecific distances of most insects are very low. Virgilio et al. (2010) studied the 15,948 DNA barcodes involving 1,995 insect species across six insect orders (Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera and Orthoptera), and found 95% of all intraspecific K2P distances ranging from 0 to 7.64%. However, the intraspecific genetic distances of *P. sinensis* sp. n. are very high (up to 12.54%), which is in accord with the previous studies on some other proturan species: up to 21.3% in eight individuals of *Ionescuellum haybachae* from two Austria populations (Resch et al. 2014), and up to 31.98% separating 21 representatives of *Acerentomon italicum* in three Italian populations from an Austrian population (Galli et al. 2015). The similar situation was also found in another basal hexapod group–Collembola: six collembolan species sampled from various locations worldwide with high intraspecific variation for COI from 11.33% to 21.47% (Porco et al. 2012). Compared with insects, basal hexapods are more ancient, and probably accumulated more random genetic mutations. Another possible reason is the lack of gene flow due to the low dispersal ability of basal hexapods. Anyway, we need more data to compare the difference between intra- and interspecific divergence, for the evaluation of the standard DNA barcoding efficacy in Protura.

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Atlanta ariejansseni, a new species of shelled heteropod from the Southern Subtropical Convergence Zone (Gastropoda, Pterotracheoidea)

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Abstract

The Atlantidae (shelled heteropods) is a family of microscopic aragonite shelled holoplanktonic gastropods with a wide biogeographical distribution in tropical, sub-tropical and temperate waters. The aragonite shell and surface ocean habitat of the atlantids makes them particularly susceptible to ocean acidification and ocean warming, and atlantids are likely to be useful indicators of these changes. However, we still lack fundamental information on their taxonomy and biogeography, which is essential for monitoring the effects of a changing ocean. Integrated morphological and molecular approaches to taxonomy have been employed to improve the assessment of species boundaries, which give a more accurate picture of species distributions. Here a new species of atlantid heteropod is described based on shell morphology, DNA barcoding of the Cytochrome Oxidase I gene, and biogeography. All specimens of *Atlanta ariejansseni* **sp. n.** were collected from the Southern Subtropical Convergence Zone of the Atlantic and Indo-Pacific oceans suggesting that this species has a very narrow latitudinal distribution (37–48°S). *Atlanta ariejansseni* **sp. n.** was found to be relatively abundant (up to 2.3 specimens per 1000 m^3 water) within this narrow latitudinal range, implying that this species has adapted to the specific conditions of the Southern Subtropical Convergence Zone and has a high tolerance to the varying ocean parameters in this region.

Keywords

Atlantidae, biogeography, DNA barcoding, shelled heteropod, southern subtropical convergence zone

Introduction

The Southern Ocean Sub-Tropical Front (STF) is the boundary between the colder, fresher Sub-Antarctic Zone (SAZ) and the warmer, more saline subtropical waters to the north (Orsi et al. 1995). The Southern Subtropical Convergence Zone (SSTC) is a narrow region along the STF with highly variable physical parameters experiencing strong currents and large gradients of salinity and temperature (Longhurst 1998, Graham and Boer 2013). The STF acts as a dispersal barrier for many zooplankton taxa, resulting in changes in genetic population structure and biomass across this front (Labat et al. 2001, Hiral et al. 2015, Burridge et al. in review a, b). This region is also at a high risk from ocean changes, particularly ocean acidification, because of the high solubility of CO_2 in cold water (Roberts et al. 2014).

The shelled atlantid heteropods are likely to be particularly susceptible to ocean acidification. Although, to date, there have been no studies into the effects of ocean changes upon atlantids, we can expect that they will react in a similar way to the shelled pteropods (Thecosomata). While not closely related, atlantids share many of the characteristic features that make shelled pteropods vulnerable to ocean acidification. These include living in the upper layers of the ocean, one of the areas most affected, and producing a very small (up to ~10 mm), thin shell of aragonite, which is particularly vulnerable to dissolution in waters undersaturated with carbonate (Fabry et al. 2008). In pteropods, synergistic effects of decreasing carbonate saturation and increasing temperature has been shown to reduce the ability to produce aragonite shells (e.g. Lischka and Riebesell 2012). These effects have already been recorded in natural populations living at high latitudes (Bednaršek et al. 2012), which are predicted to be affected first (Steinacher et al. 2009). However, improvements in taxonomy are extremely important to understanding the effects of these changes on holoplanktonic gastropods. Roberts et al. (2014) found that different forms of the pteropod species *Limacina helicina* (Phipps, 1774), living in the same area of the Southern Ocean, showed opposing trends in shell weight over a long-term study. This demonstrates the importance of assessing species boundaries in order to fully understand the effects of a changing ocean.

Here an integrated morphological and molecular approach is used to present a new species of atlantid heteropod, *Atlanta ariejansseni,* that is restricted to a narrow transitional zone of only 11° of latitude within the SSTC, but has a circumpolar longitudinal range. In common with other sub-polar planktonic gastropod species, *A. ariejansseni* reaches relatively high abundances compared to other atlantids and is the dominant atlantid species living in this area. Most atlantid species are thought to be restricted to warmer tropical and sub-tropical waters, with only one other species, *Atlanta californiensis* Seapy & Richter, 1993, showing a preference for cold water regions in the California Current. *Atlanta ariejansseni* is the only atlantid species specific to sub-polar waters and that appears to be tolerant of such a variable environment.

Methods

All specimens examined and included in this study were recorded within the SSTC, between 37°S and 48°S (Fig. 1). A total of 184 specimens of *A. ariejansseni* were examined from a number of sources (Table 1). From the Atlantic Ocean, 164 specimens for combined molecular and morphological analysis were collected during the Atlantic Meridional Transects AMT20 and AMT24 (Burridge et al. in review a). On both cruises, specimens were caught using a WP2 bongo net with an aperture diameter of 0.71 m and a mesh of 200 μm. Specimens from AMT24 were fixed and preserved in 96% ethanol and stored at -20 °C prior to DNA barcoding. Specimens from AMT20 were fixed and stored in 96% ethanol and stored at room temperature. Storage at room temperature is not optimal for the preservation of DNA; therefore, specimens from AMT20 were not used for DNA barcoding. From the Pacific Ocean, two further specimens, collected by Erica Goetze during the DRFT cruise of the RV *Revelle* in 2001, were used for molecular analysis (Table 1). Finally, 18 Indo-Pacific specimens were examined from sediment trap samples, collected from south of Tasmania between 1997–2006 by the Antarctic Climate and Ecosystems Cooperative Research Centre (Bray et al. 2000, Roberts et al. 2011). Upon removal from the sediment traps, specimens were washed in buffered peroxide to remove organic matter and dried.

Two published records of atlantids are also available for this region and both are considered here to include misidentified specimens of *A. ariejansseni* sp. n. Howard et al. (2011) recorded 14 specimens of *Atlanta gaudichaudi* Gray, 1850 in net hauls and a sediment trap positioned south of Tasmania. However, specimens from the same sediment traps (Roberts et al. 2011) that were re-examined for this study were also originally misidentified as *A. gaudichaudi.* A single image of a specimen caught by Howard et al. (2011) is morphologically consistent with *A. ariejansseni*, but is too small to identify with certainty.

Pilkington (1970) described a single species of atlantid, provisionally identified as *Atlanta helicinoidea* Gray, 1850, off-shore of Taiaroa Head, New Zealand. Pilkington (1970) found it difficult to identify specimens to species level, noting that the morphology did not agree perfectly with any of the atlantid species that had already been described. The detailed descriptions and figures presented by Pilkington (1970) unquestionably resemble the shell morphology of *A. ariejansseni.* Moreover, descriptions of the juvenile stages made by Pilkington (1970) match the juvenile specimens that were examined for this study. Therefore, the *Atlanta* specimens described by Pilkington (1970) are considered to be *A. ariejansseni*.

DNA barcoding

A total of 17 undamaged adult (N = 9) and juvenile (N = 8) specimens of *A. ariejansseni* were selected from samples collected during AMT24 and DRFT research

Table 1. Details of all known specimens of *A. ariejansseni,* including sampling information.

Ocean	Cruise or project	Station	Latitude	Longitude	Sampling depth	Sampling time (local)	SST (°C)	Bottom depth (m)	Type of material	No. specimens Adult	No. specimens Juvenile	Notes on specimen use and storage	Institute or reference
Atlantic	AMT20	33	-44,20	-48,95	200	04:25–05:32	-	5223	Plankton haul specimens in ethanol.	3	0	2 paratypes coated for SEM. 1 specimen destroyed for radula extraction.	Plymouth Marine Laboratory
		74	-45,02	-50,28	-	13:09–14:03	-	5695		0	10	4 paratypes, 2 coated for SEM, 2 in 96% ethanol. 6 specimens in 96% ethanol.	
	AMT24	26	-37,89	-28,74	372	03:04–03:54	13,68	3622		1	2	2 specimens DNA barcoded (juvenile, destroyed). 1 remaining in 96% ethanol.	Naturalis Biodiversity Center
		27	-40,12	-30,91	216	03:03–03:52	13,89	4491		8	13	5 specimens DNA barcoded (3 adult, 2 juvenile, destroyed). Remaining specimens in 96% ethanol.	
		28	-41,48	-33,86	228	02:59–03:48	11,5	4943		8	69	1 holotype in 96% ethanol (adult). 1 specimen DNA barcoded (adult, destroyed). Remaining specimens in 96% ethanol.	
		29	-43,02	-37,14	253	03:00–03:49	11,5	5219		13	35	7 specimens DNA barcoded (4 adult, 3 juvenile, destroyed). Remaining specimens in 96% ethanol.	
Pacific	DRFT	14	-38,32	-161,14	-	-	-	-		1	1	2 specimens DNA barcoded (destroyed).	
	n/a	Taiaroa Head	-45,77	170,89	-	-	-	-	Plankton hauls, published data	Abundant		n/a	Pilkington (1970)
Indo-Pacific	SAZ-Sense	47°S	-47,00	141,00	-	-	-	-		1			Howard et al. 2011
		TS-2	-44,88	142,98	20	1:12	-	-		4			
		PS-1 V. haul	-46,42	140,53	20	13:55–10:25	-	-		7			
		PS-1 RMT 1	-46,47	140,37	30-70	18:37–19.11	-	-		2			
		47°S	-47,76	142,07	-	-	-	-	Dry shells, sediment trap	2	16	2 paratypes (J). All specimens dry.	Bray et al. 2000

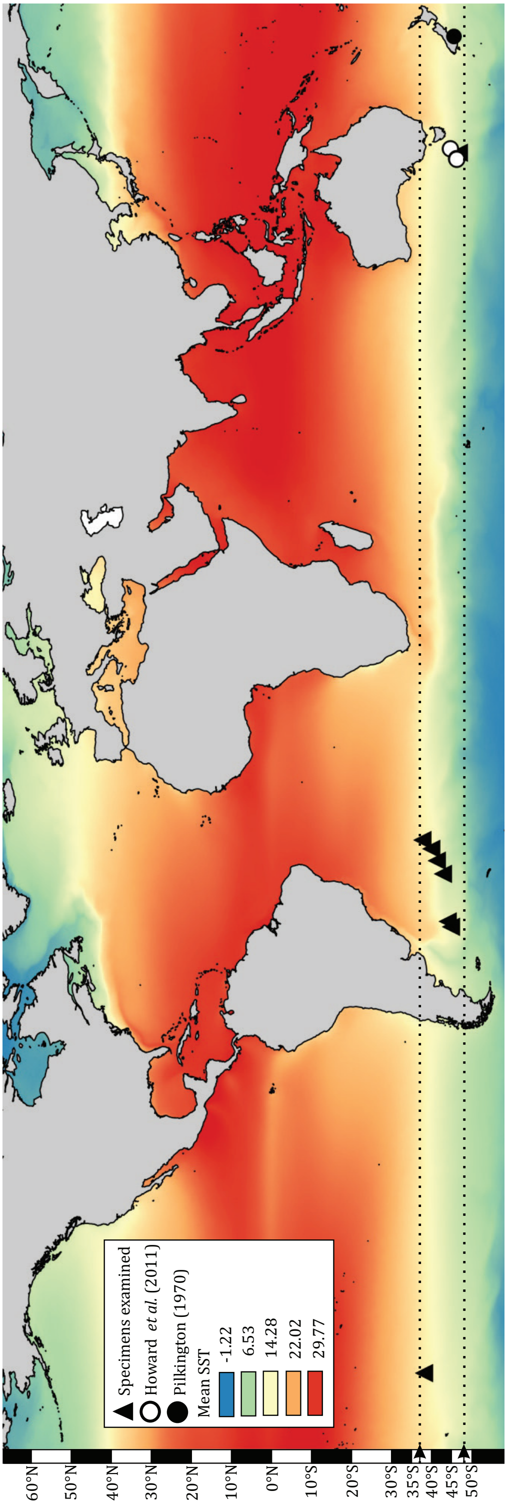

Figure 1. The biogeography of *A. ariejansseni* based on known specimens. Dashed lines show the latitudinal limits of distribution at 37°S and 48°S.

Table 2. Original specimen codes and GenBank accession numbers for all specimens included in the phylogenetic analysis (Fig. 2).

Species	Specimen code or reference	GenBank accession number
Atlanta ariejansseni	Aari_AMT24_26_01	KX343177
	Aari_AMT24_26_02	KX343178
	Aari_AMT24_27_01	KX343179
	Aari_AMT24_27_02	KX343180
	Aari_AMT24_27_03	KX343181
	Aari_AMT24_27_04	KX343182
	Aari_AMT24_27_05	KX343183
	Aari_AMT24_28_01	KX343184
	Aari_AMT24_29_01	KX343185
	Aari_AMT24_29_02	KX343186
	Aari_AMT24_29_03	KX343187
	Aari_AMT24_29_04	KX343188
	Aari_AMT24_29_05	KX343189
	Aari_AMT24_29_06	KX343190
	Aari_AMT24_29_07	KX343191
	Aari_DRFT_14_01	KX343192
	Aari_DRFT_14_02	KX343193
Atlanta selvagensis	Asel_AMT24_05_03	KX343194
	Asel_AMT24_06_01	KX343195
	Asel_AMT24_06_02	KX343196
	Asel_AMT24_06_04	KX343197
	Asel_AMT24_14_02	KX343198
Atlanta gaudichaudi	Jennings et al. 2010	FJ876837
		FJ876839
Oxygyrus inflatus		FJ876848.1
		FJ876849.1
Protatlanta souleyeti	Wall-Palmer et al. in press	KU841501
		KU841495
		KU841506
		KU841502
		KU841497
		KU841494
		KU841496
		KU841493
Pterotrachea coronata	Jennings et al. 2010	FJ876852.1
		FJ876853.1
Pterotrachea hippocampus		FJ876854.1
		FJ876855.1
Firoloida desmarestia		FJ876850.1
		FJ876851.1

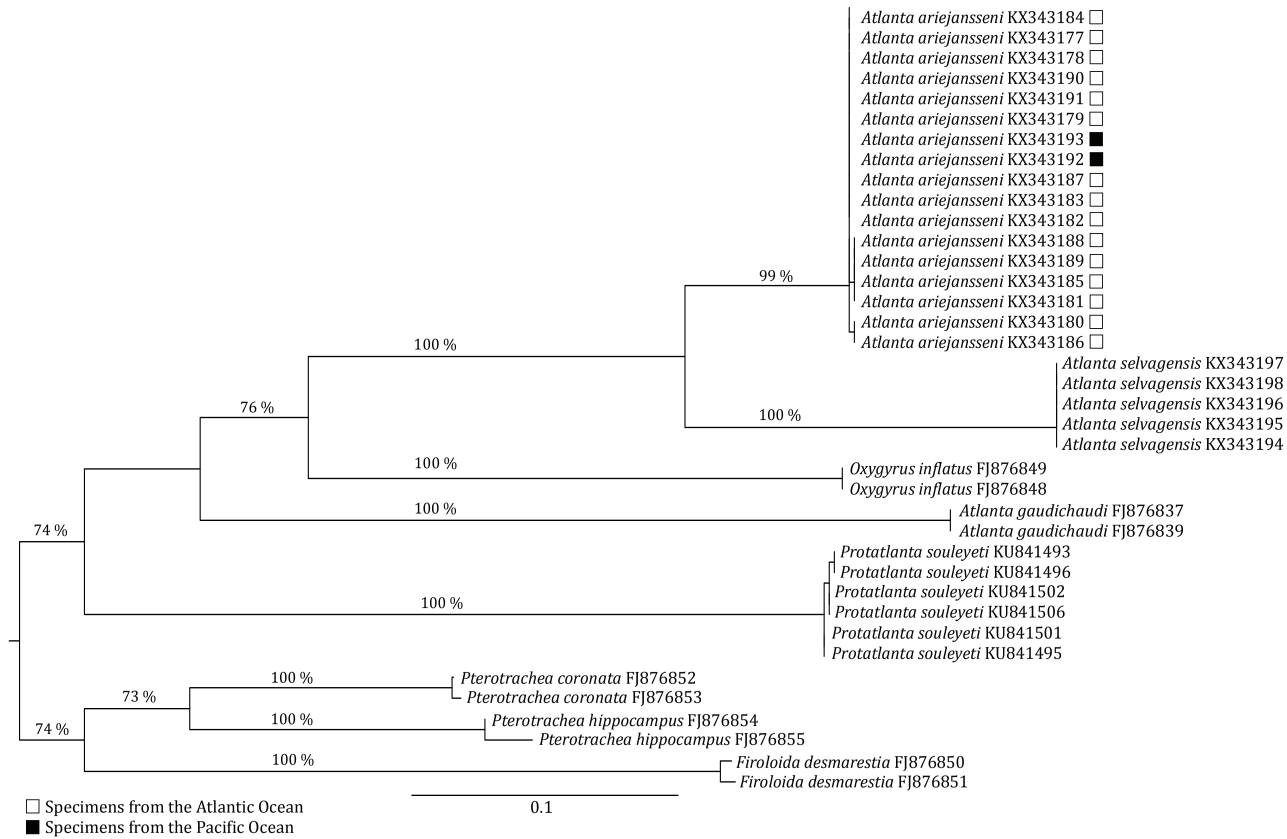

Figure 2. Maximum-likelihood tree showing the relationship of *A. ariejansseni* to different species of *Atlanta*, different Atlantidae genera, and different Pterotracheoidea families, based on Cytochrome Oxidase I DNA sequences. Branch lengths are proportional to the amount of inferred change, indicated by the scale bar. Only bootstrap support (1000 replicates) above 70% are displayed. GenBank sequence numbers are presented in Table 2. Sequences from Jennings et al. 2010 begin with FJ.

Table 3. Average K2P distances between *A. ariejansseni* and the Atlantidae species *A. gaudichaudi*, *A. selvagensis*, *Protatlanta souleyeti* and *Oxygyrus inflatus*.

	A. ariejansseni	*A. gaudichaudi*	*A. selvagensis*	*P. souleyeti*
A. ariejansseni (n = 17)				
A. gaudichaudi (n = 2)	0,25			
A. selvagensis (n = 5)	0,14	0,27		
P. souleyeti (n = 6)	0,26	0,24	0,24	
O. inflatus (n = 2)	0,22	0,25	0,25	0,25

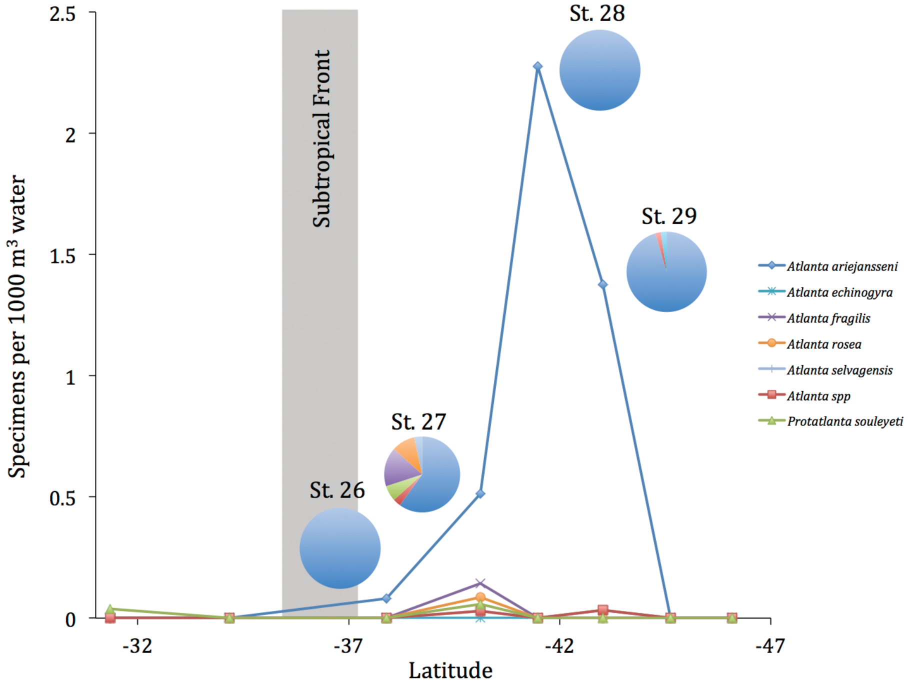

Figure 3. Abundance and pie charts of relative abundance (%) of atlantids at southern Atlantic stations of the AMT24 cruise.

cruises. DNA barcoding was also carried out for the morphologically similar species *Atlanta selvagensis* de Vera & Seapy, 2006 from the Atlantic Ocean. Five specimens of adult (N = 2) and juvenile (N = 3) *A. selvagensis* were selected from AMT24 sites (St. 5, 34.75°N, 26.62°W; St. 6, 31.30°N, 27.73°W and St. 14, 3.8°N, 25.78°W). All specimens were imaged prior to analysis using a Zeiss automated z-stage light microscope. DNA was extracted from whole specimens, using the NucleoMag 96 Tissue kit by Macherey-Nagel on a Thermo Scientific KingFisher Flex magnetic bead extraction robot, with a final elution volume of 75 µl. A standard Cytochrome Oxidase I (COI) barcoding fragment (Hebert et al. 2003) was amplified using primers jgLCO1490 and jgHCO2198 (Geller et al. 2013). Primers were tailed with M13F and M13R for sequencing (Messing 1983). PCR reactions contained 17.75 µl mQ, 2.5 µl 10x PCR buffer CL, 0.5 µl 25mM $MgCl_2$, 0.5 µl 100mM BSA, 1.0 µl 10 mM of each primer, 0.5 µl 2.5 mM dNTPs and 0.25 µl 5U Qiagen Taq, with 1.0 µl of template DNA, which was diluted 10 or 100 times for some samples. PCR was performed using an initial denaturation step of 180 s at 94 °C, followed by 40 cycles of 15 s at 94 °C, 30 s at 50 °C and 40 s at 72 °C, and finishing with a final extension of 300 s at 72 °C and pause at 12 °C. Sequencing was carried out by Macrogen, Europe.

All sequences were aligned and edited using the ClustalW algorithm in MEGA 6 (Tamura et al. 2013) and submitted to GenBank (Fig. 2, Table 2). Previously published COI sequences from GenBank (Jennings et al. 2010, Wall-Palmer et al. in press), identified as *Atlanta inclinata* Gray, 1850, *Oxygyrus inflatus* Benson, 1835, *Firoloida desmarestia* Lesueur, 1817, *Pterotrachea hippocampus* Philippi, 1836, *Pterotrachea coronata* Forsskål in Niebuhr, 1775 and *Protatlanta souleyeti* (Smith, 1888), were added to represent the families and genera most closely related to *A. ariejansseni*. Based on these data, a maximum-likelihood tree was constructed in MEGA6 using nucleotide sequences in a General Time Reversible model with gamma distribution and invariant sites (GTR+G+I) and 1000 bootstraps. Kimura-2-parameter (K2P) genetic distances were calculated between and within species belonging to the family Atlantidae using MEGA 6 (Tamura et al. 2013).

Results and discussion

Genetic diversity

DNA barcoding of seventeen *A. ariejansseni* specimens and five *A. selvagensis* specimens from the southern Atlantic (N = 15, N = 5 respectively) and Pacific (N = 2, N = 0 respectively) oceans shows that *A. ariejansseni* forms a monophyletic group with a bootstrap support of 100% (Fig. 2). *Atlanta ariejansseni* has an average K2P distance of 0.14–0.25 from other species in the genus *Atlanta* and 0.22–0.26 from other genera of Atlantidae (*Oxygyrus* and *Protatlanta* respectively, Table 3).

Biogeography

All known specimens of *A. ariejansseni* were collected between 37°S and 48°S (Table 1) within the SSTC in water temperatures of 6.5–14.3°C (Fig. 1). Along the AMT24 transect, the most northern occurrence of the key thecosome pteropod species *Limacina helicina antarctica* Woodward, 1854 was at St. 26 (31.34°S), the same station as *A. ariejansseni* (Burridge et al. in review a). However, the range of *L. helicina antarctica* extends much further south than *A. ariejansseni*, which, along with all other atlantid species, were not found at sites south of 48°S. In the Atlantic Ocean, *A. ariejansseni* was found at four AMT24 stations (St. 26–29) between 37°S and 43°S. *Atlanta ariejans-*

seni was found to be the most abundant atlantid at these stations and the only species present at stations 26 and 28 (Fig. 3). At a latitude of -41.47°S, *A. ariejansseni* reached a maximum abundance of 2.3 specimens per 1000 m^3.

Specimens of *A. ariejansseni* have been caught at different times of the day in the upper 372 m of the water column (Table 1). Low numbers of specimens were caught at the ocean surface (20–70 m) at all times of the day. However, highest numbers were caught in 228–253 m water depth at night between 03:00 and 04:00 local time (Table 1).

Systematics

Phylum MOLLUSCA
Class GASTROPODA Cuvier, 1797
Subclass CAENOGASTROPODA Cox, 1960
Order LITTORINIMORPHA Golikov & Starobogatov, 1975
Superfamily PTEROTRACHEOIDEA Rafinesque, 1814
Family ATLANTIDAE Rang, 1829
Genus *Atlanta* Lesueur, 1817

***Atlanta ariejansseni* sp. n.**
http://zoobank.org/7E9AEE5E-5F7F-480C-9673-89A3E9979FE9
Figures 4–6

Type locality. AMT24 station 28, 41.48°S, 33.86°W. Specimen collected on the 27th October 2014 at 02:59–03:48 local time at a water depth of 0–228 m.

Holotype. Figure 5j–l. Housed at the Naturalis Biodiversity Center, Leiden, accession number RMNH.5004155. For specimen dimensions, see Table 4. Collected by Alice K Burridge.

Paratypes. Figure 4a–i and k. See Table 4 for details.

Additional material. See Table 1.

Diagnosis. *Atlanta* species with a spire of 3 ¼ to 3 ½ whorls. The spire is moderately high, rounded and with deep sutures and covered in small, low projections approximately arranged in lines.

Description. Shell small and transparent, with adult shells ranging from 2012 to 3059 μm in diameter excluding the keel and 2237 to 3370 μm including the keel in examined material. The shell inflates at 3 ¼ to 3 ½ whorls and has a total of 4 ½ to 4 ¾ whorls. The keel begins at 3 ¾ whorls and inserts between the final whorl and the spire for around ¼ whorl. The keel is tall and gradually truncated with a yellow-brown keel base. The keel often has a slightly undulating shape. The soft tissue varies greatly in colour among individuals from mottled white to orange-pink and dark grey (Fig. 5). Some specimens were observed to have a pearlescent lustre to the shell surface.

The spire is moderately high, well-visible in apertural view, with deep sutures, giving the whorls a rounded appearance (Fig. 6). The spire surface is ornamented with numer-

Table 4. Overview of type material.

Specimen	Description	Illustrated?	Locality		Institute registration number	Storage	Dimensions	
			Latitude	Longitude			Number of whorls	Diameter without keel (μm)
Aari_AMT24_28_01 (holotype)	Adult	5j–l	-41,48	-33,86	RMNH.5004155	Wet 96% ethanol	4½-4¾	2260
Aari_AMT20_33_01 (paratype)	Adult	Fig. 4a, c–d	-44,20	-48,95	RMNH.5004156	Dry, coated for SEM	4¼–4½	1478
Aari_AMT20_33_02 (paratype)	Adult	Fig. 4b, e–f	-44,20	-48,95	RMNH.5004157	Dry, coated for SEM	4½	2336
Aari_AMT20_74_01 (paratype)	Juvenile	Fig. 4i	-45,02	-50,28	RMNH.5004158	Dry, coated for SEM	3	330
Aari_AMT20_74_02 (paratype)	Juvenile	Fig. 5k	-45,02	-50,28	RMNH.5004159	Dry, coated for SEM	3½	480
Aari_AMT20_74_03 (paratype)	Juvenile	none	-45,02	-50,28	RMNH.5004160	Wet 96% ethanol	-	-
Aari_AMT20_74_04 (paratype)	Juvenile	none	-45,02	-50,28	RMNH.5004161	Wet 96% ethanol	-	-
Aari_47S_01 (paratype)	Juvenile	Fig. 4g	-47,00	141,00	NHMUK 20160080	Dry	3½	460
Aari_47S_02 (paratype)	Juvenile	Fig. 4h	-47,00	141,00	NHMUK 20160081	Dry	3¾	543

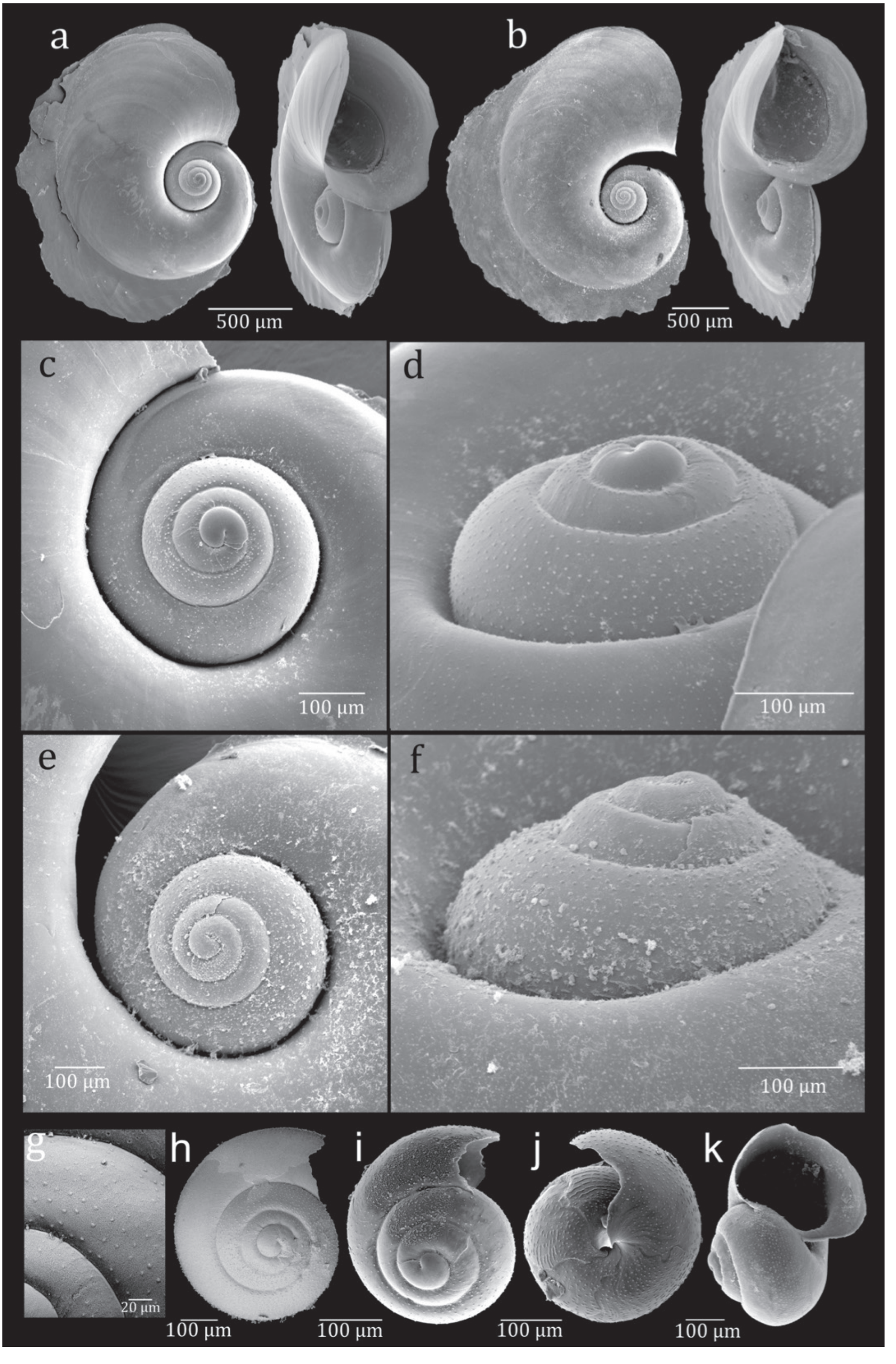

Figure 4. SEM images of *A. ariejansseni*. Aari_AMT20_33_01 (**a, c–d**); Aari_AMT20_33_02 (**b, e–f**); Aari_47S_01 (**g**); Aari_47S_02 (**h**); Aari_AMT20_74_01 (**i**); Aari_AMT20_74_05 (**j**); Aari_AMT20_74_02 (**k**). Specimens g and h were imaged using low vacuum SEM and were not sputter coated.

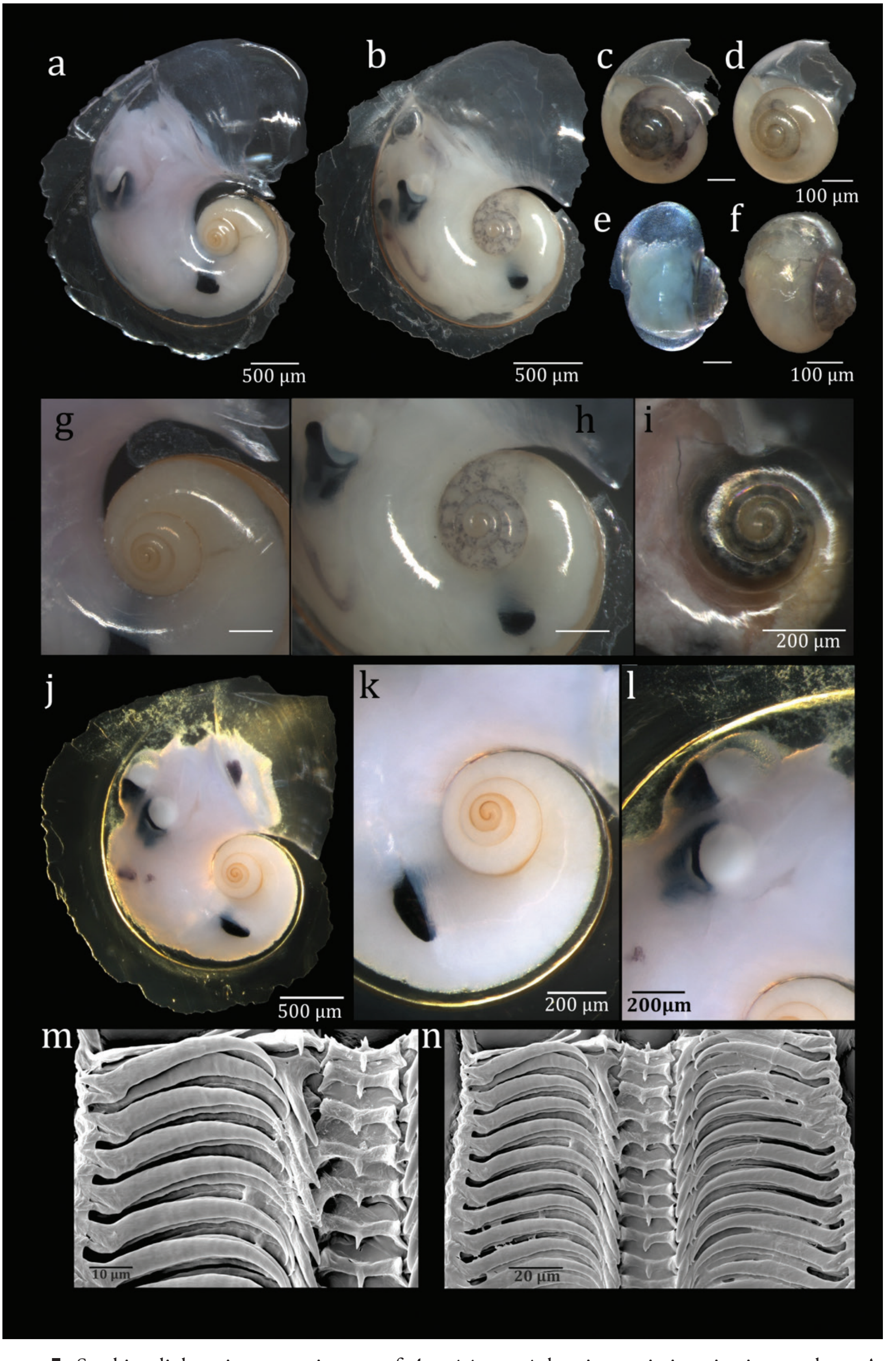

Figure 5. Stacking light microscopy images of *A. ariejansseni* showing variations in tissue colour. Aari_AMT24_29_01 (**a, g**); Aari _AMT24_27_01 (**b, h**); Aari_AMT24_26_01 (**c**); Aari_AMT24_26_02 (**d**); Aari_AMT24_27_04 (**e**); Aari_AMT24_27_04 (**f**); Aari_AMT24_28_01 (**i**); Aari_AMT24_28_01 (**j–l**); Radula of Aari_AMT20_33_03 (**m–n**).

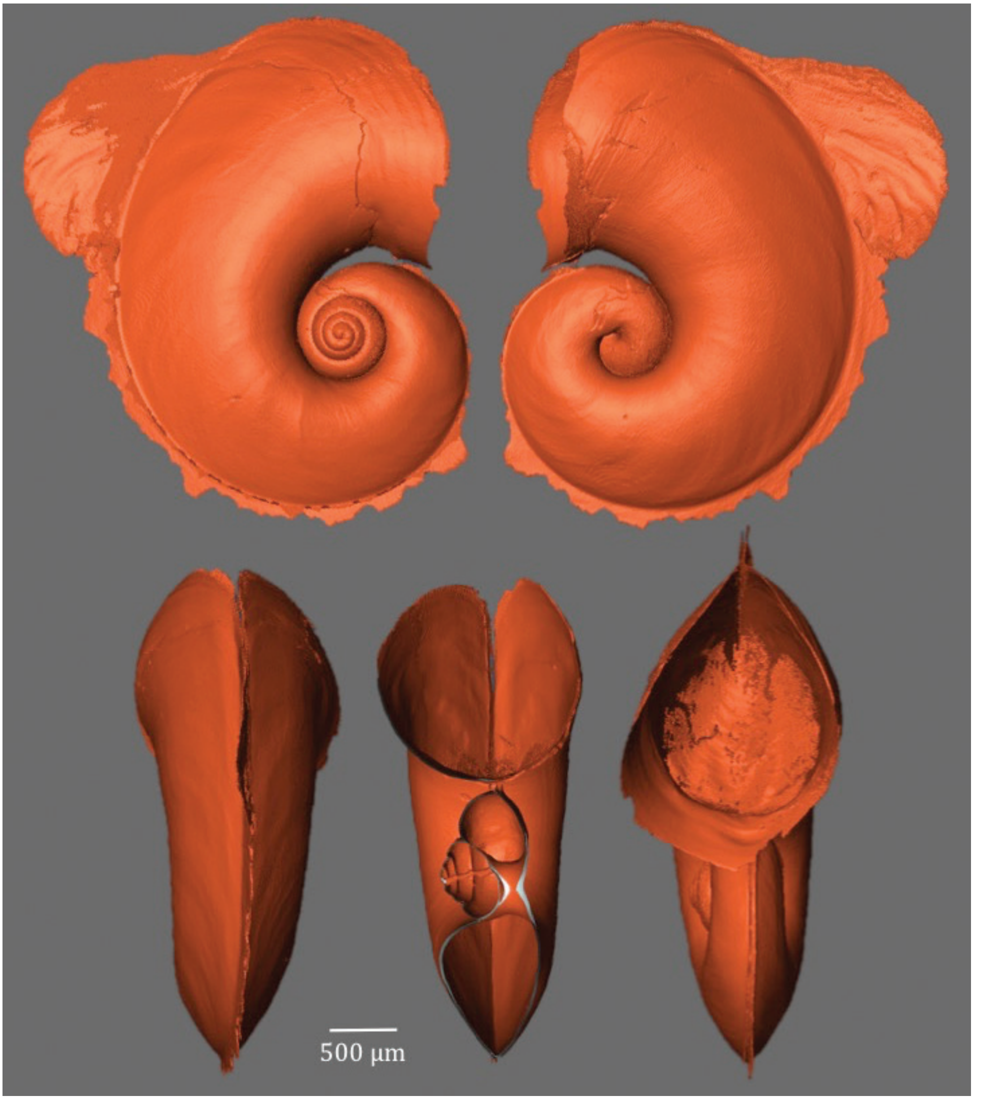

Figure 6. X-ray tomography of *A. ariejansseni* specimen Aari_AMT20_33_03.

ous low projections in the form of punctae roughly arranged in 9–12 spiral rows over the surface of whorls 2–4 (Fig. 4). These low projections can vary in their spatial coverage, from closely spaced to sparse (Fig. 4g–h). This gives the spire a rough appearance under a light microscope. The projections are clearly visible using SEM (Fig. 4). No other species of atlantid has been found with this type of micro-ornamentation in the inner spire. Juvenile specimens have approximately six fine lines of small projections running around the side of the shell, although these are not always obvious under light microscopy. Around the base of the juvenile shell the projections can become so closely positioned that they become irregular, frequently interrupted spiral lines in some specimens (Fig. 4j)

The operculum is type c, the radula is type I (Fig. 5m–n) and the eyes are of type a (Seapy et al. 2003), with no transverse slit (Fig. 5h and l).

Discussion. The rounded spire, number whorls, opercular, radula and eye type all suggest that *A. ariejansseni* belongs within the *Atlanta inflata* group of Richter and Seapy (1999). The most morphologically similar species are *Atlanta californiensis* and *A. selvagensis. Atlanta californiensis* has the same number of whorls in the spire and the same overall adult shape as *A. ariejansseni*, but it does not have any shell ornamentation. *Atlanta californiensis* also has much shallower spire sutures than *A. ariejansseni*. *Atlanta selvagensis* is a slightly smaller species that does show shell ornamentation of the spire in the form of spiral lines that are frequently interrupted and highly variable; however, the ornamentation of *A. ariejansseni* can clearly be distinguished from that of *A. selvagensis.* Molecular results presented here also confirm that the two species are closely related, but separated by a K2P genetic distance of 0.14. No molecular data is available for *A. californiensis.*

Previous publications have identified *A. ariejansseni* as *A. gaudichaudi* (Howard et al. 2011) and *A. helicinoidea* (Pilkington 1970). However, these two species are also morphologically different from *A. ariejansseni.* Although *A. helicinoidea* belongs to the *A. inflata* group, the spire has an extra whorl and the ornamentation is much coarser than that of *A. ariejansseni*. *Atlanta gaudichaudi* is described as having no shell ornamentation, although some authors show this species with a single spiral line on the spire (Seapy et al. 2003). However, *A. gaudichaudi* does not have the low projections that are found on the spire of *A. ariejansseni*. DNA barcoding also shows that these two species are not closely related, with an average K2P genetic distance of 0.25.

Distribution. All specimens were found between 37°S and 48°S latitude, in a narrow circumtropical band located in the Southern Subtropical Convergence Zone. Specimens were collected from the epipelagic layer (upper 372 m) using oblique plankton tows in the Atlantic and Pacific oceans. For a summary of biogeography and sampling information, see Fig. 1 and Table 1.

Etymology. Named after Arie Janssen, Naturalis Biodiversity Center, Netherlands, in recognition of his commitment and longstanding contributions to holoplanktonic gastropod research.

Conclusions

Combined molecular, morphological, and biogeographical information has allowed the introduction of a new species of the genus *Atlanta* that can be easily identified by means of its shell ornamentation using light microscopy. *Atlanta ariejansseni* is the only atlantid species that has been found living at high latitudes, restricted to a narrow circumpolar region. It is, therefore, an extremely important species in the current race to understand the effects of a changing ocean. It can be assumed that this species is able to tolerate a variable environment, which suggests that it may also be able to adapt to a changing ocean. This resilience and adaptability may be demonstrated by the successful rearing of veliger *A. ariejansseni* through to adults under laboratory conditions by Pilkinton (1970), which has never since been accomplished with other atlantid species.

Large sampling efforts have been made for holoplanktonic gastropods in the Southern Ocean; however, *A. ariejansseni* has never been recognised as an undescribed species in these studies. This is undoubtedly due to our incomplete understanding of atlantid taxonomy, particularly for the Atlantic Ocean. We hope that this study will increase awareness of *A. ariejansseni* and encourage others to record this circumpolar species when observed to build up a more complete biogeography. It is only with more biogeographical and ecological data that we will be able to determine the ecology and effects of a changing ocean upon this species.

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We are grateful to Donna Roberts (University of Tasmania) for providing specimens from sediment traps from off-shore of Tasmania. The Australian Antarctic Division supports this ongoing sediment trap program (AAS #1156). We would like to thank Elaine Fileman and Rachel Harmer (Plymouth Marine Laboratory) for providing specimens from AMT20. We are grateful to Aline Nieman, Kevin Beentjes and Frank Stokvis (Naturalis Biodiversity Center) for help with DNA barcoding of specimens and Erica Goetze and Rachel Harmer for plankton collection on cruises AMT20, AMT24 and DRFT. We would like to acknowledge the Plymouth Electron Microscopy Centre and Glenn Harper for help with SEM imaging, the scientists and crew who took part in cruises AMT20, AMT24 and DRFT, and the Atlantic Meridional Transect (AMT) programme. This study is a contribution to the international IMBER project and was supported by the UK Natural Environment Research Council National Capability funding to Plymouth Marine Laboratory and the National Oceanography Centre, Southampton. This is contribution number 302 of the AMT programme. We acknowledge Diamond Light Source for time on Beamline/Lab I13-2 under Proposal MT12300-1 and Christophe Rau and Andrew Bodey for help with x-ray tomography. We are extremely grateful to María Moreno-Alcántara and Nathalie Yonow for reviewing our manuscript and for their constructive comments. DW-P was funded by the Leverhulme Trust (RPG-2013-363, 2014-2017, PA Christopher Smart, Plymouth University, Co-A Richard Kirby, Marine Biological Association, Plymouth) and a Martin-Fellowship from the Naturalis Biodiversity Center, Leiden (2015).

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RESEARCH ARTICLE

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New blind species and new records of *Sinella* from Nanjing, China (Collembola, Entomobryidae)

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Abstract

Two new blind species of *Sinella* are described from Nanjing, China. *Sinella quinseta* **sp. n.** from Purple Mountain possesses unique 5+5 central macrochaetae on Abd. II, and can be distinguished from other species of the genus by the postlabial chaetae and the dorsal chaetotaxy. *Sinella qixiaensis* **sp. n.** from Qixia Mountain is characterized by the paddle-like S-chaetae of Ant. III organ and the smooth straight chaetae on the manubrium and base of dens; it differs from two closely related species by the smooth manubrial chaetae, the labial chaetae, the Ant. III organ, and the macrochaetae on Abd. II. *Sinella fuyanensis* Chen & Christiansen and *Sinella quinocula* Chen & Christiansen were also newly recorded from Nanjing.

Keywords

Springtail, eyeless, *Sinella quinseta* sp. n., *Sinella qixiaensis* sp. n.

Introduction

The genus *Sinella* has a worldwide distribution, and is particularly abundant in China. Deharveng (1990), Chen and Christiansen (1993) and Zhang et al. (2009, 2011) made main contributions to the modern taxonomy of this genus. To date, a total of 37 species, including 25 eyed (Ding and Zhang 2015) and 12 blind ones, have been reported from China. Among them, only four-eyed but no blind species were recorded from Nanjing, Jiangsu Province: *Sinella curviseta* Brook, 1882, *Sinella triocula* Chen & Christiansen, 1993, *Sinella affluens* Chen & Christiansen, 1993, and *Sinella quinocula* Chen & Christiansen, 1993. In the present paper, two new blind species and two new records are reported from Nanjing.

Materials and methods

Specimens were cleared in Nesbitt's fluid, mounted under a coverslip in Marc André II solution, and studied using a Nikon E80i microscope. The labial chaetae terminology follows Gisin's system (1967). The dorsal and ventral chaetotaxy of head and the Ant. III organ are described after Chen and Christiansen (1993). Dorsal body chaetae are designated following Szeptycki (1979) and Zhang et al. (2011). The number of macrochaetae is given by half-tergite in the descriptions (left side of tergites drawn in figures). Tergal S-chaetotaxic formula follows Zhang and Deharveng (2015). All materials are deposited in the collections of the Department of Entomology, College of Plant Protection, Nanjing Agricultural University (NJAU), P. R. China.

Abbreviations

Th. thoracic segment;
Abd. abdominal segment;
Ant. antennal segment;
mac macrochaeta/ae;
mic microchaeta/ae;
ms S-microchaeta/ae;
sens ordinary tergal S-chaeta/ae.

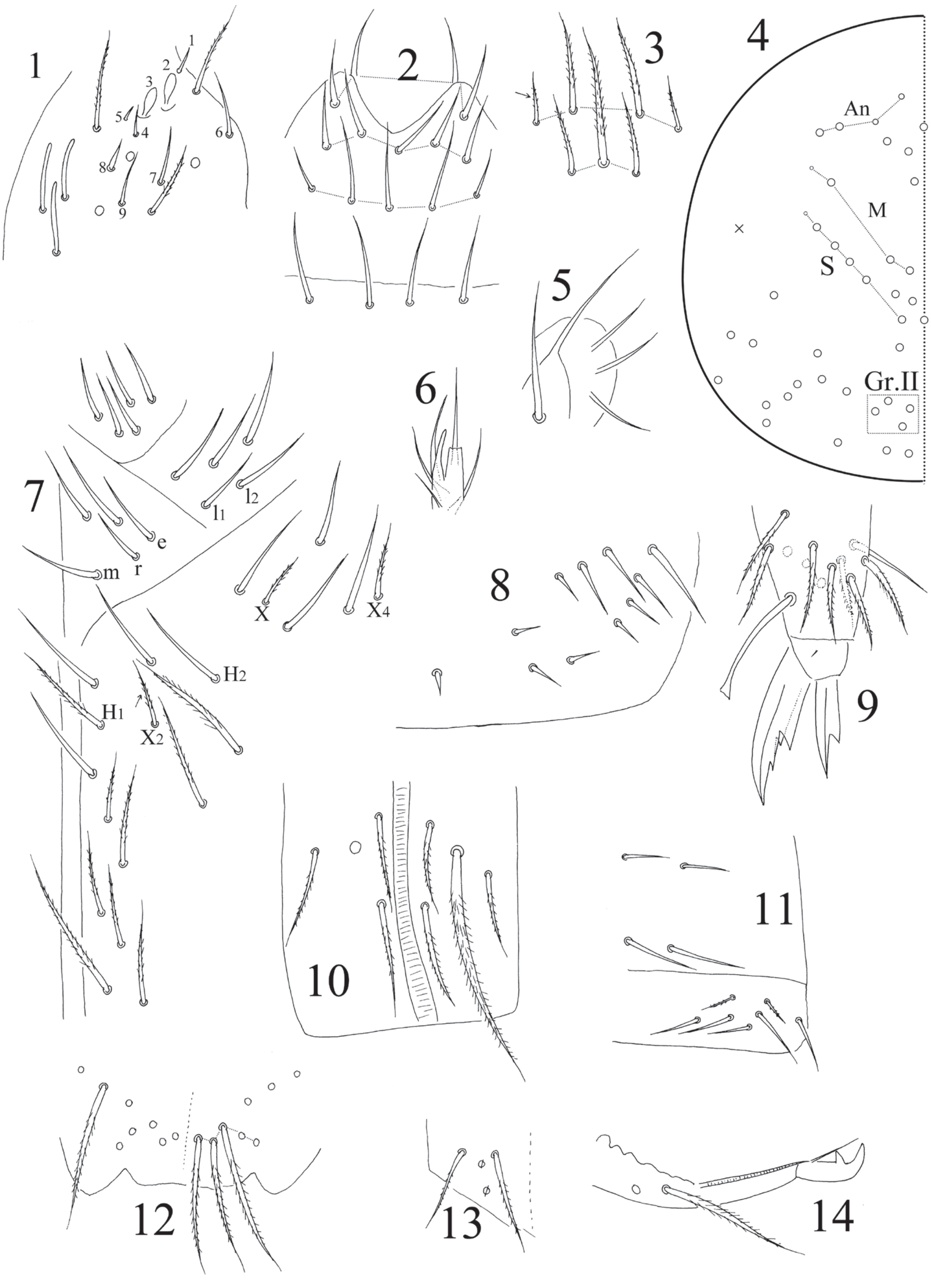
Taxonomy

***Sinella quinseta* sp. n.**
http://zoobank.org/C83F07ED-4F4C-492D-A2B6-BBCCA5352450
Figs 1–18

Material. Holotype: ♀ on slide, China, Jiangsu Province, Nanjing, Purple Mountain, Tomb of Liao Zhongkai and his wife He Xiangning, 32.056°N, 118.830°E, altitude 38 m, 10 April 2009, Feng Zhang and Daoyuan YU leg. (# C9581). Paratypes: 1 ♂ and 4 ♀♀ on slides and 5 juveniles in alcohol, same data as holotype.

Etymology. Named after the unique 5+5 central mac on Abd. II in this new species.

Diagnosis. No eyes. Two internal sens of Ant. III organ expanded. Long smooth straight chaetae absent on antennae. Clypeal chaetae 7(5). Postlabial chaetae X, X_2 and



Figures 1–14. *Sinella quinseta* sp. n. **1** Ant. III organ **2** labrum **3** clypeal chaetae (arrow indicates that the chaeta may be absent) **4** dorsal cephalic chaetotaxy **5** maxillary outer lobe **6** lateral process of labial palp E **7** chaetae on the ventral side of head **8** trochanteral organ **9** hind claw **10** anterior face of ventral tube **11** ventral face and lateral flap of ventral tube **12** distal part of anterior face of manubrium **13** manubrial plaque **14** mucro.

X_4 ciliate. No "smooth" inner differentiated tibiotarsal chaetae. Tenent hairs clavate. Manubrium without smooth chaetae. Tergal ms as 1, 0|1, 0, 0, 0. Abd. II with 5+5 central mac. Abd. IV with 5+5 central and 5+5 lateral mac.

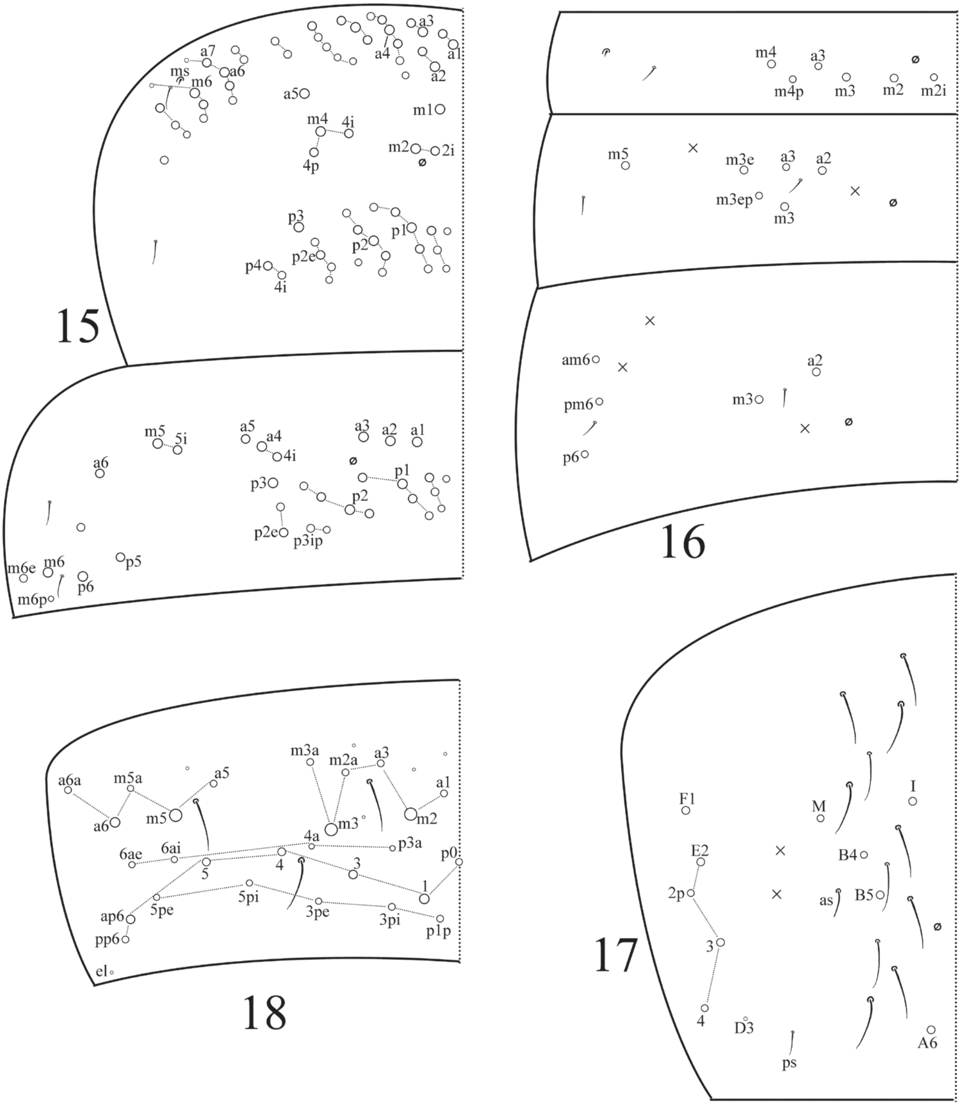
Description. Body length up to 1.17 mm. Body pale in alcohol.

Antenna 1.69–1.80 times as long as cephalic diagonal. Antennal segments ratio as I : II : III : IV = 1 : 2.00–2.17 : 1. 82–1.90 : 3.12–3.18. Smooth spiny mic at base of antennae 3 dorsal, 3 ventral on Ant. I, 1 internal, 1 external and 1 ventral on Ant. II. Ant. II distally with 1 rod-like S-chaeta. Two internal sens of Ant. III organ expanded (Fig. 1). Long smooth straight chaetae absent on antennae.

Eyes absent. Prelabral and labral chaetae 4/ 5, 5, 4, all smooth; the three median chaetae of the row a longer than lateral ones (Fig. 2). Labral papillae absent. Clypeal chaetae 7(5), arranged in two rows; the inner two chaetae of the anterior row of four chaetae smooth in one specimen; most lateral two small chaetae absent in two specimens (Fig. 3). Dorsal cephalic chaetotaxy with four antennal (An), three median (M) and five sutural (S) mac; Gr. II with four mac (Fig. 4). Mandible teeth 4+5. Subapical chaeta of maxillary outer lobe thicker than apical one and subequal in length; three smooth sublobal hairs on maxillary outer lobe (Fig. 5). Lateral process of labial palp slightly thicker than normal chaetae, with tip beyond apex of labial papilla E (Fig. 6). Labial chaetae as mrel$_1$l$_2$, all smooth, r/m = 0.60–0.68; chaetae X, X_2 and X_4 ciliate; X_2 often absent; chaeta H_1 ciliate; H_2 smooth in one specimen and ciliate in others. Cephalic groove with 9(8) chaetae, 2(3) smooth and others ciliate (Fig. 7).

Trochanteral organ with 9–13 smooth spiny chaetae; 7–9 in arms and 2–4 between them (Fig. 8). Inner differentiated tibiotarsal chaetae ciliate with ciliations not closely appressed to axis. Tibiotarsi distally with ten chaetae in a whorl. Unguis with three inner teeth; two paired teeth unequal, outer one large. Unguiculus with a large outer tooth. Tenent hairs clavate (Fig. 9). Abd. IV 2.44–3.32 times as long as Abd. III along dorsal midline. Ventral tube anteriorly with 4–5 ciliate chaetae; one of them much larger than others (Fig. 10); posteriorly with 4 smooth chaetae; each lateral flap with 5 smooth and 2 ciliate chaetae (Fig. 11). Manubrium without smooth chaetae. Manubrium anteriorly with 5+5 ciliate chaetae in the most distal row (Fig. 12). Manubrial plaque with 2+2 pseudopores and 2+2 ciliate chaetae (Fig. 13). Distal smooth part of dens 1.34–1.85 times as long as mucro. Mucro bidentate with apical tooth longer than subapical one; basal spine long, nearly reaching tip of the apical tooth (Fig. 14).

Th. II with 3 (m1, m2, m2i) medio-medial, three (m4, m4i, m4p) medio-lateral, 20–22 posterior mac, one ms and two sens; ms inner to sens. Th. III with 29–32 mac and two lateral sens; mac a6i absent (Fig. 15). Abd. I with six (a3, m2–4, m2i, m4p) mac, one ms and one sens; sens inner to ms. Abd. II with five (a2, a3, m3, m3e, m3ep) central, one (m5) lateral mac and two sens. Abd. III with two (a2, m3) central, three (am6, pm6, p6) lateral mac and two sens; ms absent (Fig. 16). Abd. IV with five central (I, M, B4, B5, A6), five lateral mac (E2–4, E2p, F1), and approximately 13 sens; as and ps shorter than others (Fig. 17). Abd. V with three sens; chaeta p5a absent (Fig. 18).



Figures 15–18. Tergal chaetotaxy in *S. quinseta* sp. n. **15** thorax **16** Abd. I–III **17** Abd. IV **18** Abd. V.

Ecology. In decomposing leaves along the roads.

Remarks. *Sinella quinseta* sp. n. is characterized by blindness, ciliate postlabial chaeta H_1 and 5+5 central mac on Abd. II. It is most similar to *S. yunnanica* Zhang & Deharveng, 2011 in being blind, its claw structure, the lateral process of labial palp, mucro, and chaetotaxy of head, thorax and Abd. IV, but differs from it in the presence of expanded internal S-chaetae on Ant. III organ, ciliate H_2, X, X_2 and X_4 posterior to labium, 5+5 central mac on Abd. II, and the ventral tube.

***Sinella qixiaensis* sp. n.**
http://zoobank.org/DBFF3DC3-BC1D-4FC3-B5E3-5CB4E1D076E1
Figs 19–37

Material. Holotype: ♂ on slide, China, Jiangsu Province, Nanjing, Qixia Mountain, 32.160°N 118.960°E, altitude 114 m, 6 December 2014, Daoyuan Yu and Chunyan Qin leg. (#14NJQX4). Paratype: 4 ♀♀ on slides and 5 in alcohol, same data as holotype.

Etymology. Named after the type locality.

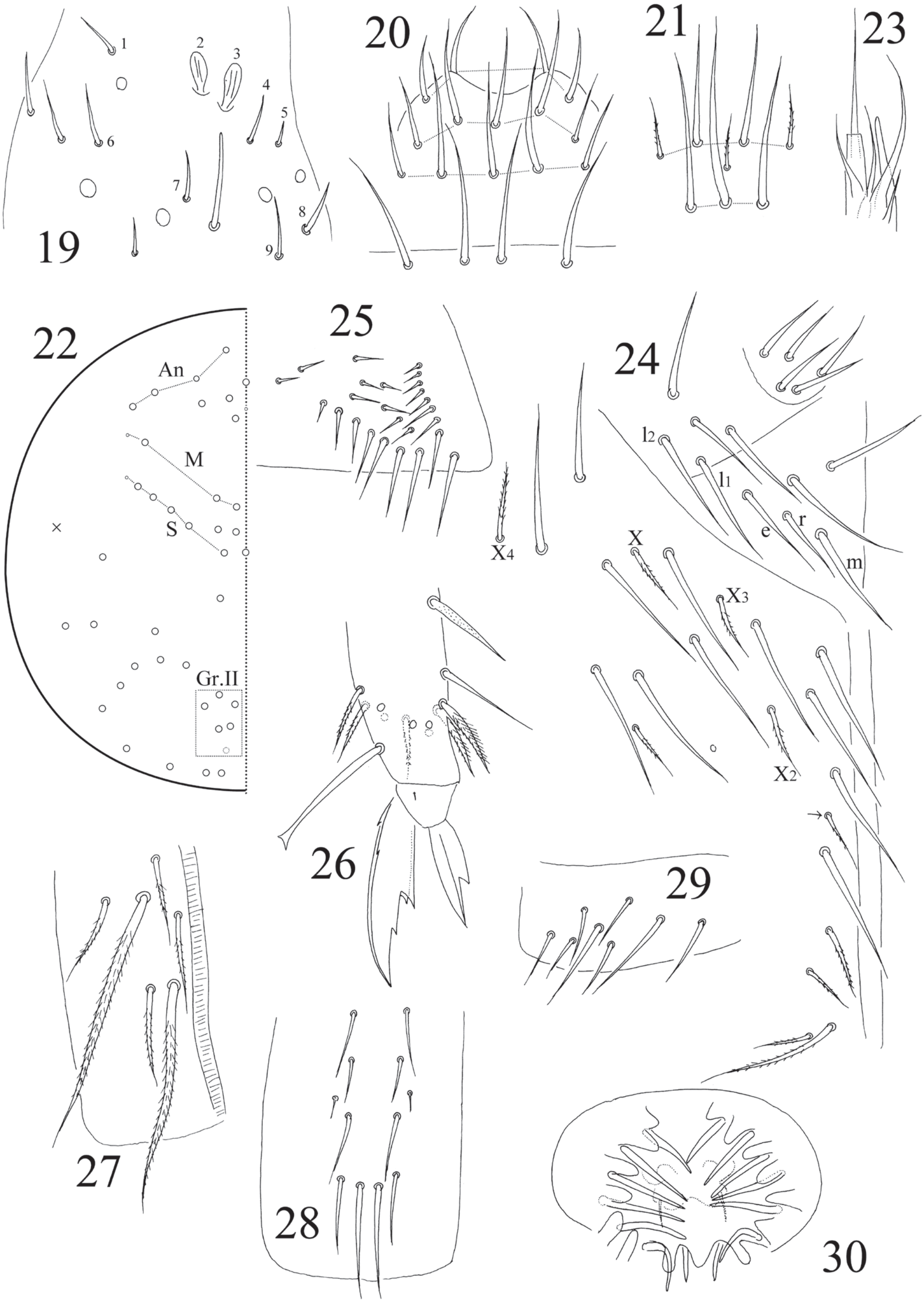
Diagnosis. No eyes. Two internal sens of Ant. III organ paddle-like. Long smooth straight chaetae present on antennae. Clypeal chaetae eight. Postlabial chaetae X and $X_{2–4}$ ciliate. "Smooth" inner differentiated tibiotarsal chaetae present. Tenent hairs I and II pointed or clavate, and III always clavate. Manubrium with smooth chaetae. Tergal S-microchaetae as 1, 0|1, 0, 0, 0. Abd. II with 4(3) central mac on each side. Abd. IV with 7+7 central and 6+6 lateral mac.

Description. Body length up to 2.01 mm. Body pale in alcohol.

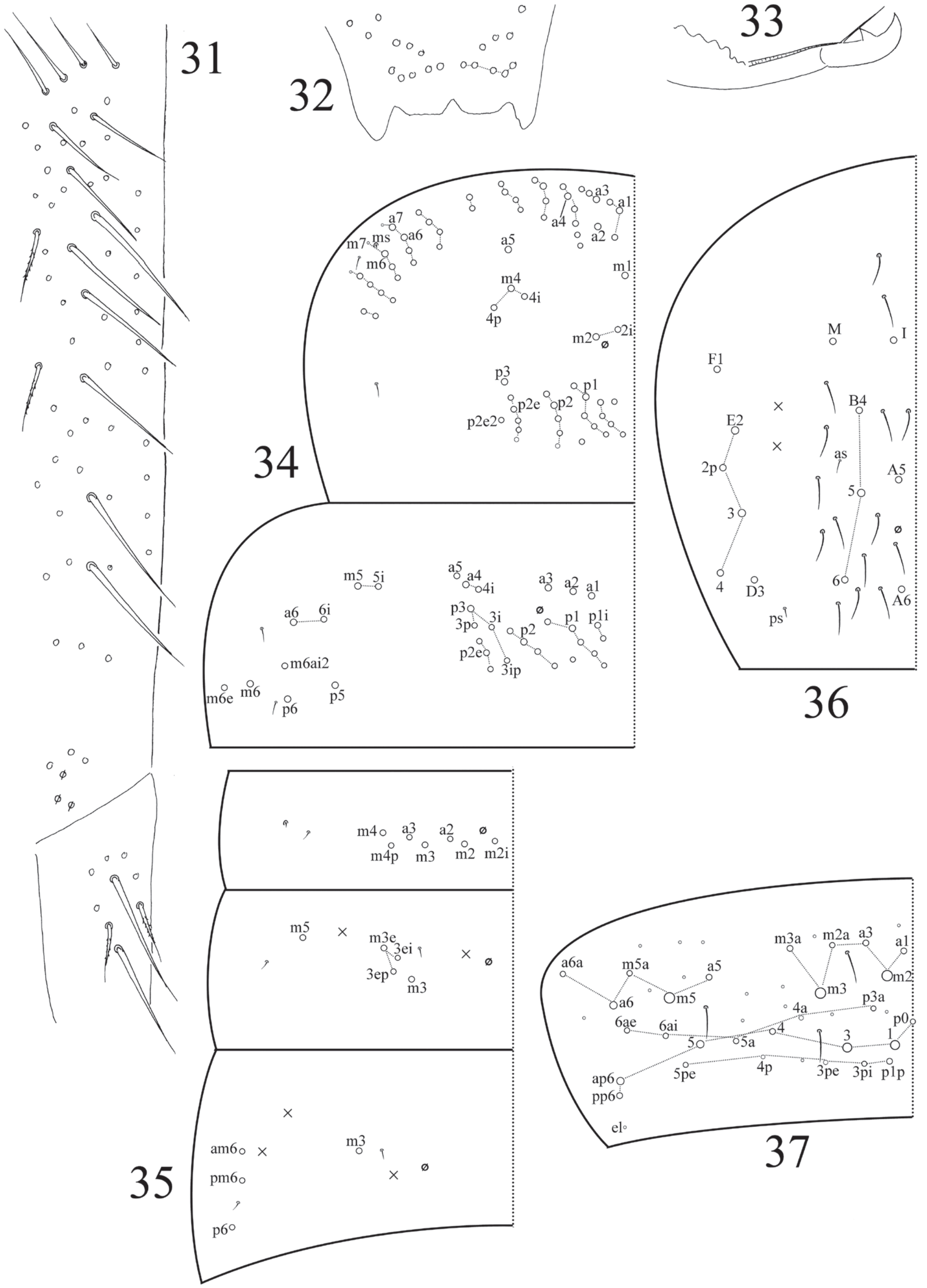
Antenna 2.41–2.68 times as long as cephalic diagonal. Antennal segments ratio as I : II : III : IV = 1 : 1.66–1.96 : 1. 59–1.83 : 2.44–3.00. Smooth spiny mic at base of antennae three dorsal, three ventral on Ant. I, one internal, one external and two ventral on Ant. II. Ant. II distally with two rod-like sens. Two internal sens of Ant. III organ paddle-like (Fig. 19). Ant. IV with a knobbed subapical organ. Long smooth straight chaetae at least five ventral on Ant. I, at least 13 ventral on Ant. II, and one ventral on Ant. III.

Eyes absent. Prelabral and labral chaetae 4/ 5, 5, 4, all smooth; median three chaetae of the row a longer than lateral ones; labral intrusion not U-shaped (Fig. 20). Labral papillae absent. Clypeal chaetae eight in number, of which three are ciliated and small (Fig. 21). Dorsal cephalic chaetotaxy with four antennal (An), three median (M) and five sutural (S) mac; Gr. II with 5–6 mac (Fig. 22). Mandible teeth 4+5. Subapical chaeta of maxillary outer lobe larger than apical one; three smooth sublobal hairs on maxillary outer lobe. Lateral process of labial palp slightly thicker than normal chaetae, with tip beyond apex of labial papilla E (Fig. 23). Labial chaetae as $mrel_1l_2$, all smooth, r/m=0.61–0.76; chaetae X and $X_{2–4}$ ciliate; chaeta X_3 rarely absent. Cephalic groove with 8–9 chaetae, 4(5) of them smooth and others ciliate (Fig. 24).

Trochanteral organ with approximately 24 smooth spiny chaetae; 13–15 in arms and 9–11 between them (Fig. 25). Partial inner differentiated tibiotarsal chaetae "smooth" with ciliations closely appressed to axis. Tibiotarsi distally with ten chaetae in a whorl. Unguis with three inner, one outer, and two lateral teeth; two paired inner teeth unequal, outer one large. Unguiculus with a large outer tooth. Tenent hairs I and II pointed or clavate, and III always clavate (Fig. 26). Abd. IV 3.13–4.67 as long as Abd. III along dorsal midline. Ventral tube anteriorly with 6+6 ciliate chaetae, two of them much larger than others (Fig. 27); posteriorly with 12 smooth chaetae (Fig. 28); each lateral flap with eight smooth chaetae (Fig. 29). Male genital plate with seven pairs of projections and internally with one pair of small chaetae (Fig. 30). Manubrium dorsally with about 13+13 smooth chaetae (Fig. 31); ventrally with 5+5 distal ciliate



Figures 19–30. *Sinella qixiaensis* sp. n. **19** Ant. III organ **20** labrum **21** clypeal chaetae **22** dorsal cephalic chaetotaxy **23** labial palp **24** chaetae on the ventral side of head **25** trochanteral organ **26** hind claw **27–29** ventral tube **27** anterior face **28** posterior face **29** lateral flap **30** male genital plate.



Figures 31–37. *Sinella qixiaensis* sp. n. **31** dorsal side of manubrium and base of dens **32** distal part of anterior face of manubrium **33** mucro **34–37** tergal chaetotaxy **34** thorax **35** Abd. I–III **36** Abd. IV **37** Abd. V.

chaetae (Fig. 32). Manubrial plaque with 3+3 pseudopores and 3+3(2) ciliate chaetae. Base of dens with 2+2 smooth chaetae (Fig. 31). Distal smooth part of dens 1.04–1.12 as long as mucro. Mucro bidentate with apical tooth larger; basal spine long, with tip nearly reaching apical tooth (Fig. 33).

Th. II with three (m1, m2, m2i) medio-medial, three (m4, m4i, m4p) medio-lateral, 22–24 posterior mac, one ms and two sens; ms inner to sens. Th. III with 30–34 mac and two lateral sens; m5i, a6i, p5, p6, m6 and m6e as mac (Fig. 34). Abd. I with seven (a2–3, m2–4, m2i, m4p) mac, one ms and one sens; sens inner to ms. Abd. II with 4(3) (m3, m3e, m3ep, m3ei) central, one (m5) lateral mac and two sens; mac m3ei only absent on one side of one specimen. Abd. III with one (m3) central, three (am6, pm6, p6) lateral mac and two sens; ms absent (Fig. 35). Abd. IV with seven central (I, M, A5–6, B4–6), six lateral mac (D3, E2–4, E2p, F1), and at least 17 sens; sens as and ps short (Fig. 36). Abd. V with 3 sens (Fig. 37).

Ecology. In decomposing leaves along the roads.

Remarks. *Sinella qixiaensis* sp. n. is characterized by blindness, the paddle-like sens of Ant. III organ and abundant smooth chaetae on the manubrium. It is most similar to *Sinella insolens* Chen & Christiansen, 1993 and *Sinella sineocula* Chen & Christiansen, 1993. It differs from the former in the presence of smooth manubrial chaetae and the absence of labial chaeta M_{1s}, and also differs from *S. sineocula* in the presence of smooth manubrial chaetae, the paddle-like sens of Ant. III organ, and the presence of mac m3ei on Abd. II.

Sinella fuyanensis Chen & Christiansen, 1993

Sinella (*Sinella*) *fuyanensis* Chen & Christiansen, 1993: 27. Type locality: China (Jiangxi).

Material. ♀ on slide and 4 in alcohol, China, Jiangsu Province, Nanjing, Lao Mountain, Long Cave, 32.051°N, 118.527°E, altitude 112 m, 10 April 2015, Daoyuan YU and Chunyan QIN leg. (# 15NJLS).

Ecology. Known only from caves.

Distribution. China (Jiangxi, Jiangsu).

Sinella quinocula Chen & Christiansen, 1993

Sinella (*Sinella*) *quinocula* Chen & Christiansen, 1993: 24. Type locality: China (Anhui).

Material. ♀ on slide and 5 in alcohol, China, Jiangsu Province, Nanjing, Lao Mountain, Longxing temple, 32.051°N, 118.527°E, altitude 112 m, 10 April 2015, Daoyuan YU and Chunyan QIN leg. (# 15NJLS).

Ecology. Under stones.

Distribution. China (Anhui, Jiangsu, Shaanxi).

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Description of a new species of *Metabemisia* Takahashi, 1963 from China (Hemiptera, Aleyrodidae)

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Abstract

A new whitefly species, *Metabemisia leguminosa* **sp. n.**, collected from an undetermined leguminous herb is described from Wuzhishan Mountain, Hainan Island, China. The puparium of the new species differs from that of all other *Metabemisia* species by the presence of 4–5 rows of very small distinct papillae along the margin, the absence of the first abdominal seta, and the indistinct thoracic tracheal pores. An identification key to the worldwide species of *Metabemisia* is provided.

Keywords

Aleyrodidae, *Metabemisia*, taxonomy, new taxa, China

Introduction

The genus *Metabemisia* (Hemiptera: Aleyrodidae) was established by Takahashi (1963) with *M. distylii* Takahashi as its type species by monotypy. Only three species have hitherto been placed in this genus. Takahashi (1963) described *M. distylii* from Japan on *Distylium racemosum.* Mound (1967) described *M. filicis* from Scotland on *Dryopteris* sp., *Nephrolepis* sp. and *Davallia* sp.; from England on *Pteris togoensis* or *Cyclosorus dentate*, and Ko et al. (1998) recorded the same species from Taiwan (China) on *Tectaria decurrens*. Martin (2001) described *M. palawana* from Philippines on *Lastreopsis* sp.

A faunal survey of Aleyrodidae was conducted in some nature reserves of Hainan Island in May 2012 as the Aleyrodidae fauna in these areas had not been previously investigated in detail. Puparia of an undescribed species of this genus were collected from Wuzhishan Mountain, this being the first record of the genus from Mainland China.

Material and methods

The puparia of the new species were collected from an undetermined leguminous herb found on Wuzhishan Mountain, 18°51'N, 109°39'E, 561 m, Hainan Island, China on 18 May, 2012. The puparia were mounted on glass slides following the method suggested by Martin (1987), as compared with other methodologies such as the method given by Hodgesa and Evans (2005) and Dubey and David (2012), the steps are almost same except slight differences. The terminology for morphological structures follows Bink-Moenen (1983), Martin (1985) and Gill (1990). The measurements were made through measuring 9 specimens including the holotype, using a LEICA MZAPO stereo-microscope. The Scanning Electron Microscope (SEM) images were taken using Philips XL30-Environmental Scanning Electron Microscope at 20 kV/EHT and 80 Pa between 157 to 1258 times magnification. The detail steps of SEM study following Wang et al. (2014).

The holotype is deposited in the Insect Collection of Yangzhou University (YZU). A paratype will be deposited in each of the following institutions: Natural History Museum (BMNH), London, UK; Zoological Survey of India (ZSI), Kolkata, India; the remainder of the paratypes are currently deposited in Insect Collection of Yangzhou University and Shanghai Entomological Museum, Chinese Academy of Sciences (SHEM).

Taxonomy

Metabemisia Takahashi

Metabemisia Takahashi, 1963: 52. Type species: *Metabemisia distylii*, by monotypy.

Diagnosis. Puparium elliptical, with a single row of submarginal setae, *M. distylii* and *M. filicis* bear ten pairs of submarginal setae while *M. palawana* bears 14 pairs. Vasiform orifice elongate-cordate to triangular, much longer than wide, the trapezoidal operculum occupying about half of orifice (Takahashi 1963; Martin and Camus 2001). This genus resembles *Parabemisia* Takahashi in the shape of puparium and the presence of a row of submarginal setae, but can be distinguished by the lingula wanting lateral tubercles and in the presence of caudal tracheal cleft. It also resembles *Neomaskellia* Quaintance & Baker, but differ in the characters of vasiform orifice.

***Metabemisia leguminosa* sp. n.**
http://zoobank.org/CAFBAA3C-E0BA-45D5-8BD7-90DE08FB377E
Figs 1–12

Type locality. China, Hainan Island, Wuzhishan Mountain, 18°51'N, 109°39'E, 561 m, on Leguminous herb, 18.v.2012, leg. JR Wang.

Type material. Holotype: China, Hainan Island, Wuzhishan Mountain, 18°51'N, 109°39'E, 561 m, 1 puparium on slide, on leguminous herb, 18.v.2012, leg. J R Wang (WZS-NO.1), deposited in YZU.

Paratypes: Fifteen paratypes, same data as the holotype, 15 puparia on 15 slides, (WZS-NO.2–4: BMNH-1, ZSI-2); (WZS-NO.5–16: SHEM-2, YZU-10). 17 dry puparia on leguminous leaves with above collection data available at YZU.

Diagnosis. This species is characterized by the submarginal area with ten pairs of subequal longsetae (Figs 2, 6), about 74.6–93.6μm,the presence of 4–5 rows of very small distinct pore along the margin (Figs 1, 5), the absence of the first abdominal setae, and the thoracic tracheal pores being indistinct, the submedian depressions are particularly distinct on abdominal segment I–VI (Fig. 7), vasiform orifice triangular (Figs 4, 8), longer than wide, lingula with a pair of apical setae (Figs 4, 8).

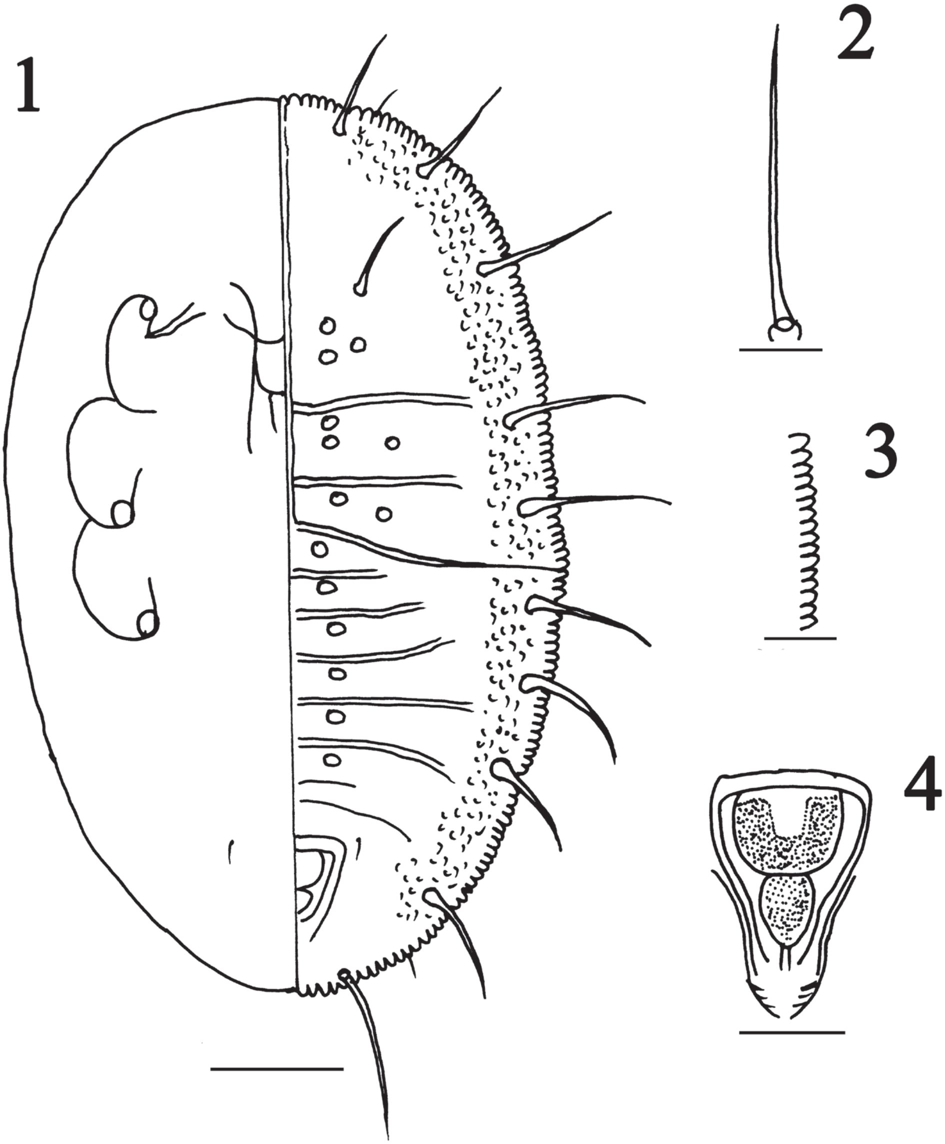
Description. Puparia (fourth instar). Body yellowish, elliptical, 581–723 μm long, 306–395 μm wide, broadest at the metathoracic region. Margin crenulate (Figs 3, 6), 23–25 crenulations in 0.1 mm. Approximately 4–5 rows of very small distinct papillae present along the margin. Paired anterior and posterior marginal setae 19–24 μm and 18–22 μm long, respectively.

Dorsum. Submarginal area with ten pairs of long setae, nine of which are subequal in length, about 72.3–76.8 μm, each arising from a small tubercle; caudal setae 90.6–95.4 μm; cephalic setae 41.7–44.8 μm; eighth abdominal setae 8.1–8.8 μm long, first abdominal setae absent. Longitudinal and transverse molting sutures all reaching the margin. A pair of sub-median depressions present on each thoracic and abdominal segment I–VI, approximately 43.3 μm apart. Abdominal segments I–VI nearly equal in length, while abdominal segment VII only about half of abdominal segment VIII, less than half as long as abdominal segment VI.

Vasiform orifice. Triangular, distinctly longer than wide, 62.1–64.6 μm long, 42.6–45.2 μm wide; operculum inverted trapezoid, covering nearly half the orifice, 25.8–29.1 μm long, 32.1–35.2 μm wide. Lingula exposed, knobbed, expand at the base, 13.1–16.2 μm long, 14.2–17.8 μm wide, nearly reaching the hind margin of the orifice, with a pair of apical setae, 10.8–13.1 μm in length. Caudal furrow distinct.

Venter. Thoracic tracheal folds and pores not discernible. Ventral abdominal setae placed on either side of anterior angles of vasiform orifice, finely pointed and 7–9 μm long, 67 μm apart. Adhesive pads present at apex of legs.

Third instar (Figs 10–11)**.** yellowish, elliptical, about 514–558μm long, 289–303μm wide, the other morphological characteristics are basically identical with the puparia except the vasiform orifice region. The operculum (Fig. 11) protruded in the central part, about 18.6–20.3 μm long, 34.9–36.7 μm wide, and covering about half



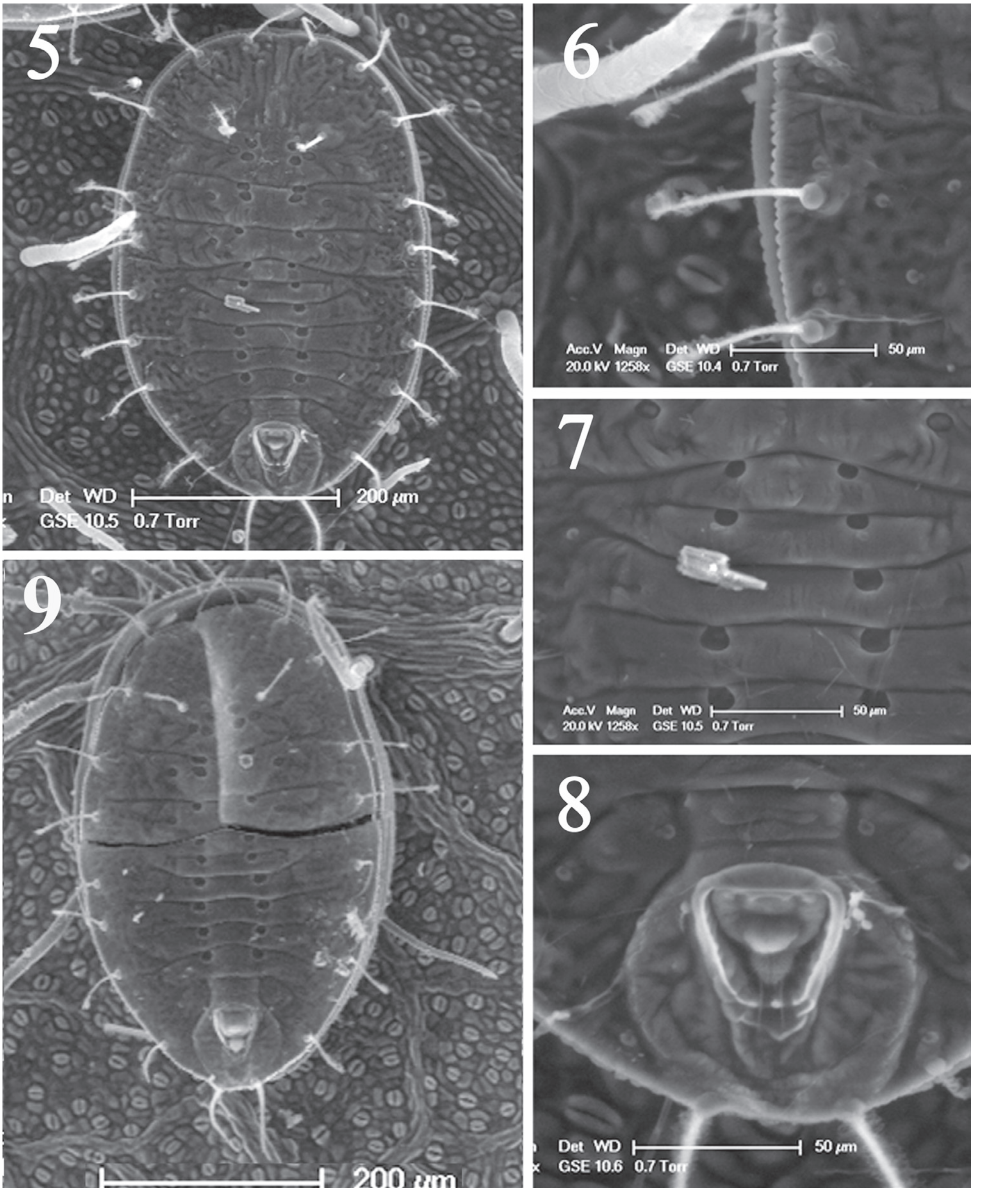
Figures 1–4. *Metabemisia leguminosa* sp. n., holotype puparium, China (Hainan). **1** puparium, dorsal (right) and ventral (left) views **2** submarginal seta **3** margin **4** vasiform orifice. Scale bars: 0.1 mm (**1**); 0.02 mm (**2**); 0.04 mm (**3**); 0.03 mm (**4**).

of the orifice. Lingula (Fig. 11) particularly developed and upward, extending beyond the hind margin of the orifice, about double the length of operculum, 40.7–42.1 μm long; with a pair of apical setae, about 17.4–18.6 μm long.

Other instars. Unknown.

Host plants. Leguminosae.

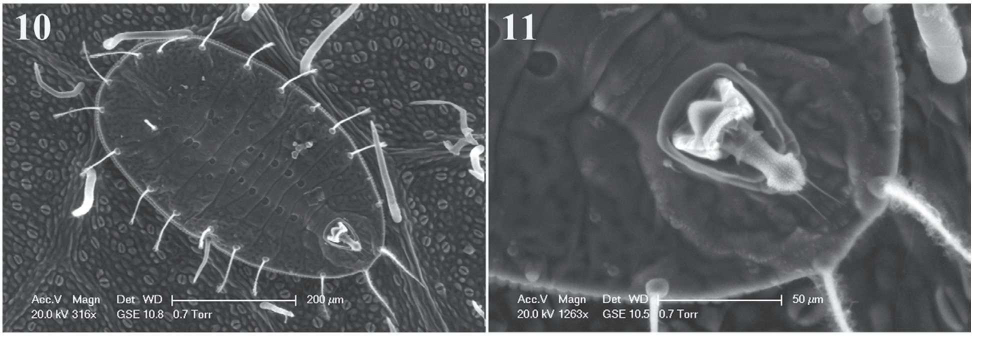
Distribution. China (Hainan Island).



Figures 5–9. Scanning Electron Microscope (SEM) photographs of *Metabemisia leguminosa* sp. n., China (Hainan) **5** puparium, dorsal view **6** margin and submarginal setae **7** the sub-median depressions on abdominal segments **8** vasiform orifice **9** empty pupal case, dorsal view.

Biology. Specimens were found in clusters of 5–8 per leaf, centrally on the under surface of leaves. No evident signs of damage have been noted on the host plant. No parasitoids were obtained from the puparia. No ant attendance was observed.

Etymology. The species name was derived from the family name of the host plant; adjective.



Figures 10–11. Scanning Electron Microscope (SEM) photographs of *Metabemisia leguminosa* sp. n., China (Hainan) **10** third instar, dorsal view **11** vasiform orifice of third instar.

Figure 12. The live images of *Metabemisia leguminosa* sp. n., China (Hainan). **A** puparium, dorsal view **B** empty pupal case, dorsal view.

Key to the puparia of *Metabemisia* species

(Puparia characters obtained from original descriptions)

1	Outline elongate-oval; dorsal bears 14 pairs of submarginal setae; vasiform orifice elongate-cordate; lingular setae absent	***M. palawana***
–	Outline oval; dorsal bears 10 pairs of submarginal setae; vasiform orifice triangular; lingular setae present	**2**
2	The thoracic tracheal pores distinct; 1st abdominal setae present; without or with only one row of papillae along the margin	**3**
–	The thoracic tracheal pores indistinct; 1st abdominal setae absent; with 4–5 rows of papillae along the margin	***M. leguminosa* sp. n.**
3	Dorsal without papillaeand ridges; the lingula without basal tubercles, the caudal furrow is longer than the vasiform orifice	***M. distylii***
–	Margin with 33 pairs of papillae bearing wax glands and with ridges lead from the caudal setae to the vasiform orifice; the lingula tip with basal tubercles weekly developed, the caudal furrow is shorter than the vasiform orifice	***M. filicis***

Remarks

The new species resembles *M. filicis* by the ten pairs of submarginal setae, and by having a pair of sub-median depressions present on the abdominal and thoracic segments. However, in the new species the sub-median depressions are present on abdominal segments I-VI while in *M. filicis* on abdominal segments I-VII (Mound 1967). In addition the new species differs from *M. filicis* by the absence of the first abdominal setae, the indistinct thoracic tracheal pores andthe presence of 4-5 rows of very small distinct papillae along the margin. It also resembles the species of *Neomaskellia* Quaintance & Baker, 1913, *N. andropogonis* Corbett, 1926 and *N. bergii* (Signoret, 1868), but differs from them by the number of submarginal setae and the shape of vasiform orifice (Martin 1987).

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RESEARCH ARTICLE

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A revision of the genus *Pseudoechthistatus* Pic (Coleoptera, Cerambycidae, Lamiinae, Lamiini)

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Abstract

The genus *Pseudoechthistatus* Pic, 1917 is redefined and revised. Five species of the genus are described as new, *P. sinicus* **sp. n.** and *P. chiangshunani* **sp. n.** from central Yunnan, China, *P. pufujiae* sp. n. from western Yunnan, China, and *P. holzschuhi* **sp. n.** and *P. glabripennis* **sp. n.** from southern Yunnan and northern Vietnam. *Pseudoechthistatus birmanicus* Breuning, 1942 is excluded from the fauna of China. Three poorly known species, *P. obliquefasciatus* Pic, 1917, *P. granulatus* Breuning, 1942, and *P. acutipennis* Chiang, 1981 are redescribed, and the type localities of the former two species are discussed. Endophallic structure of seven species in inflated and everted condition are studied and compared with their relatives. Illustrations of habitus and major diagnostic features of all species are provided. Some biological notes are reported. An identification key as well as a distributional map are presented.

Keywords

Taxonomy, new species, Lamiini, endophallus, China, Vietnam, Myanmar, Oriental region

Introduction

The little-known genus *Pseudoechthistatus* Pic, 1917 was established based on a flightless species, *P. obliquefasciatus* Pic, 1917 from Dali, Yunnan, China. Later, Breuning (1942) revised the genus in his revision of the Phrissomini and added two species, *P. birmanicus* from Myanmar and *P. granulatus* from Tatsienlou (Kangding), Sichuan, China. Chiang (1981) described *P. acutipennis* from Mt. Omei (Emeishan), Sichuan, China as the fourth species of the genus. Hence, in the Titan database (Tavakilian and Chevillotte 2015), a total of four valid species was included in *Pseudoechthistatus*.

Specimens of the genus *Pseudoechthistatus* were so rare that all four species were described from single specimens and only a few additional specimens have been reported since the original publications. Li (1988) listed "Fugong, Yunnan" as an additional locality for *P. granulatus* (voucher specimen not available to the authors). This datum referred to Pu (1992). In the same paper, Pu (1992) reported *P. birmanicus* from Yaojiaping, Yunnan as a new country record for China based on a single female specimen. Ultimately for Chinese fauna, three species were included in Hua (2002) and four species were listed by Löbl and Smetana (2010) in their catalogues.

In the course of our studies of material from several major collections and from several expeditions to Yunnan, China, during 2010 to 2015, five new species were discovered (including four winged species). The generic definition of *Pseudoechthistatus* is broadened to legitimately include all those species. The four known species were determined based on high-quality photographs of their type specimens, three of them were reexamined and redescribed based on fresh material. *Pseudoechthistatus birmanicus* is excluded from the fauna of China, and the type localities of *P. obliquefasciatus* and *P. granulatus* are discussed. Endophallic structure of seven species in inflated and everted condition are described, figured and compared with their relatives from *Paraleprodera* Breuning, 1935. The basic observing method for endophallic comparison is discussed and proposed to be done in everted and inflated condition at least in Lamiini *sensu lato*.

Specimens are deposited in the following institutions, museums or private collections; abbreviations as shown in the text:

CBWX	Collection of Wen-Xuan Bi, Shanghai, China
CCCC	Collection of Chang-Chin Chen, Tianjin, China
CCH	Collection of Carolus Holzschuh, Villach, Austria
CGQH	Collection of Gui-Qiang Huang, Chongqing, China
CHTL	Collection of Tian-Long He, Huainan, Anhui, China
CJM	Collection of Ming Jin, Shanghai, China
CLB	Collection of Bin Liu, Beijing, China
CLC	Collection of Chao Li, Beijing, China
CSXB	Collection of Xiao-Bin Song, Shanghai, China
CTT	Collection of Tomáš Tichý, Opava, Czech Republic
CZDY	Collection of De-Yao Zhou, Shanghai, China
IZAS	Institute of Zoology, Chinese Academy of Sciences, Beijing, China

MHBU	Museum of Hebei University, Baoding, China
MNHN	Muséum National d'Histoire Naturelle, Paris, France
NHMB	Naturhistorisches Museum (Museum Frey, Tutzing), Basel, Switzerland
NHRS	Naturhistoriska riksmuseet, Stockholm, Sweden
NMNH	National Museum of Natural History (Smithsonian Institution), Washington, USA
SHEM	Shanghai Entomology Museum, Chinese Academy of Sciences, Shanghai, China
SWU	College of Plant Protection, Southwest University, Chongqing, China

Labels of the type specimens are quoted verbatim; double quotation marks (" ") are used for a single label, a slash (/) is used to separate lines on the same label, italics indicate handwriting, notes are included in [ ], Chinese characters are transcribed in the modern system.

Terminology of endophallic structures follows Danilevsky et al. (2005), Danilevsky and Kasatkin (2006) and Yamasako and Ohbayashi (2011). The abbreviations used in the present paper are as follows: **APH** – apical phallomere; **BPH** – basal phallomere; **CS** – crescent shaped sclerites; **CT** – central trunk; **MPH** – median phallomere; **MT** – medial tube; **PB** – preapical bulb; **ab** – apical bulb; **af** – apical furrow; **bb** – apical bubble; **bs** – basal swelling of central trunk; **gn** – gonopores; **im** – internal membrane of apical furrow; **vs** – ventral swelling of central bladder; **ltc** – lateral tubercles of central trunk, **vbt** – ventral basal tubercle of preapical bulb (first-time used herein).

Taxonomy

Pseudoechthistatus Pic, 1917

Pseudoechthistatus Pic, 1917: 6. Type species: *Pseudoechthistatus obliquefasciatus* Pic, 1917, by monotypy.

Pseudechthistatus (sic): Breuning 1942: 132; Breuning 1961: 318; Löbl and Smetana 2010: 286.

Pseudoechthistatus: Gressitt 1951: 349; Chiang et al. 1985: 104.

Redescription. Body elongate, medium sized (ca. 15.0–25.0 mm long). Head subequal to the pronotal width at base. Eyes coarsely faceted, strongly emarginate; lower lobe small, weakly prominent, subequal to or slightly longer than width. Frons wider than long. Antennal tubercles moderately prominent and separated. Antennae long, ca. 1.6–2.0 times (in male) or 1.2–1.4 times (in female) as long as body length; scape moderately long, apical cicatrix completed, the 3rd antennomere longest, ca 1.5–1.8 times as long as scape, 4th antennomere slightly longer than (in male) or subequal to (in female) scape, 4th to 10th successively shortened and narrowed, last antennomere slightly longer than penultimate; basal antennomeres (3–4 in male, 4–7 in female) distinctly fringed beneath. Both maxillary and labial terminal palpomeres fusiform. Pronotum cylindrical, subequal to or slightly longer than width at base; with two indistinct transverse grooves at the anterior and posterior margins; disk with a rugose longitudinal ridge, slightly raised medially, both sides with a developed or reduced, longitudinal pubescent band; with a lateral spine moderate long and acute apically at anterior middle of each side; prosternal intercoxal process narrow, slightly emarginate at apex, lower than coxae; procoxal cavities closed posteriorly; mesosternal intercoxal process without tubercle and obliquely sloped in lateral view; mesocoxal cavities open externally to mesepimera; metasternum short to moderately long, ca 1.0–1.8 times as long as mesosternal length. Scutellum broadly rounded posteriorly. Elytra elongate, ca. 1.8–2.2 times as long as humeral width, widest at the middle or at humeri or subparallel-sided in basal half, gradually to strongly narrowed after the middle, rounded or obliquely truncated to acute apically; disk finely to coarsely punctured, granules absent or moderately to strongly developed, with few erect or suberect setae; each elytron conspicuously with a moderate to large sized, median, moderately to strongly raised, glabrous tubercle subbasally (Figs 38–40); generally provided with three light pubescent markings**:** the first annular marking around the subbasal tubercle (subbasal annular marking), the second band complete or discontinuous, nearly transverse to strongly oblique, across the elytron near middle (middle band), the third stripe longitudinally near apical one-fourth toward elytral apex (preapical stripe). Hindwings developed to highly reduced. Legs long and slender, protibia with a subapical tooth beneath (weak in females), mesotibia with a subapical oblique groove externally, tarsus four segmented. Tarsal claws free, divaricate to moderately divergent.

Male genitalia. Tergite VIII (Figs 49–55, a) trapezoidal, truncated to slightly emarginated apically, with moderately long setae. Tegmen (Figs 49–55, b, c) in lateral view moderately curved, rhombic in shape and widest at middle or behind middle in ventral view; lateral lobes moderately slender, ca. one-fourth of total length of tegmen, which moderately provided with long setae on apex. Median lobe (Figs 49–55, d, e) slightly shorter than tegmen; moderately curved in lateral view; apex rounded to subacuminate in antero-dorsal view. Endophallus in everted condition (Figs 58–64) S-shaped, long and slender, subequal to or slightly longer than triple length of median lobe; BPH, MPH and APH well defined, crescent shaped sclerites (cs) present, MPH subdivided into MT, CT and PB by a constriction; the length of MT ca. 2.0–2.5 times as long as the length of BPH, CT slightly shorter than PB, the combined length of CT and PB subequal to the length of BPH and slightly shorter than median lobe; BPH hardly swollen apically; PB cylindrical at base with developed anterior bulb, CT developed, basal swelling (bs) strongly swollen ventrolaterally or with distinct lateral tubercles (ltc), slightly swollen posterodorsally, MT with ventral swelling (vs) generally rudimentary; APH variable, moderately to strongly constrictive or moderately swollen, apical bulb (ab) sclerotized apically or at least in ventral side (when APH strongly constrictive), apical furrow (af) with internal membrane (im) well developed (Fig. 58b); apical bulb (ab), apical part of CT and PB, ventral side of basal swelling (bs) provided with spicules; ejaculatory ducts paired; gonopores (gn) situated near apex of apical bubble (bb), a pair of rod-like sclerite generally absent.

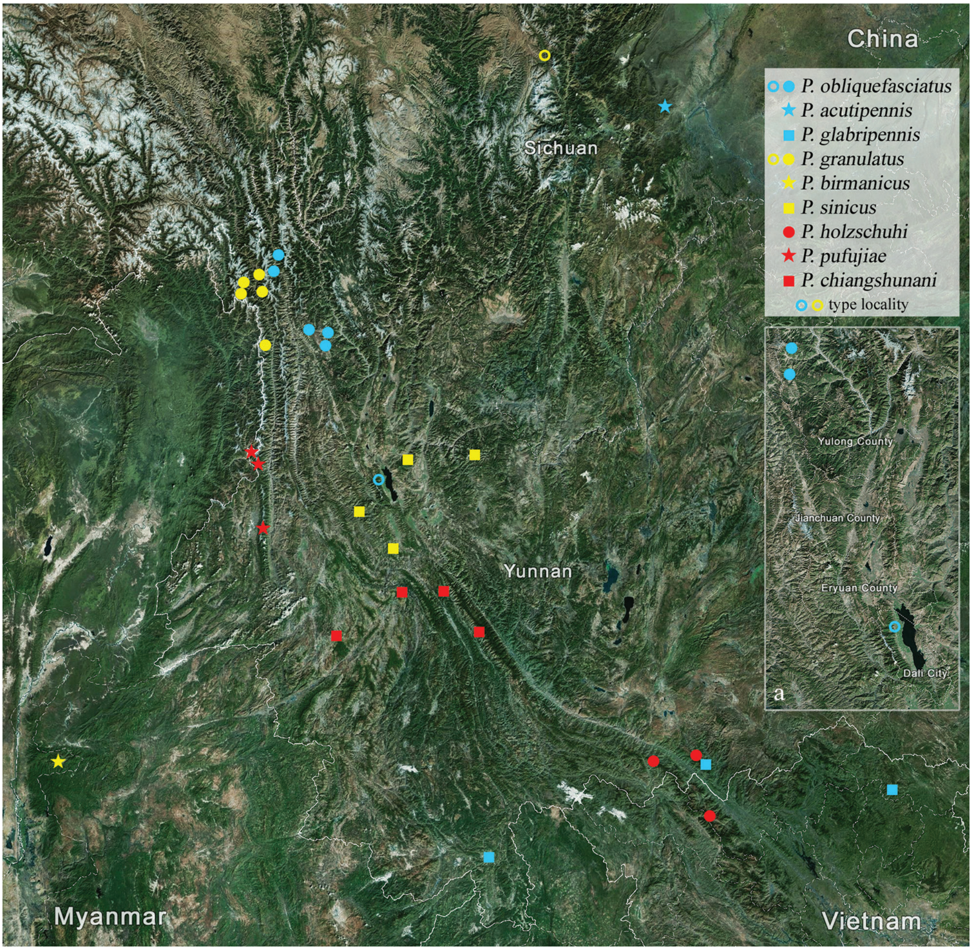
Female genitalia. Setae of sternites VIII sparse and short, apical ones longer (Fig. 56f). Distinct lateral notch present and positioned behind the distinct pigmented patch on sternites VIII (Fig. 56f). The paraproct is very short and devoid of baculi; the coxite lobes are very long and bear small styli (Figs 56g, 56h). Spiculum ventrale (Fig. 56f) longer than abdomen, slightly expanded apically. Female genital track (Fig. 57) with well-developed vaginal plate (VP); bursa copulatrix (BC) moderately long, spermathecal duct attached before middle of bursa, compose of a thin long duct and an expanded and curved apical part. Spermathecal capsule (SP) and gland (SPGL) positioned on apex of spermathecal duct (SPD). Spermathecal capsule strongly sclerotised, crutch shaped (Fig. 57a), apical part more than twice of basal part in length, the whole capsule larger than the expanded apical part of spermathecal duct. Spermathecal gland is an elongate membranous sac, with its length variable but always more than triple length of spemathecal duct.

Distribution (Map 1). China, Myanmar, Vietnam.

Remarks. This genus is unique with a conspicuous raised subbasal tubercle on each elytron among the oriental genera of Lamiini. It is superficially resembles *Mesechthistatus* Breuning, 1950, but immediately distinguished by antennal scape with a complete cicatrix, basal antennomeres distinctly fringed beneath, pronotum with a rugose median longitudinal ridge, and elytra lacking lateral carinae. *Pseudoechthistatus* shares some characters with *Paraleprodera* Breuning, 1935: antennae normal (without swollen), scape with a complete cicatrix, basal antennomeres distinctly fringed beneath, pronotal lateral spine present, prosternal process normal (not angularly enlarged between coxae), protibia with a subapical tooth beneath (at least in male), and similar to some species of *Paraleprodera* (e.g. *Par. diophthalma*, *Par. bisignata*, *Par. bigemmata*) by possess the subbasal tubercle (or tubercles) on each elytron, but is distinguished by elytron with single large raised subbasal tubercle, pronotum with a rugose longitudinal ridge medially, endophallus with CT developed, swollen in dorsal and ventral sides and APH without a pair of U-shaped sclerite (the latter with the subbasal tubercle composed of small granules, CT of endophallus simple and APH with a pair of U-shaped sclerite (Figs 67f, 68g)). It is most close to another group of *Paraleprodera* (e.g. *Par. carolina*, *Par. itzingeri*, *Par. mesophthalma*) with regard to the overall form, especially the presence of the median rugose longitudinal ridge on pronotum, the shape and proportion of the endophallus and the absence of the U-shaped sclerite on APH. But it is distinguished from them by elytron with a subbasal tubercle, endophallus with CT swollen postero-dorsally and PB cylindrical at base (without a ventral tubercle (vbt) (Figs 65, 66)).

Breuning (1942) mentioned that *Pseudoechthistatus* has the claws "divergent" (divergence less than 90°). According to our observation, the claws of this genus are free, and most species have them "divaricate" (divergence exceeding 100°), only some species or individuals (especially of the type species) have the claws in transitional (divergence between 80° to 90°).

The subbasal tubercle on each elytron of this genus is usually single and complete. However, a few individuals (two of nearly one hundred specimens) have the subbasal tubercle separated by several grooves (Fig. 29). This was considered an aberration and



Map 1. Distribution of the species of *Pseudoechthistatus*. **a** enlargement of Dali area.

is not included in the generic diagnosis, but it may indicate that the single subbasal tubercle have originated from several converging small tubercles (or granules) as present in e.g. *Paraleprodera diophthalma* Pascoe.

The type species of this genus is flightless, having a shortened metasternum (subequal to mesosternum in length), constricted humeri and reduced hindwings. These three related structures were considered as generic characters by Breuning (1942). However, *P. birmanicus* with the normal metasternum length (metasternum / mesosternum length ratio ca. 1.8) and normal hindwings, while *P. acutipennis* is transitional (metasternum / mesosternum length ratio ca. 1.5). Therefore, at least for this genus, the shortened metasternum should be treated as an infrageneric apomorphy.

Pseudoechthistatus was placed originally in the tribe Phrissomini by Breuning (1942), and this was followed by Gressitt (1951) and Breuning (1961). Sama (2008) synonymized Phrissomini with Lamiini. Löbl and Smetana (2010) placed the genus *Pseudoechthistatus* under the tribe Monochamini which was separately used from Lamiini. In this paper, we place it under Lamiini and follow Breuning (1943, as Agniini), Gressitt (1951), Breuning (1961) and Ohbayashi and Niisato (2007) who consider Lamiini to include Monochamini (sensu Löbl and Smetana 2010).

Pseudoechthistatus obliquefasciatus **Pic, 1917**

Figures 1, 2, 17, 21, 29, 30, 38, 41, 49, 56–58, Map 1

Pseudoechthistatus obliquefasciatus Pic, 1917: 7. Type locality: Tali, Yunnan, China. Type depository: MNHN.

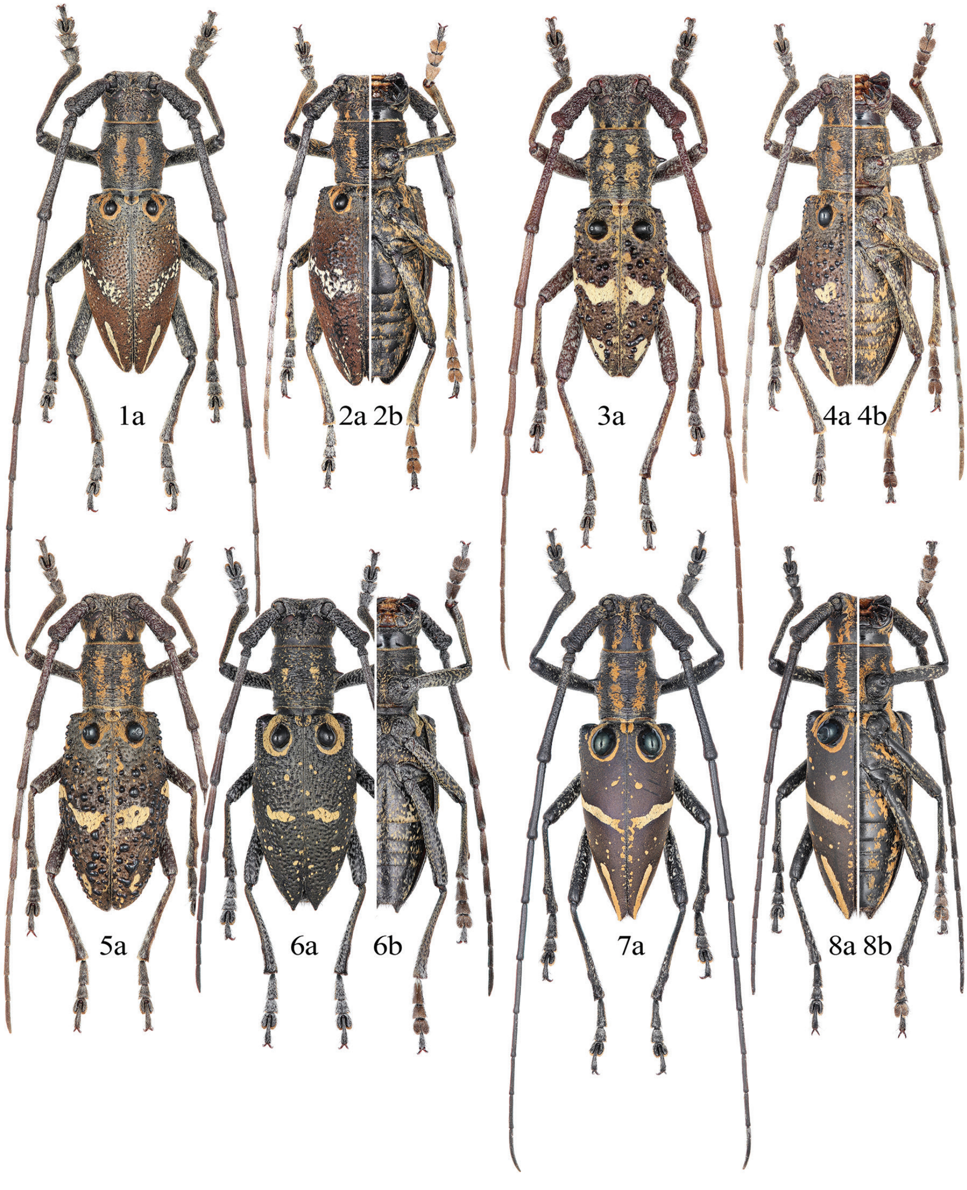
Pseudechthistatus (sic) *obliquefasciatus*: Breuning 1942: 133; Hua 2002: 227; Hua et al. 2009: 466; Löbl and Smetana 2010: 286.

Pseudoechthistatus obliquefasciatus: Gressitt 1951: 349; Chiang et al. 1987: 694; Li 1988: 46; Pu 1992: 601; Li 2009: 159.

Type material examined. Holotype (Fig. 17), female, "Tali / Hte yunnan", "*Pseudoechthistatus Pic / obliquefasciatus Pic* ", "*?? / ?? / (cc? Breuning)*", "*vari? echthistatus / Pascoe / ??? / p. 359*", "*gene echthistatus / n. sp. ? /* (*? in coll Boppe*)", "Museum Paris / Coll. M. Pic", "*type*", "*type*", "TYPE" [red label] examined through five photographs taken by N. Ohbayashi in MNHN, 2014, the hand-written labels are mostly illegible.

Additional material examined (6 males, 12 females): 1 female, Yunnan Weixi Pantiange, 2900 m, 1981.VII.21, leg. Shu-Yong Wang (IZAS, IOZ(E) 1904795); 1 female, Yunnan Weixi Pantiange, 2920 m, 1981.VII.22, leg. Xue-Zhong Zhang (IZAS, IOZ(E) 1904796); 1 female, CHINA, Yunnan, Weixi, Pantiange, Zhazi; N27.34904°, E99.28188°–N27.34647°, E99.27661°, 2917–3029 m, 2009.VII.10, Shi H.L. coll., beating (IZAS, IOZ(E) 1905218); 3 females, Yunnan, Diqing, Weixi, Najieluo, 2921 m, 2014.VI.29, leg. Xiao-Dong Yang (CCCC); 2 males, 1 female, ditto but 2872 m, 2014.VII.1 (CCCC); 1 male, ditto but 3106 m (CCCC); 1 female, Yunnan, Lijiang, Yulong, Ludian, 3219m, 2014.VII.3, leg. Xiao-Dong Yang (CCCC); 2 males, 3 females, Yunnan, Pass 50 km W Judian, 2005.VI.11–13, leg. Ivo Jeniš (CCH); 1 male, 1 female, Yunnan, Yanmen, 2005.VI.13–23, leg. E. Kučera (CCH).

Redescription. Male (Fig. 1). Body length 18.0–22.2 mm, humeral width 5.5–6.2 mm. Body dark brown; head, pronotum and ventral surface covered with intermixed light yellowish and tawny pubescence. Head with four short tawny vittae behind upper eye lobes. Antennal scape, pedicel and 3rd antennomere with sparse pale pubescence, 4th to 9th antennomeres with same color of pubescence at basal half. Pronotum with two longitudinal tawny bands on each side of disk and other two longitudinal bands on lateral margins postmedially, the discal bands distinctly longer than half of pronotal length. Scutellum densely clothed with tawny pubescence, sparse along middle. Elytron with pubescence predominantly brown, with tawny pubescence forming the



Figures 1–8. Habitus of *Pseudoechthistatus* spp. **1–2** *P. obliquefasciatus* Pic, 1917 **3–5** *P. granulatus* Breuning, 1942 **6** *P. acutipennis* Chiang, 1981 **7–8** *P. glabripennis* sp. n. (paratype) **1, 3, 7** male **2, 4–6, 8** female. **a** dorsal view **b** ventral view. Not to scale.

subbasal annular marking and few small spots scattered at basal one fifth, with light yellowish pubescence forming the middle band and the preapical stripe; the middle band moderately broad, strongly oblique (inclined at an angle of 40 to 50 degrees to the transverse axis), complete or interrupted or dispersed into small spots, hardly reaching suture; the preapical stripe narrow, well developed, subequal to or slightly shorter than one-fourth of elytral length. Legs (Fig. 30) clothed with yellowish and tawny pubescence of which the tawny one forming small spots moderately scattered on femora and becoming denser on tibiae.

Body elongate, oblong oval. Head (Fig. 21) with frons moderately punctured; lower eye lobe subequal in length and width, 0.7 times as long as gena. Antennae 1.9 times as long as body length, surpassing elytral apex by six antennomeres; 3rd antennomere ca. 1.8 times as long as scape, ca. 1.2 times as long as 4th antennomere; scape and 3rd antennomere coarsely punctured; scape to 3rd or 4th antennomere sparsely fringed beneath. Elytra ca. 1.4 times as wide as pronotal base, 2.0–2.1 times as long as humeral width; humeri slightly constricted, widened at basal two-fifth, then convergent toward rounded apices; disk moderately punctured, slightly denser near suture, becoming shallower at apical one-third, moderately granulated on basal half, becoming weaker anteriorly; subbasal tubercle moderate in size, as wide as or slightly narrower than scutellar width. Hindwings (Fig. 41) strongly reduced, 0.7 times as long as elytral length. Legs long and slender, metatibiae exceeding elytral apices at base.

Male genitalia (Figs 49, 58). Tergite VIII (Fig. 49a) transverse, slightly emarginated apically and nearly straight at sides, length 0.9 times as long as width. Tegmen (Fig. 49b–c) with lateral lobe widest at base, gently narrowed at basal one-third, then slightly dilated toward rounded apex. Median lobe (Fig. 49d–e) with apex subacute in antero-dorsal view. Endophallus (n = 3, Fig. 58) subequal to triple length of median lobe, the length of MT ca. 2.4 times as long as the length of BPH, the length of CT+PB slightly longer than the length of BPH; MPH strongly curved at apical one-third, PB cylindrical at basal one-third, basal swelling (bs) of CT moderately developed; APH moderately constrictive, ca. 0.6 times as wide as the maximum width of PB at base, with apical bulb (ab) heavily sclerotized apically in ventral side (Fig. 58c), obliquely truncated in lateral view; small spicules sparsely distributed on apical bulb and anterior margin of PB.

Female (Fig. 2). Body length 16.0–22.1 mm, humeral width 4.6–6.4 mm. Almost identical to male in general appearance. Antennae ca. 1.2 times as long as body length, apical three antennomeres surpassing elytral apex; scape to 5th or 6th antennomere fringed beneath; pronotum subequal in length and basal width; elytron longer in proportion to body length (elytra 2.2–2.3 times as long as humeral width); legs comparatively short, metatibiae exceeding elytral apices at basal half. Female genitalia as Fig. 56.

Diagnosis. Elytron with predominant brown pubescence, middle band strongly oblique, subbasal tubercle as wide as or slightly narrower than scutellar width; elytral apices rounded; humeri slightly constricted; hindwings strongly reduced. Endophallus with APH constrictive, apical bulb (ab) heavily sclerotized apically in ventral side, obliquely truncated in lateral view.

Distribution (Map 1). China: Yunnan.

Remarks. Slightly intraspecific variation can be observed between the population from northern area (Weixi County: Najieluo; Deqin County: Yanmen) and southern area (Weixi County: Pantiange; Yulong County: Ludian, Judian), the northern population with elytra relatively long: elytral length / humeral width ca. 2.1 in male and 2.3 in female, while in southern population, elytral length / humeral width ca 2.0 in male and 2.2 in female. And the holotype is identical to the population from southern area. Currently, sympatry has not been confirmed among the flightless species of this genus, with the exception that the holotype from "Tali" seemingly overlaps with the range of another flightless species, *P. sinicus*. However, the old name "Tali" or "Tali Fu" (Breuning, 1942), which had been abandoned in 1913 covered a vast region including today's Dali City, Yunlong County, Eryuan County, Binchuan County, Xiangyun County etc. (Dai et al. 2005: 164). The exact type locality of this species is difficult to determine unless further information is acquired. However, based on the similarity of external characters, we conclude that the type specimen might have been collected from the north of Eryuan county or further north (Map 1a).

Pseudoechthistatus acutipennis **Chiang, 1981**

Figures 6, 20, 28, 32, 44, Map 1

Pseudoechthistatus acutipennis Chiang, 1981: 80, 84, pl. 1, fig. 7. Type locality: Mt. Omei, Sichuan, China. Type depository: SWU.

Pseudoechthistatus acutipennis: Chiang et al. 1985: 104, pl. VII, fig. 111.

Pseudechthistatus (sic) *acutipennis*: Hua 2002: 227; Hua et al. 2009: 246, 390, pl. CIX, 1252; Löbl and Smetana 2010: 286.

Type material examined. Holotype (Fig. 20), female, "Sichuan Emeishan *Jiulaodong* / 196*2.VII.9* / *Chen Li-Juan et al.*", "*Pseudechthistatus* / *acutipennis sp. n.* / det. Chiang Shu-Nan 19*78*", "Holotype" [red label] examined through two photographs provided by Li Chen from SWU, 2014.

Additional material examined. 1 female, Sichuan, Emeishan, Jiulinggang, 1900 m, 2014.VIII.7, leg. De-Yao Zhou (CZDY).

Redescription. Female (Fig. 6). Body length 17.0–18.0 mm, humeral width 5.2–5.4 mm. Body brownish black; head, pronotum sparsely covered with pale and tawny pubescence, ventral surface with intermixed pale and grayish yellow pubescence forming small spots scattered throughout. Antennal scape, pedicel and basal half of 3rd antennomere with sparse pale pubescence, 4th to 8th antennomeres indistinctly with the same pubescence at base, remainder with fine brown pubescence. Pronotum with a pair of longitudinal tawny bands on each side of disk, slightly shorter than one-third of pronotal length. Scutellum clothed with tawny pubescence, except a median glabrous line. Elytron with tawny pubescence forming the subbasal annular marking and some small spots sparsely scattered throughout; with the same pubescence forming the middle band, which moderately oblique, widely interrupted near lateral margin, transversely near suture; remainder with very fine dark brown pubescence. Legs (Fig. 32) moderately clothed with intermixed pale and yellowish pubescence interrupted by scattered glabrous spots.

Body elongate, oblong oval. Head (Fig. 28) with frons densely and coarsely punctured; lower eye lobe 1.2 times as long as width, 0.8 times as long as gena. Antennae 1.2 times as long as body length, surpassing elytral apex by three antennomeres; 3rd antennomere 1.5 times as long as scape, ca. 1.4 times as long as 4th antennomere; scape coarsely punctured; scape to 4th antennomere sparsely fringed beneath. Pronotum subequal in length and basal width, lateral spine short, slightly thickened at base, with acute apex; metasternum 1.5 times as long as mesosternal length. Elytra ca. 1.5 times as wide as pronotal base, 2.1 times as long as humeral width; subparallel-sided in basal one-third, very weakly widened at middle, then moderately convergent toward strongly acute apices; disk densely and coarsely punctured, moderately granulated on basal half and near humerus; subbasal tubercle moderately developed and raised, ca. 1.2 times as wide as scutellar width. Hindwings (Fig. 44) reduced, 1.3 times as long as elytral length. Legs moderately long and slender, metatibiae exceeding elytral apices at basal one-third.

Male. Unknown.

Diagnosis. Body and elytra brownish black, very finely pubescent (besides the tawny pubescent markings); pronotal longitudinal bands reduced, shorter than one-third of pronotal length; elytral middle bands widely interrupted near lateral margin, preapical stripe absent; elytral apices strongly acute, disk densely and coarsely punctured; hindwings reduced.

Distribution (Map 1). China: Sichuan.

Pseudoechthistatus birmanicus **Breuning, 1942**

Figure 18, Map 1

Pseudechthistatus (sic) *birmanicus* Breuning, 1942: 133. Type locality: Ruby Mines, Myanmar. Type depository: NHMB.

Pseudoechthistatus birmanicus: Pu 1992: 601 [misidentification].

Pseudechthistatus (sic) *birmanicus*: Hua et al. 2009: 465; Löbl and Smetana 2010: 286 [partly identified].

Type material examined. Holotype (Fig. 18), male, “H^{te} Birmanie / Mines des Rubis / 1200 m–2300 m / Doherty 1890”, “*Pseudechthistatus / birmanicus / mihi Type!* / det. Breuning” examined through three photographs taken by J. Yamasako and N. Ohbayashi in NHMB, 2012.

Redescription (based on quality photographs, and modified from the original description). **Male.** Body length 21.0 mm, body width 7.5 mm. Body dark brown, body covered with tawny and brown pubescence. Head with four short tawny vittae behind upper eye lobes. Antennal scape with sparse light yellowish pubescence, basal half of 3rd antennomere with sparse fine light yellowish pubescence. Pronotum with paired discal longitudinal band rather long, longer than two-thirds of pronotal length. Elytron with pubescence predominantly brick-red; middle pubescent band light yellowish, broad, well defined, nearly transverse, reaching suture; the preapical stripe same color as middle band, well developed, moderately broader at base. Body elongate. Antennae 1.7 times as long as body length, surpassing elytral apex by five antennomeres; 3rd antennomere 1.7 times as long as scape, 1.1 times as long as 4th antennomere; scape moderately punctured, 3rd antennomere sparsely punctured on basal half; scape to 3rd antennomere fringed beneath. Pronotum slightly longer than width at base, lateral spine short, slightly thickened at base with moderate acute apex; metasternum 1.8 times as long as mesosternal length. Elytra 1.6 times as wide as pronotal base at humeri, 1.8 times as long as humeral width; subparallel-sided in basal one-fourth, very weakly widened a little before middle, then moderately convergent toward subacute apices; disk sparsely and finely punctured, sparsely provided with large but flat granules extending to apical one-fourth; subbasal tubercle close to elytral base, moderately developed and raised, ca. 1.3 times as wide as scutellar width. Hindwings developed, distinctly longer than elytral length.

Distribution (Map 1). Myanmar: Mandalay (Mogok = Ruby Mines).

Remarks. This species is only known from its type locality, Ruby Mines (= Mogok), Myanmar at present. Based on our examination of photos of the holotype, the distribution of this species in Yunnan, reported by Pu (1992) is considered a misidentification of *P. pufujiae* sp. n., which is described in this paper.

Pseudoechthistatus granulatus Breuning, 1942

Figures 3–5, 19, 22, 31, 39, 42, 50, 60, 69, 70, Map 1

Pseudechthistatus (sic) *granulatus* Breuning, 1942: 133. Type locality: Tatsienlu (?). Type depository: NHMB

Pseudoechthistatus granulatus: Gressitt 1951: 349; Li 1988: 46; Pu 1992: 601; Li 2009: 158, 182.

Pseudechthistatus (sic) *granulatus*: Hua 2002: 227; Hua et al. 2009: 465; Löbl and Smetana 2010: 286.

Type material examined. Holotype (Fig. 19), female, "*Tatsienlu*", "*Pseudechthistatus* / *granulatus* / *mihi Type!* / det. Breuning" examined through three photographs taken by J. Yamasako & N. Ohbayashi in NHMB, 2012.

Additional material examined. (22 males, 20 females): 1 male, Yunnan Prov., Gaolinggongshan, Fugong County, Shiyueliangxiang, Shibaliyingdi, 3105 m, 27.18380°N, 98.71021°E, 2004.V.7 night, leg. Hong-Bin Liang (IZAS, IOZ(E) 1904798); 1 male, 1 female, Yunnan, Fugong, Shibaliyingdi, 3105 m, 2005.VIII.9, leg. Hong-Bin Liang (CBWX); 1 male, CHINA, Yunnan Prov. Gongshan County, No12 Bridge–Yakou, 2750–3680 m, N27.43, E98.28, 2000.VII.18, leg. H. B. Liang, Sino-America Exped. (IZAS, IOZ(E) 1904797); 2 females, Yunnan, Gongshan, Gabocun, 2478 m, 2014.VI.14, leg. Xiao-Dong Yang (CCCC); 2 females, ditto except 2500 m, 2015.VI.16, leg. Wen-Xuan Bi (CBWX); 1 male, Yunnan, Gongshan, Sendang–Dabadi, 2834 m, 2014.VI.16, leg. Xiao-Dong Yang (CCCC); 1 male, 1 female, ditto except 2840 m, 2015.VI.20, leg. Wen-Xuan Bi (CBWX); 1 male, ditto except leg. Yu-Tang Wang (CCCC); 1 female, ditto except leg. Xiao-Dong Yang (CCCC); 1male, ditto except Dabadi, 3020 m, 2015.VIII.11, leg. Wen-Xuan Bi (CBWX); 12 males, 6 females, Yunnan, Gongshan, Nageluo, 2850–2750 m, 2015.VI.12, leg. Wen-Xuan Bi (CBWX); 1 female, ditto except 2750 m, leg. Yu-Tang Wang (CCCC); 3 males, 4 females, ditto except 2015.VI.15, leg. Wen-Xuan Bi (CBWX); 1 female, ditto except 2750 m, leg. Chao Wu (CBWX); 1 female, ditto except 2015.VIII.12, leg. Xiao-Dong Yang (CCCC).

Redescription. Male. (Fig. 3). Body length 15.0–16.8 mm, humeral width 4.0–4.6 mm. Body dark brown; head and pronotum covered with yellowish, tawny and brown pubescence, ventral surface with yellowish pubescence forming small spots sparsely scattered throughout. Head with four short tawny vittae behind upper eye lobes. Antennal scape, pedicel and 3rd antennomere with sparse light yellowish pubescence, 4th to 8th antennomeres with same color pubescence at base, remainder with fine brown pubescence. Pronotum with two longitudinal tawny bands on each side of disk and other two longitudinal bands on lateral margins; the discal bands longer than two-thirds of pronotal length, sometimes interrupted anteromedially. Scutellum densely clothed with tawny pubescence, slightly sparse along middle. Elytron with pubescence predominantly brown, with tawny pubescence narrowly forming the subbasal annular marking, and some small spots scattered mainly near suture, with yellowish (or tawny) pubescence forming the middle band and the preapical stripe; the middle band usually moderately oblique, shape variable, widely interrupted to nearly interrupted near lateral margin, broadly and transversely reaching suture (in some individuals, the middle band complete, obliquely reaching suture directly without broadening and curving); the preapical stripe reduced, slightly shorter than one-fifth of elytral length. Legs (Fig. 31) clothed with sparse brown and dense yellowish pubescence of which the lighter one forming small spots moderately scattered on femora and becoming denser on tibiae.

Body elongate, oblong oval. Head (Fig. 22) with frons sparsely punctured; lower eye lobe 1.3 times as long as width, 0.8 times as long as gena. Antennae ca. 1.8–1.9 times as long as body length, surpassing elytral apex by 5–6 antennomeres; 3rd antennomere ca. 1.8 times as long as scape, ca. 1.3 times as long as 4th antennomere; scape and basal half of 3rd antennomere coarsely punctured; scape to 3rd antennomere sparsely fringed beneath. Pronotum 1.2 times as long as basal width, lateral spine developed, moderately thickened at base with acute apex; metasternum subequal in length to mesosternum. Elytra ca. 1.4 times as wide as pronotal base, 2.0 times as long as humeral width; humeri slightly constricted, widened at basal two-fifth, then convergent toward obliquely truncated apices; disk moderately punctured, becoming shallower at apical one-third, distinctly with moderate to large size, raised granules moderately sparse; subbasal tubercle developed, ca. 1.3 times as wide as scutellar width. Hindwings (Fig. 42) strongly reduced, 0.8 times as long as elytral length. Legs long and slender, metafemora slightly exceeding elytral apices.

Male genitalia (Figs 50, 60). Tergite VIII (Fig. 50a) transverse, slightly emarginated apically and rounded at sides, length 0.8 times as long as width. Tegmen

(Fig. 50b–c) with lateral lobe widest at base, gently narrowed toward rounded apex. Median lobe (Fig. 50d–e) with apex subacute in antero-dorsal view. Endophallus (n = 3, Fig. 60) longer than triple length of median lobe, the length of MT ca. 2.5 times as long as the length of BPH, the length of CT+PB slightly longer than the length of BPH; MPH strongly curved at apical one-third, PB cylindrical at basal one-third, basal swelling (bs) of CT developed; APH moderately constrictive, ca. 0.6 times as wide as the maximum width of PB at base, with apical bulb (ab) heavily sclerotized apically, obliquely truncated in lateral view; small spicules densely distributed on apical bulb and anterior margin of PB.

Female (Figs 2, 3). Body length 17.2–20.7 mm, humeral width 5.0–5.6 mm. Almost identical to male in general appearance. Antennae ca. 1.3–1.4 times as long as body length, apical 3–4 antennomeres surpassing elytral apex; scape to 7th antennomere fringed beneath; lower eye lobe subequal in length and width, 0.5 times as long as gena; pronotum subequal in length and basal width; elytron longer in proportion to body length (ca. 2.2 times as long as humeral width); legs comparatively short, metatibiae exceeding elytral apices at base.

Diagnosis. Lower eye lobe rather short, 0.5 times as long as gena (in female); elytron with granules large and raised, sparsely scattered throughout, middle band variable, complete or interrupted to nearly interrupted near lateral margin; humeri slightly constricted; hindwings strongly reduced. Endophallus with APH constrictive, apical bulb (ab) heavily sclerotized apically, obliquely truncated in lateral view.

Distribution (Map 1). China: Sichuan(?), Yunnan.

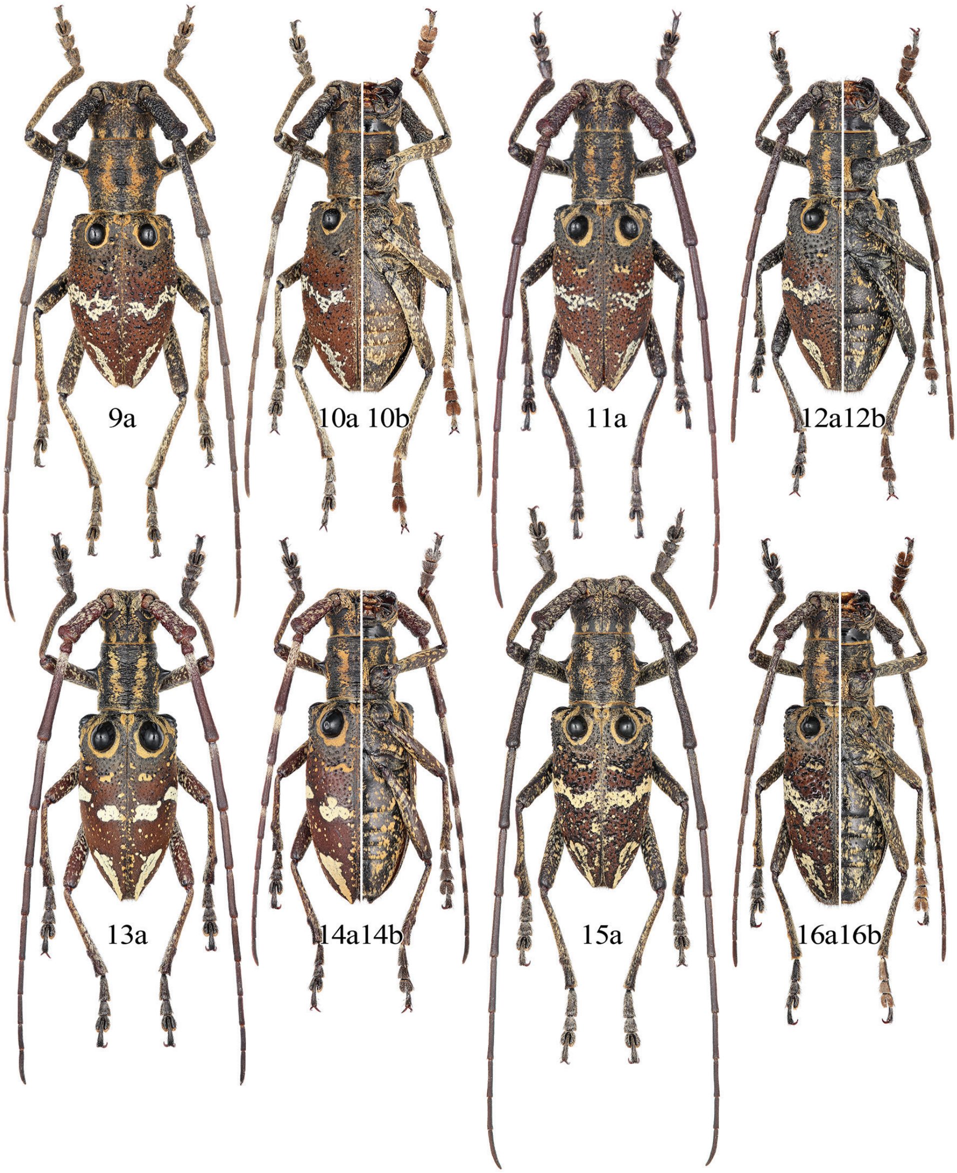
Remarks. Based on the morphological similarities, the population from Gongshan County and Fugong County of Yunnan Province are considered as *P. granulatus* temporarily. The type locality of *P. granulatus*, "*Tatsienlu*"(= Kangding County) perceived to be doubtful for the following reasons. Based on reliable collecting data, the distribution of a flightless species (at least among this genus) does not support such remote distance (more than 400 km away from "*Tatsienlu*" to the population in Yunnan). Moreover, no individual has thus far been found in the intervening area. The population from Gongshan and Fugong could not be separated from the type specimen from "*Tatsienlu*" morphologically. The weak differences, such as slightly longer antennae and lighter pubescence color should be treated as intraspecific variation. Furthermore, females from Yunnan share the shorter lower eye lobes with the female type specimen, while other congeners have longer lower eye lobes (except for *P. pufujinae* sp. n.). The poor and handwritten label of the holotype (Fig. 19) is presumably simply mislabeled. In other words, "Tatsienlu" had been written on labels merely to indicate the general region, and the exact locality could be farther afield (Cox, 1945: 209, 212). Until now, no additional specimens have been reported or found from Kangding. (The first author had visited Kangding three times, trying hard to find topotype specimens but without success.) 5) Fugong was included in the distribution list by Li (1988, 2009) and Pu (1992). In order to clarify this doubt, further studies are necessary based on obtaining the topotype, especially the male specimens from Kangding.

Pseudoechthistatus sinicus **sp. n.**
http://zoobank.org/B402F732-1A65-41AE-B152-6C465BAB955E
Figures 9, 10, 24, 34, 43, 52, 59, 71, Map 1

Type material. Holotype: male, "Yunnan, Dayao County, Santaixiang / Xiaobaicaoling / 2980 m 2013.V.29–30 / leg. Wen-Xuan Bi" (IZAS, IOZ(E) 1905347). Paratypes (22 males, 22 females): 3 males, 4 females, same data as holotype but (CBWX); 1 male, 1 female, same data as holotype but (SHEM); 1 male, 1 female, same data except "leg. Xiao-Dong Yang" (CCCC); 1 male, "CHINA. Yunnan, Binchuan / Jizushan / 2300 m 2010.VII.12 / leg. Xiao-Bin Song" (CBWX); 1 male, ditto except "2010.VII.16" (CSXB); 3 females, " CHINA. Yunnan, Binchuan / Jizushan / 2258 m 2010.VI.10 / leg. Xiao-Dong Yang" (CCCC); 2 females, "CHINA, Yunnan, Dali zhou, / Binchuan county, Jizushan, / 2500–3200 m, 26.–31.VII.1993, / leg. C. Holzschuh" (CCH); 1 female, "Djo-Kou-La / alt. 1200 m / Nord Ouest Yunnan" (NHRS-JLKB000024084); 1 male, "YUNNAN 1800–2500 m / 25.10N 100.21E / WEISHAN mt. / 22–25. VI.92 / David Král leg." (CCH); 10 males, 7 females, "CHINA. Yunnan, Weishan / Weibaoshan 2400–2500 m / 2015.VIII.16 / leg. Wen-Xuan Bi" (CBWX); 3 males, 3 females, ditto except "leg. Xiao-Dong Yang" (CCCC); 1 male, "Yunnan Yongping to Yangbi / 1955.V.29. / leg. Yang Xing-Chi", "*Pseudoechthista- / tus obliquefasciatus / Pic* / det. Chiang Shu-Nan 19*61*", "100" (IZAS, IOZ(E) 1905348).

Description. Male (Fig. 9). Body length 16.5–23.0 mm, humeral width 5.0–7.0 mm. Body dark brown; head, pronotum and ventral surface covered with tawny and brown pubescence. Head with four short tawny vittae behind upper eye lobes. Antennal scape with sparse light yellowish and brown pubescence; pedicel, basal two-thirds of 3rd antennomere and basal half of 4th antennomere with light yellowish pubescence, remainder with fine brown pubescence. Pronotum with two longitudinal tawny bands on each side of disk and other two longitudinal postmedian bands on lateral margins, the discal bands slightly longer than half of pronotal length. Scutellum densely clothed with tawny pubescence. Elytron with pubescence predominantly reddish brown, with tawny pubescence narrowly forming the subbasal annular marking and some small spots scattered near suture and humerus, with light yellowish pubescence forming the middle band and the preapical stripe; the middle band narrow, moderately oblique, irregularly marginated, zigzagged near middle, hardly reaching suture; the preapical stripe narrow, well developed. Legs (Fig. 34) densely clothed with tawny and brown pubescence of which the tawny one forming small spots sparsely scattered on femora and becoming denser on tibiae.

Body elongate, oblong oval. Head (Fig. 24) with frons sparsely and moderately punctured; lower eye lobe 1.1 times as long as width, 0.5 times as long as gena. Antennae ca. 1.6–1.7 times as long as body length, surpassing elytral apex at base of 6th antennomere; 3rd antennomere ca. 1.6 times as long as scape, ca. 1.3 times as long as 4th antennomere; coarsely punctured on scape to basal half of 3rd antennomere; scape to 3rd antennomere fringed beneath. Pronotum subequal in length and basal width,



Figures 9–16. Habitus of *Pseudoechthistatus* spp. **9–10** *P. sinicus* sp. n. (paratype) **11–12** *P. chiangshunani* sp. n. (11 holotype, 12 paratype) **13-14** *P. holzschuhi* sp. n. (paratype) **15-16** *P. pufujiae* sp. n. (paratype) **9, 11, 13, 15** male **10, 12, 14, 16** female. **a** dorsal view **b** ventral view. Not to scale.

lateral spine moderately long, thickened at base with acute apex; metasternum ca. 1.3 times as long as mesosternal length. Elytra 1.4 times as wide as pronotal base at humeri, 1.8 times as long as humeral width; humeri slightly constricted, widened at basal two-fifth, then convergent toward obliquely truncated apices; disk finely punctured, moderately granulated near humerus and behind basal one-fourth, weakened near apical one-third; subbasal tubercle moderately developed and raised, ca. 1.2 times as wide as scutellar width. Hindwings (Fig. 43) reduced, slightly shorter than elytral length. Legs long and slender, metafemora slightly exceeding elytral apices.

Male genitalia (Figs 52, 59). Tergite VIII (Fig. 52a) transverse, truncated apically and rounded at sides, length 0.8 times as long as width. Tegmen (Fig. 52b–c) with lateral lobe subparallel-sided in basal half, moderately narrowed toward acute apex. Median lobe (Fig. 52d–e) with apex acuminate in antero-dorsal view. Endophallus (n = 4, Fig. 59) subequal to triple length of median lobe, the length of MT ca. 2.4 times as long as the length of BPH, the length of CT+PB slightly longer than the length of BPH; MPH moderately curved at apical one-third, PB cylindrical at basal one-third, basal swelling (bs) of CT slightly swollen laterally; APH strongly constricted, ca. 0.5 times as wide as the maximum width of PB at base, with apical bulb (ab) heavily sclerotized apically, obliquely truncated in lateral view; small spicules densely distributed on apical bulb and apical two-fifths of PB.

Female (Fig. 10). Body length 17.0–22.0 mm, humeral width 5.4–6.6 mm. Almost identical to male in general appearance. Antennae ca. 1.2–1.3 times as long as body length, apical three or four antennomeres surpassing elytral apex; scape to 5th or 6th antennomere fringed beneath; 3rd to 7th antennomeres with light pubescence basally; elytron longer in proportion to body length (ca. 2.0 times as long as humeral width); legs comparatively short, metatibiae exceeding elytral apices at basal one-fourth.

Remarks. This new species can be distinguished from most of the congeners by elytra comparatively shorter (only 1.8 times as long as humeral width), humeri distinctly constricted in both sexes; hindwings reduced; granules moderate in size near humerus and behind basal one-fourth, weakened near apical one-third; APH of endophallus strongly constricted. It is similar to *P. obliquefasciatus* by color pattern but can be easily distinguished by elytra relatively shorter in length, with bigger subbasal tubercles, median pubescent band not so oblique and APH of endophallus more strongly sclerited. It is similar to *P. granulatus* by size of elytral subbasal tubercles but can be separated by shorter elytra, weaker granules, and denser ventral tawny pubescence.

Etymology. The new species is named after the country of its type locality.

Distribution (Map 1). China: Yunnan.

Pseudoechthistatus chiangshunani **sp. n.**

http://zoobank.org/9FC642FC-C803-4C5B-B720-416FBC239D19

Figures 11, 12, 25, 35, 46, 53, 64, Map 1

Type material. Holotype: male,"Yunnan Prov., Zhengyuanxian / Jiujiazhen, Qianjiazhai / 2012.V.6 2600 m", "N24°17.143' / E101°15.060' / leg. Ling-Zeng Meng "(IZAS, IOZ(E) 1905352). Paratypes (16 males, 9 female): 1 male, "*Yunnan Jingdong*", "*Paraleprodera opsiptera n. sp.* / det. Chen Shi-Xiang 19" (IZAS, IOZ(E) 1905346); 1 male, "*Yunnan Jingdong*", "*Jingdong Wuliangshan / 1800–2430 m. / 1958.*

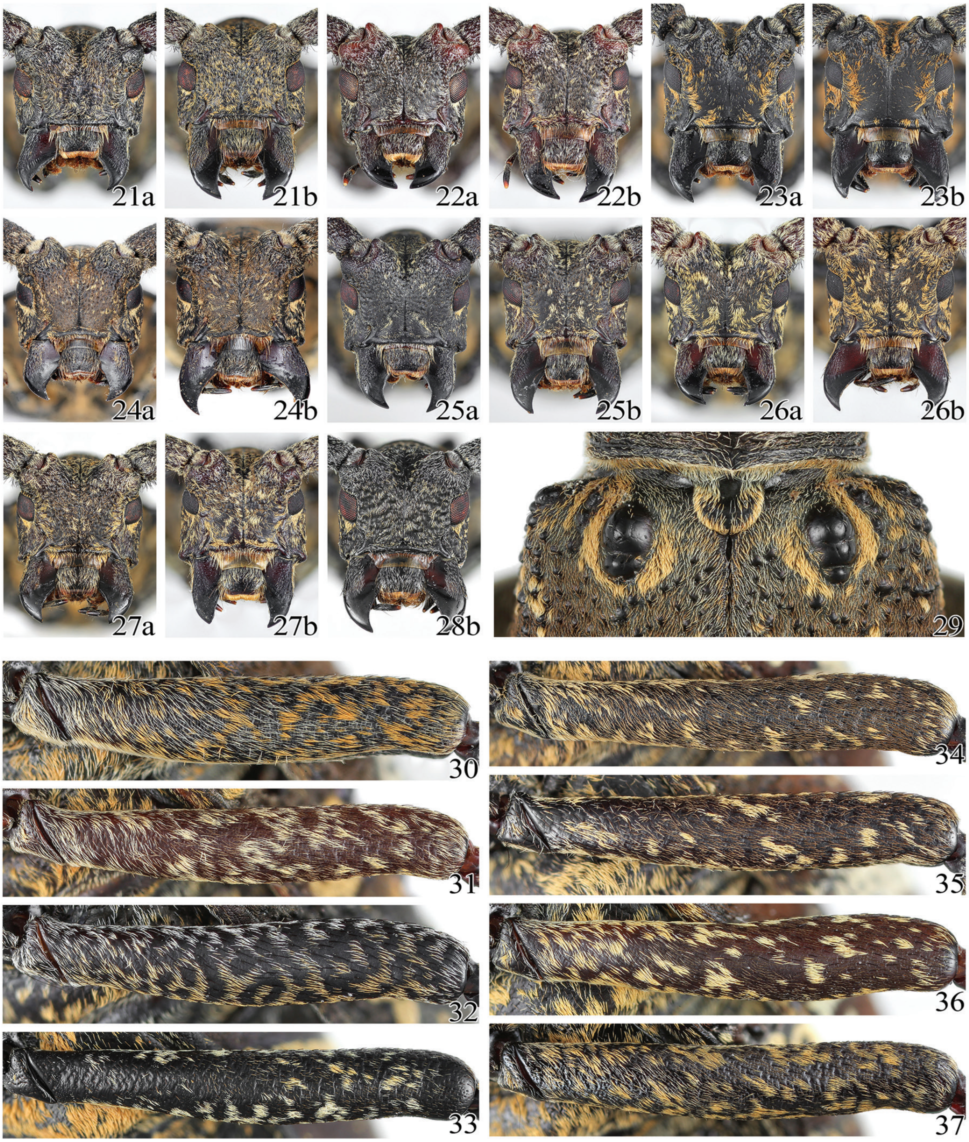
Figures 17–20. Habitus and label of the holotype of *Pseudoechthistatus* spp. **17** *P. obliquefasciatus* Pic, 1917 (female) **18** *P. birmanicus* Breuning, 1942 (male) **19** *P. granulatus* Breuning, 1942 (female) **20** *P. acutipennis* Chiang, 1981 (female).

III." (IZAS, IOZ(E) 1905217); 2 males, "2009-VIII-1–3 / Yunnan, Zhenyuanxian, Jiujiaxiang / leg. Ji-Shan Xu & Jian-Xiong Zhang", "N24.279°/ E101.264°/ Alt. 2160 m" (MHBU); 1 female, "CHINA. Yunnan, Yongde / Yalianxiang, Damaidi / 2175m 2012.V.8 / leg. Xiao-Dong Yang" (CCCC); 4 males, 1 female, "CHINA. Yunnan, Lincang / Manwanzhen, Shuibatoucun / Dahebadi 2103 m 2015.X.15 / leg. Bin Liu" (CLB); 1 female, ditto except "2113 m 2015.X.21" (CLB); 5 males, 3 females, ditto except "1950 m 2016.II.20–29 / local collector" (CLB); 1 male, 1 female, ditto except "1960 m 2016.I.23 / leg. Zi-Chun Xiong" (CZDY); 1 male, 1 female, ditto except "2016.II.10"(CZDY); 1 male, 1 female, ditto except "2016.III.21"(CZDY).

Description. Male. (Fig. 11). Body length 16.0–24.3 mm, humeral width 4.9–7.9 mm. Body brownish black; head and pronotum covered with yellowish, tawny and brown pubescence, ventral surface with tawny pubescence forming small spots sparsely scattered throughout. Head with four tawny vittae on basal half of occiput behind upper eye lobes. Antennal scape, pedicel and basal one-fifth of 3rd antennomere sparsely annularted with light yellowish pubescence, remainders with fine brown pubescence. Pronotum with two longitudinal tawny bands on each side of disk and other two longitudinal bands on lateral margins, the discal bands slightly longer than half of pronotal length. Scutellum densely clothed with tawny pubescence, slightly sparse along middle. Elytron with pubescence predominantly reddish brown, with tawny pubescence forming the subbasal annular marking, a short discontinuous transverse band at basal one-third near suture and a few small spots scattered near humerus and along suture, with light yellowish pubescence forming the middle band and the preapical stripe; the middle band narrow, moderately oblique, nearly interrupted at middle, zigzaged near suture, hardly reaching suture; the preapical stripe narrow, well developed. Legs (Fig. 35) clothed with sparse light brown and dense light yellowish pubescence of which the lighter one forming small spots moderately scattered.

Body elongate, oblong oval. Head (Fig. 25) with frons sparsely and coarsely punctured; lower eye lobe 1.2 times as long as width, 0.6 times as long as gena. Antennae ca. 1.6–1.7 times as long as body length, surpassing elytral apex at base of 6th antennomere; 3rd antennomere ca. 1.8 times as long as scape, ca. 1.3 times as long as 4th antennomere; coarsely punctured on scape to 3rd antennomere; scape to 4th antennomere fringed beneath. Pronotum slightly longer than width at base, lateral spine developed, thickened at base with acute apex; metasternum ca. 1.5 times as long as mesosternal length. Elytra ca. 1.6 times as wide as pronotal base, 1.8 times as long as humeral width; subparallel-sided in basal two-thirds, slightly widened at basal half, then moderately convergent toward subacute apices; disk moderately and deeply punctured, moderately granulated near humerus to behind basal one-third, becoming indistinct subapically; subbasal tubercle strongly developed and raised, ca. 1.4 times as wide as scutellar width. Hindwings (Fig. 46) developed, ca. 1.4 times as long as elytral length. Legs long and slender, metafemora almost exceeding elytral apices.

Male genitalia (Figs 53, 64). Tergite VIII (Fig. 53a) transverse, slightly emarginated apically and straight sided, length 0.8 times as long as width. Tegmen (Fig.53b–c) with lateral lobe subparallel-sided toward rounded apex. Median lobe (Fig. 53d–e) with apex rounded in antero-dorsal view. Endophallus (n = 4, Fig. 64) slightly longer than triple length of median lobe, the length of MT ca. 3.0 times as long as the length of BPH, the length of CT+PB slightly longer than the length of BPH; MPH strongly



Figures 21–37. Habitus of *Pseudoechthistatus* spp. **21–28** head in frontal view **29** subbasal tubercle of elytron showing an abnormal form **30–37** femora in ventral view showing pubescence patterns **21, 29, 30** *P. obliquefasciatus* Pic, 1917 **22, 31** *P. granulatus* Breuning, 1942 **23, 33** *P. glabripennis* sp. n. **24, 34** *P. sinicus* sp. n. **25, 35** *P. chiangshunani* sp. n. **26, 36** *P. holzschuhi* sp. n. **27, 37** *P. pufujiae* sp. n. **28, 32** *P. acutipennis* Chiang, 1981. **a** male **b** female.

curved at apical two-fifths, PB cylindrical at basal one-fourth, basal swelling (bs) of CT moderately swollen anterolaterally; APH moderately swollen, slightly wider than the maximum width of PB at base, obliquely truncated in lateral view, with apical bubble (bb) provided with a pair of short rod-like sclerite subapically; small spicules evenly distributed on basal half of apical bulb and apical half of PB.

Female (Fig. 12). Body length 20.7–22.1 mm, humeral width 6.2–7.0 mm. Almost identical to male in general appearance. Antennae 1.2 times as long as body length, apical three antennomeres surpassing elytral apex; scape to 7th antennomere fringed beneath; humeri slightly constricted; elytron longer in proportion to body length; legs comparatively short, metatibiae exceeding elytral apices at basal half.

Remarks. This new species is similar to *P. sinicus* sp. n., but is distinguishable by having the hindwings fully developed, punctures on elytra distinct and deeper, and APH of endophallus swollen. It resembles *P. holzschuhi* but differs in having antennae (at least 3rd to 4th antennomeres) without yellowish annulations, 3rd antennomere fringed beneath (fringed only at basal half in *P. holzschuhi*), punctures and granules on elytra more developed, elytra wider (compare with its length), humeri constricted in female. It can be distinguished from *P. birmanicus* by the longer 3rd antennomere, deeper elytral punctures, smaller elytral granules and narrower median band on elytra, and the subbasal tubercle of elytron not so close to elytral base.

Etymology. The new species is dedicated to the late Shu-Nan Chiang (1914–2013), an entomologist specialized in the taxonomy of Chinese Cerambycidae.

Distribution (Map 1). China: Yunnan.

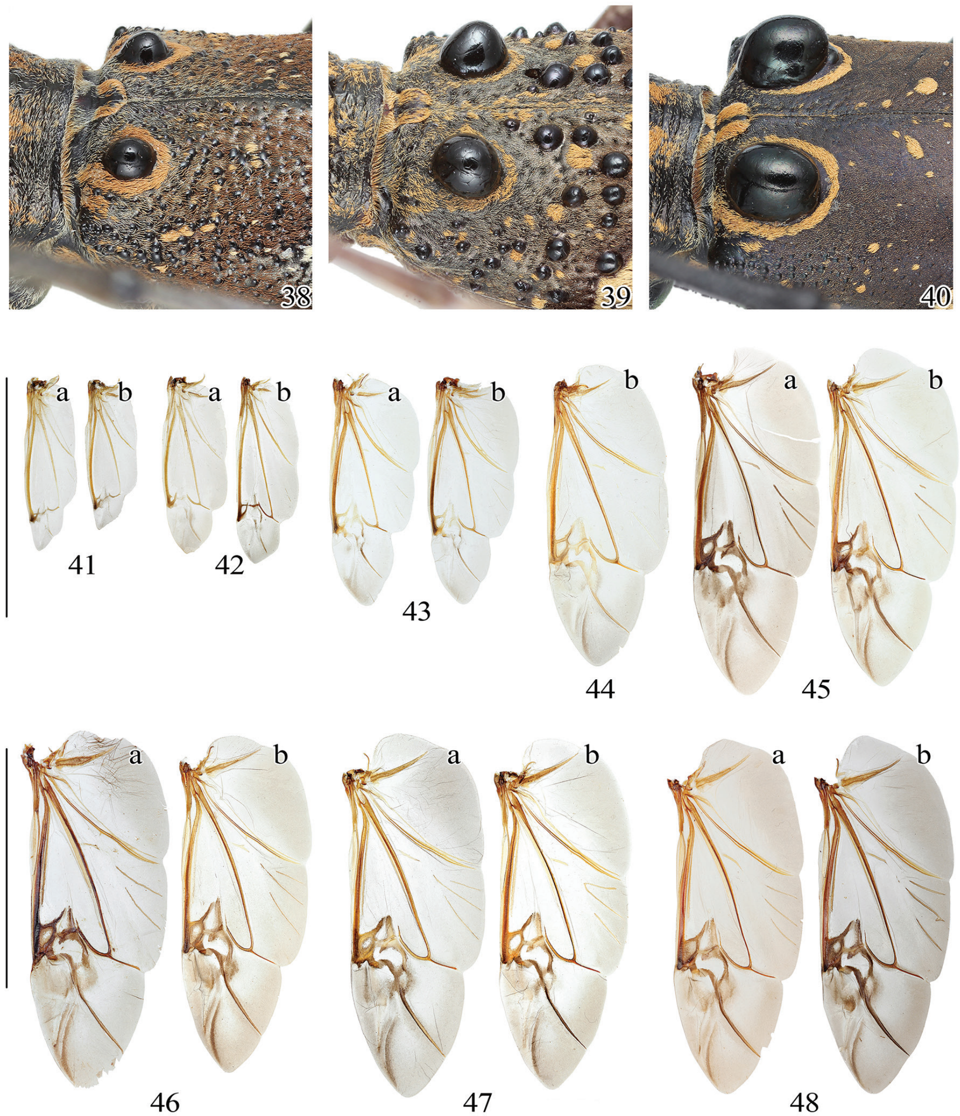
Pseudoechthistatus holzschuhi **sp. n.**

http://zoobank.org/C63ABD26-AF63-4390-8DA0-ACD8A41FE469

Figures 13, 14, 26, 36, 47, 54, 63, Map 1

Type material. Holotype: male, "CHINA. Yunnan, Jinping / Fenshuiling / 2311 m 2010.IX.18 / leg. Xiao-Dong Yang" (IZAS, IOZ(E) 1905353). Paratypes (8 males, 11 females): **China**: 1 female, same data as holotype except "2011.V.22" (CCCC); 1 female, ditto except 2011.V.26" (CCCC); 1 male, ditto except "2011.V.22 / leg. Jia-Hong Lin" (CCCC); 1 male, 1 female, "Yunnan Jinping Fenshuiling / 2010-VI-01 / leg. Wen-Hsin Lin 2250 m" (CJM); 1 female, "*Jinping / leg. Zeng Qing-Yao / 1957.V*", "Yunnan: *Jinping* / 195*7.V*"No. 56, host plant: fallen wood of *Quercus* sp. (IZAS, IOZ(E) 1905349); 1 female, "CHINA. Yunnan, Pingbian / Daweishan / 2000 m 2012.IX.28 / leg. Xiao-Dong Yang" (CCCC); **Vietnam**: 1 male, "VIETNAM. Lào Cai prov. / Sapa Mt. / 1600 m 2015.VII / local collector" (CBWX); 2 males 1 female, "May 2015; Vietnam / SAPA Mt. / 1800 m / native col. / Lao Cai" (CTT); 2 males, ditto except "June 2014" (CTT); 1 male, ditto except "June 2015" (CTT); 4 females, ditto except "July 2015" (CTT); 1 female, ditto except "September 2015" (CTT).

Description. Male (Fig. 13). Body length 17.5–25.4 mm, humeral width 5.4–8.0 mm. Body dark brown; head, pronotum covered with yellowish, tawny and brown pubescence, ventral surface with light brown pubescence forming small spots sparsely scattered throughout. Head with four tawny vittae behind upper eye lobes of which the middle two are narrow and indistinct. Antennal scape and pedicel with sparse



Figures 38–48. Habitus of *Pseudoechthistatus* spp (**a** male **b** female). **38–40** basal elytra in dorsal-lateral view showing shape and size of subbasal tubercles **41–48** hindwings of *Pseudoechthistatus* spp., scale = corresponding elytral length. **38, 41** *P. obliquefasciatus* Pic, 1917 **39, 42** *P. granulatus* Breuning, 1942 **43** *P. sinicus* sp. n. **44** *P. acutipennis* Chiang, 1981 **45** *P. pufujiae* sp. n. **46** *P. chiangshunani* sp. n. **47** *P. holzschuhi* sp. n. **40**, **48** *P. glabripennis* sp. n.

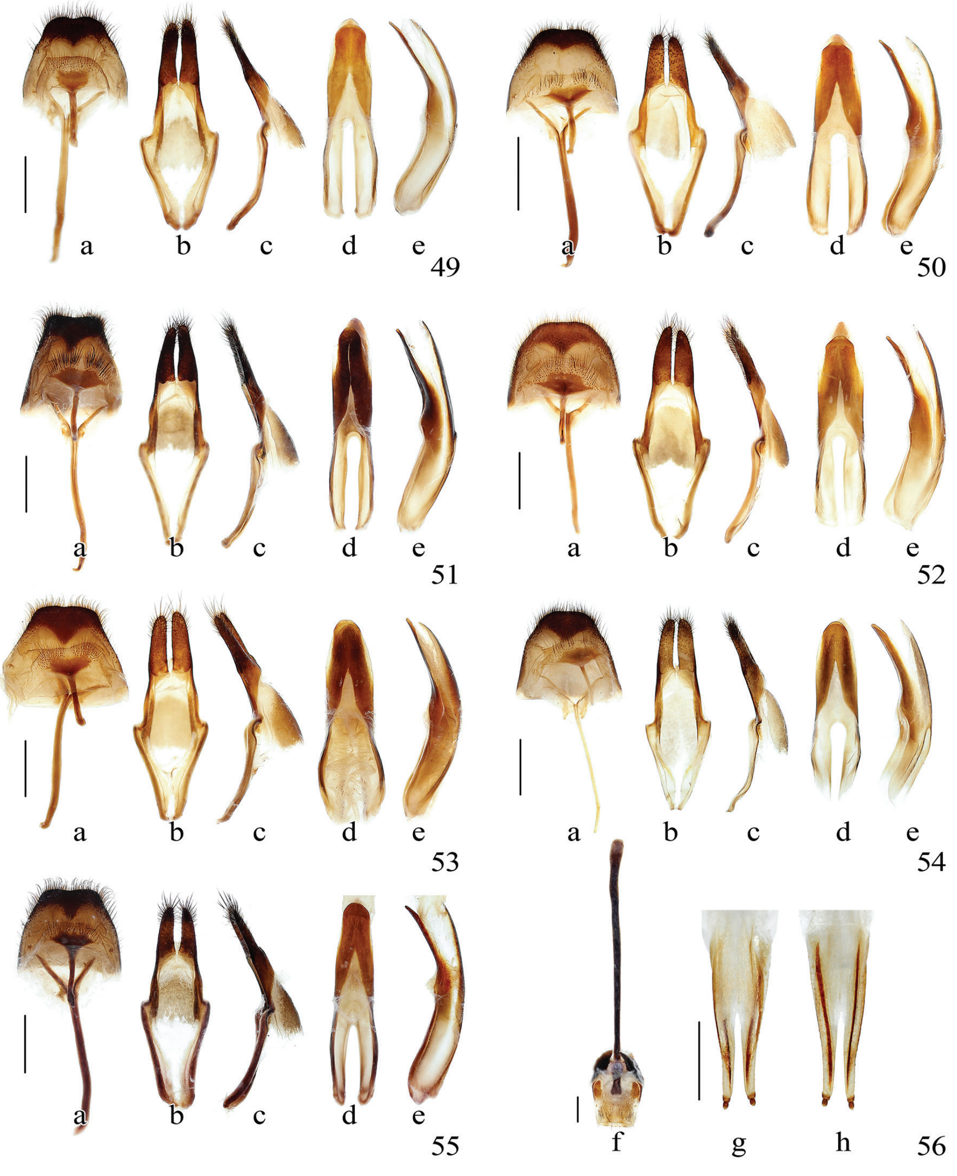
light yellowish pubescence; 3rd and 4th antennomeres annulate with light yellowish pubescence at basal one-fourth and becoming indistinct on 5th to 7th antennomeres, remainder with fine brown pubescence. Pronotum with two longitudinal tawny bands on each side of disk and another two longitudinal bands on lateral margins, the discal bands longer than two-thirds of pronotal length. Scutellum densely clothed with tawny pubescence. Elytron with pubescence predominantly brick-red, with tawny pubescence forming the subbasal annular marking, a short discontinuous transverse band at basal one-third near suture and some small spots sparsely scattered, becoming denser along suture, with light yellowish pubescence forming the middle band and the preapical stripe; the middle band moderately broad and oblique, interrupted or nearly interrupted at middle, transversely reaching suture; the preapical stripe well developed, moderately broader at base. Legs (Fig. 36) clothed with sparse brown and dense light yellowish pubescence of which the lighter one forming small spots moderately scattered on femora and becoming denser on tibiae.

Body elongate, oblong oval. Head (Fig. 26) with frons sparsely and finely punctured; lower eye lobe subequal in length and width, 0.6 times as long as gena. Antennae ca. 1.5–1.7 times as long as body length, surpassing elytral apex at base of 6th antennomere; 3rd antennomere ca. 1.7 times as long as scape, ca. 1.3 times as long as 4th antennomere; scape coarsely punctured; scape to basal half of 3rd antennomere fringed beneath. Pronotum 1.1 times as long as basal width, lateral spine developed, thickened at base with acute apex; metasternum ca. 1.3 times as long as mesosternal length. Elytra ca. 1.6 times as wide as pronotal base, 1.9 times as long as humeral width; subparallel-sided in basal half, then moderately convergent toward subacute apices; disk sparsely and finely punctured at basal half, becoming shallower posteriorly, sparsely granulated behind humerus, granules hardly reaching basal one-third; subbasal tubercle strongly developed and raised, ca. 1.7 times as wide as scutellar width. Hindwings (Fig. 47) developed, ca. 1.4–1.5 times as long as elytral length. Legs moderately long and slender, metatibiae exceeding elytral apices at basal one-fourth.

Male genitalia (Figs 54, 63). Tergite VIII (Fig. 54a) slightly wider than long, truncated apically and rounded at sides. Tegmen (Fig. 54c–d) with lateral lobe subparallel-sided toward rounded apex. Median lobe (Fig. 54e–f) with apex acuminate in antero-dorsal view. Endophallus (n = 3, Fig. 63) longer than triple length of median lobe, the length of MT ca. 2.3 times as long as the length of BPH, the length of CT+PB subequal to the length of BPH, CT slightly longer than PB; MPH moderately curved at apical two-fifth, PB cylindrical at basal one-fourth, basal swelling (bs) of CT moderately swollen anterolaterally; APH moderately swollen, slightly wider than the maximum width of PB at base, obliquely truncated in lateral view; small spicules evenly distributed on basal half of apical bulb, densely distributed on apical one-third of PB.

Female (Fig. 14). Body length 19.4–23.0 mm, humeral width 6.7–7.4 mm. Almost identical to male in general appearance. Antennae 1.2 times as long as body length, surpassing elytral apex at base of 9th antennomere; basal 7 antennomeres fringed beneath; 3rd to 6th antennomeres distinctly annulate with light yellowish pubescence at base; elytron longer in proportion to body length; legs comparatively short, metatibiae exceeding elytral apices at apical two-third.

Remarks. This new species is most similar to *P. birmanicus* and *P. chiangshunani* sp. n. by the general habitus but can be distinguished from the former by the elytral gran-



Figures 49–56. Terminalia of *Pseudoechthistatus* spp. **49, 56** *P. obliquefasciatus* Pic, 1917 **50** *P. granulatus* Breuning, 1942 **51** *P. glabripennis* sp. n. **52** *P. sinicus* sp. n. **53** *P. chiangshunani* sp. n. **54** *P. holzschuhi* sp. n. **55** *P. pufujiae* sp. n. **49–55** male. **a** tergite VIII with sternites VIII & IX **b** tegmen in ventral view **c** ditto in lateral view **d** median lobe in ventral view **e** ditto in lateral view **56** female. **f** sternite VIII **g** ovipositor in dorsal view **h** ditto in ventral view. Scale 1 mm.

ules being rather weakly developed and limited within basal one-third; elytral punctures finer and sparser; middle band of elytron interrupted or nearly interrupted and more developed pronotal lateral spines. It can also be distinguished from the latter by the antenna being shorter than body length, at least 3rd to 4th antennomeres with light yellowish pubescent annulations at base; elytra relatively smooth, granulate only at basal one-third, elytral punctures finer and sparser; female humeri similar to male, not constricted.

Etymology. The new species is named after Carolus Holzschuh, a specialist in Cerambycidae, who kindly provided his collection for this study.

Distribution (Map 1). China: Yunnan; Vietnam: Lào Cai.

Pseudoechthistatus pufujiae **sp. n.**

http://zoobank.org/CF721CCB-5265-4ED0-9A63-27A466090FEE

Figures 15, 16, 27, 37, 45, 55, 61, 73–77, Map 1

Pseudoechthistatus birmanicus: Pu 1992: 601. (*nec* Breuning, 1942).

Type material. Holotype: male, "CHINA. Yunnan, Lushui / Yaojiaping 2450 m / 2015.V.4 em. VI.9 / leg. Wen-Xuan Bi", "IOZ(E)1905345" (IZAS). Paratypes (5 males, 6 females): 2 males, 1 female, same data as holotype but (CBWX); 1 male, ditto except "em. VI.4" (CBWX); 1 male, ditto except "2015.VIII.13" (CBWX); 1 female, "Yunnan Lushui / Yaojiaping 2500 m", "1981.VI.2 / leg. Wang Shu-Yong", "*Pseudechthistatus* / *birmanicus* / *Breuning* / det. Pu Fu-Ji 19", "IOZ(E)1905350" (IZAS); 1 female, "CHINA. Yunnan, Lushui / Yaojiaping / 2700 m 2010.VI.21 / leg. Wen-Xuan Bi" (CBWX); 1 female, ditto except "2600m 2010.VI.23" (CBWX); 1 female, ditto except "2700 m 2010.VI.21 / leg. Xiao-Dong Yang" (CCCC); 1 male, "Yunnan, Lushui, Pianma / Gangfang alt.2402 m / 2014.IV.11 night / leg. Xuan-Kong Jiang, Tian Lu", "25°17.776'N / 98°45.862'E / YNGLGS-14-36", "IOZ(E)1905345" (IZAS); 1 female, "CHINA. Yunnan, Baoshan / Baihualing 2350m / 2015.V.4 em. VII.1 / leg. Wen-Xuan Bi" (CBWX).

Description. Male (Fig. 15). Body length 19.0–23.5 mm, humeral width 6.0–7.5 mm. Body dark brown; head, pronotum covered with tawny and brown pubescence, ventral surface with yellowish to light brown pubescence of which the lighter one forming small spots sparsely scattered throughout. Head with four tawny vittae behind upper eye lobes distinctly. Antennal scape, pedicel, basal two-thirds of 3rd antennomere and basal half of 4th antennomere with light yellowish pubescence, remainder with fine brown pubescence. Pronotum with two longitudinal tawny bands on each side of disk and other two indistinct longitudinal bands on lateral margins, the discal bands slightly longer than half of pronotal length. Scutellum densely clothed with tawny pubescence, slightly sparse along middle. Elytron with pubescence predominantly brick-red, with tawny pubescence forming the subbasal annular marking and some small spots scattered near suture and behind humerus, with light yellowish pubescence forming a short transverse band at basal one-fourth near suture, with the same pubescence forming the middle band and the preapical stripe; the middle band moderately broad and oblique, complete, slightly curved or strongly zigzagged near suture and reaching suture; the preapical stripe moderately broader at base. Legs (Fig. 37) densely clothed with intermixed tawny and light brown pubescence.

Figures 57–68. Terminalia of *Pseudoechthistatus* and *Paraleprodera* species. **57** spermatheca **58–67** endophallus in inflated and everted condition, lateral view **57–58** *Pseudoechthistatus obliquefasciatus* Pic **59** *P. sinicus* sp. n. **60** *P. granulatus* Breuning, 1942 **61** *P. pufujiae* sp. n. **62** *P. glabripennis* sp. n. **63** *P. holzschuhi* sp. n. **64** *P. chiangshunani* sp. n. **65** *Paraleprodera mesophthalma* Bi & Lin, 2012 **66** *Par. carolina* (Fairmaire, 1899) **67** *Par. triangularis* (Thomson, 1865) **68** *Par. d. diophthalma* (Pascoe, 1857). **a** enlargement of spermathecal capsule (SP) **b** endophallus in inflated and non-everted condition, show internal membrane (im) of apical furrow (af) **c**, **d** APH in ventral view **e** CT in ventral view **f**, **g** APH in dorsal view.

Body elongate, oblong oval. Head (Fig. 27) with frons sparsely and coarsely punctured; lower eye lobe subequal in length and width, 0.7 times as long as gena. Antennae ca. 1.7–1.8 times as long as body length, surpassing elytral apex at base of 6th antennomere; 3rd antennomere ca. 1.9 times as long as scape, ca. 1.3 times as long as 4th antennomere; coarsely punctured on scape to basal half of 3rd antennomere; scape to 3rd or 4th antennomere fringed beneath. Pronotum subequal in length and basal width, lateral spine very short, slightly thickened at base with acute apex; metasternum ca. 1.5 times as long as mesosternal length. Elytra ca. 1.5 times as wide as pronotal base, 1.8 times as long as humeral width; subparallel-sided in basal half, then moderately convergent toward subacute apices; disk deeply and coarsely punctured, sparsely and slightly granulated near humerus and scutellum; subbasal tubercle moderately developed and raised, ca. 1.2 times as wide as scutellar width. Hindwings (Fig. 45) developed, ca. 1.4 times as long as elytral length. Legs moderately long and slender, metafemora slightly exceeding elytral apices.

Male genitalia (Figs 55, 61). Tergite VIII (Fig. 55a) transverse, slightly emarginated apically and rounded at sides, length 0.9 times as long as width. Tegmen (Fig. 55b–c) with lateral lobe widest at base, gently narrowed toward subacute apex. Median lobe (Fig. 55d–e) with apex subacute in antero-dorsal view. Endophallus (n = 2, Fig. 61) subequal to triple length of median lobe, the length of MT ca. 2.5 times as long as the length of BPH, the length of CT+PB subequal to the length of BPH; MPH moderately curved at apical one-third, PB cylindrical at basal one-third, basal swelling (bs) of CT moderately swollen anterolaterally; APH strongly constricted, ca. 0.4 times as wide as the maximum width of PB at base, with apical bulb (ab) heavily sclerotized in apical half, obliquely truncated in lateral view; small spicules moderately distributed on apical bulb and apical one-third of PB.

Female (Fig. 16). Body length 18.2–22.7 mm, humeral width 5.5–7.0 mm. Almost identical to male in general appearance. Antennae ca. 1.2 times as long as body length, apical 3 antennomeres surpassing elytral apex; scape to 6th or 7th antennomere fringed beneath; lower eye lobe subequal in length and width, 0.4 times as long as gena; elytron longer in proportion to body length; legs comparatively short, metatibiae exceeding elytral apices at basal two-third.

Remarks. This new species can be distinguished from most of the congeners (except *P. acutipennis*) by elytral disk deeply and coarsely punctured throughout and limited granulated near base. It can be easily distinguished from *P. acutipennis* by pronotal bands and elytral preapical stripe developed, elytral apices subacute, hindwings developed (in *P. acutipennis*, pronotal bands reduced, preapical stripe of elytron absent, elytral apices strongly acute and hindwings reduced).

Pu (1992) misidentified this species as *P. birmanicus*, since the original description of the latter was too simple. Based on the type pictures, *P. birmanicus* can be easily separated from this new species by elytra with bigger and flattened granules from base to near apex, while elytral punctures finer. The middle band of the elytron is variable in the new species and cannot be used for a reliable diagnosis.

Etymology. The new species is dedicated to the late Fu-Ji Pu (1932–2002), a specialist in Chinese Cerambycidae.

Distribution (Map 1). China: Yunnan.

Figures 69–77. Biotope of *Pseudoechthistatus* species. **69–70** *P. granulatus* Breuning, 1942 **71** *P. sinicus* sp. n. **72–77** *P. pufujiae* sp. n.

Pseudoechthistatus glabripennis **sp. n.**
http://zoobank.org/8CF864B0-AC72-46B6-946E-E2BD976E23DB
Figures 7, 8, 23, 33, 40, 48, 51, 62, Map 1

Type material. Holotype: male, "CHINA. Yunnan / Menglun, 55 km / 650 m 2012. IV.25 / leg. Chao Wu" (IZAS, IOZ(E) 1905354). Paratypes (8 males, 9 females): **China**: 1 female, "Yunnan, Pingbian, Daweishan / peak, 2013.VIII.15 / leg. Chun-Xiang Liu & Kai-Qin Li", "2094 m light trap / 22°54'23.1"N, / 103°41'48.5"E (IZAS, IOZ(E) 1905351); 1 male, "CHINA. Yunnan, Pingbian / Daweishan / 2100 m 2010.V.20 / leg. Wen-Hsin Lin" (CCCC); 1 male, ditto except "2093 m 2012. IX.27 / leg. Xiao-Dong Yang" (CCCC); 1 female, ditto except "2090 m 2011.VI.11" (CCCC); 1 female, ditto except "2011-VI-11" (CJM); 1 male, 2 females, ditto except "2129 m 2016.IV.20" (CCCC); 1 female, ditto except "2013.V.13 / leg. Chao Li light trap" (CLC); 1 male, 2 females, "Yunnan Honghezhou Pingbian / Daweishan 2015.V.21 / leg. Tian-Long He", "22.551172°N / 103.415424°E / 1989 m observe" (CHTL); 2 males, 1 female, "Yunnansheng, Honghezhou, Pingbianxian / Daweishan Ziranbaohuqu / 2015.V.18 / Tian-Long He leg." (CGQH); **Vietnam**: 1 male, "VIETNAM: Cao Bang Prov. / Phia-Oac Mtn. road, 1800 m / 22°36.914'N, 105°51.798'E / 2 May 2012 - sweeping / S. W. Lingafelter"(NMNH); 1 male, ditto except "on road (day) / Eduard Jendek, coll."(NMNH).

Description. Male. (Fig. 7). Body length 22.0–25.6 mm, humeral width 6.7–7.4 mm. Body brownish black; head, pronotum covered with tawny and brown pubescence, ventral surface with tawny pubescence and forming two discontinuous longitudinal bands on each side of abdomen. Head with a pair of tawny vittae on each side of occiput and reaching apical margin of vertex. Antennal scape, pedicel and basal one-fourth of 3rd antennomeres moderately covered with light yellowish pubescence, remainder covered with fine brown pubescence. Pronotum with two longitudinal tawny bands on each side of disk and other two longitudinal postmedian bands on lateral margins, the discal bands about four-fifths as long as pronotal length. Scutellum densely clothed with tawny pubescence, except a narrow median glabrous line. Elytron with dark purple sheen, with tawny pubescence narrowly forming the subbasal annular marking and some small spots scattered mainly near suture, with yellowish pubescence forming the middle band and the preapical stripe, remainder with very fine pubescence; the middle band moderately oblique, complete, regularly shaped, nearly reaching suture; the preapical stripe narrow, slightly longer than one-fourth of elytral length. Legs (Fig. 33) clothed with sparse brown and dense light yellowish pubescence of which the lighter one forming small spots sparsely scattered.

Body elongate, fusiform. Head (Fig. 23) with frons sparsely and finely punctured; lower eye lobe 1.3 times as long as width, 0.6 times as long as gena. Antennae ca. 1.7–1.8 times as long as body length, surpassing elytral apex by six antennomeres; 3rd antennomere ca. 1.8 times as long as scape, ca. 1.3 times as long as 4th antennomere; coarsely punctured on scape to 3rd antennomere; scape to 3rd antennomere fringed beneath. Pronotum 1.2 times as long as basal width, lateral spine short, slightly thickened at base with acute apex; metasternum ca. 1.5 times as long as mesosternal length. Elytra 1.6 times as wide as pronotal base, 2.1 times as long as humeral width; distinctly widest across humeri, then strongly convergent toward subacute apices; disk smooth, very finely punctured, moderately granulated near humerus; subbasal tubercle strongly developed and raised, ca. 1.4–1.6 times as wide as scutellar width. Hindwings (Fig. 48) developed, ca. 1.5 times as long as elytral length. Legs long and slender, metafemora almost exceeding elytral apices.

Male genitalia (Figs 51, 62). Tergite VIII (Fig. 51a) slightly longer than width, slightly emarginated apically and straight sided. Tegmen (Fig. 51b–c) with lateral lobe widest at base, gently narrowed toward apical half then straightly toward rounded apex. Median lobe (Fig. 51d–e) with apex roundly acuminate in antero-dorsal view. Endophallus (n = 4, Fig. 62) slightly longer than triple length of median lobe, the length of MT ca. 2.1 times as long as the length of BPH, the length of CT+PB slightly shorter than the length of BPH; MPH moderately curved at apical one-fourth, PB cylindrical at basal half, basal swelling (bs) of CT well developed; APH strongly constrictive, ca. one half as wide as the maximum width of PB at base, with apical bulb (ab) slightly sclerotized ventrally, subcylindrical in lateral view; small spicules densely distributed on apical bulb, apical margin and dorsal surface of PB.

Female (Fig. 8). Body length 24.0–25.1 mm, humeral width 7.3–7.4 mm. Almost identical to male in general appearance. Antennae ca. 1.2 times as long as body length, apical 3 antennomeres surpassing elytral apex; scape to 6th antennomere fringed beneath; pronotum subequal in length and basal width; elytra subparallel-sided in basal half; elytron longer than males in proportion to body length; legs comparatively short, metatibia exceeding elytral apices at basal two-third.

Remarks. This new species is easily distinguishable from congeners by combination of the following characters: elytral disk smooth, very finely punctured and pubescent, with dark purple sheen; middle band of elytron moderately oblique, complete; elytra distinctly widest across humeri (at least in males). Endophallus with the overall shape unique, especially by basal swelling (bs) of CT distinctly tuberculate laterally; APH strongly constrictive and subcylindrical in lateral view.

Etymology. The new species is named from a combination of the Latin stem, ‘glabri’and ‘pennis’referring to the smooth surface of elytra.

Distribution (Map 1). China: Yunnan; Vietnam: Cao Bằng.

Biological notes

No biological information has been so far available for *Pseudoechthistatus*. This overview is based on notes from several collectors and the observation of the first author as well as the label data from the specimens. Most species appear to occur in broadleaf deciduous or mixed coniferous and broadleaf forests (Fig. 69) at high elevations between 1800–3000 m, with the exception of an individual of *P. glabripennis* collected at 650 m, the lowest elevation known for this genus.

Adults were mostly observed on dead leaves and branches: *P. granulatus* were feeding on dead leaves or bark of *Pterocarya* sp. (Juglandaceae) and *Acer* spp. (Aceraceae);

the population of *P. chiangshunani* from Manwanzhen, Lincang City were crawling on the trunk of dead *Juglans regia* (Juglandaceae) or feeding on dead leaves of *Alnus cremastogyne* (Betulaceae); some specimens of *P. sinicus* and *P. obliquefasciatus* were collected by beating dead branches of *Cyclobalanopsis* spp. and *Quercus* spp. (Fagaceae), while the population of *P. sinicus* in Xiaobaicaoling, Santaixiang, Dayao County, were feeding on living leaves of *Acer* sp. Some adults of *P. pufujiae* were reared from larvae collected under bark of a fallen tree of *Pterocarya* (Figs 75–77) in Yaojiaping, some larvae of *P. granulatus* were found in the same tree species in Gongshan but failed to emerge. One adult of *P. chiangshunani* was found in its pupal cell in a partly rotten wood of *Alnus cremastogyne* (Betulaceae). Two possible larvae of *P. granulatus* and *P. sinicus*, which were collected under bark of conifers but died due to the high temperature at lower elevation, were preserved properly for a further study.

Most species are nocturnal, and remain hidden in or around their host plants during daytime (Figs 71–72). Most specimens were collected by observing, beating, sweeping vegetation or by using light traps. Some individuals of *P. sinicus* were observed crawling on ground in the daytime. One female of *P. pufujiae* laying eggs on a fallen log was observed at noon (Fig. 74).

Besides the species with reduced hindwings which are apparently flightless, *P. pufujiae* (Fig. 73) with normal hindwings was observed flying only short distances when disturbed in the lab or in the field. A series of *P. glabripennis* attracted to a light trap indicates strong flying ability of that species.

Up to now, only *P. glabripennis* and *P. holzschuhi*, both with normally developed hindwings, are known to be sympatric in Fenshuiling, southeast Yunnan (Map 1). Those species with reduced hindwings appear to be allopatric. The Gongshan population of *P. granulatus* appears to be close to the northern population of *P. obliquefasciatus*, which is actually separated by the Nushan Mountains. *Pseudoechthistatus obliquefasciatus* is not known to be sympatric with *P. sinicus*, but the type locality of *P. obliquefasciatus* cannot be precisely localized (see the remarks of *P. obliquefasciatus*).

Pseudoechthistatus sinicus and hunting spiders (possibly Lycosidae) were active on ground vegetation simultaneously at night (observed in Weibaoshan and Xiaobaicaoling). In consideration of the elytral subbasal tubercles of *Pseudoechthistatus* that resemble the posterior median eyes of the spiders, we suppose this resemblance may represent a case of Batesian mimicry, but more evidence is required before any conclusion can be reached.

Discussion

The shortened metasternum (associated with reduced hindwings) was one of the diagnostic characters used to define Dorcadionini, Morimopsini, Parmenini, and Phrissomini of Lamiinae (Breuning 1950), and was followed by most subsequent authors (e.g. Gressitt 1951, Rondon and Breuning 1970). However, such an arbitrarily selected character has likely evolved many times and has been noted in many clearly distantly related genera and is therefore unsatisfactory for tribal classification (Švácha and Lawrence

2014). Sama (2008) synonymized Phrissomini and Dorcadionini with Lamiini which is acceptable, while another, probably polyphyletic, tribe Morimopsini needs further study.

In Breuning's tribal system of the Lamiinae, the occurrence of species with complete and reduced hindwings within the same genus or subgenus is uncommon, e.g. subgenus *Pseudale* of *Pterolophia* (Malihara 1988; Yamasako 2016 pers. comm.) and *Spalacopsis* (Tyson 1973; Lingafelter pers. comm.). In another instance, treating winged species under *Pseudoechthistatus* is supported not only by the similarities of external features (except the metasternum and its related characteristics) but also by the resemblances of the endophallic structures. The morphology of the endophallus is therefore considered useful for distinguishing and/or defining taxa of *Pseudoechthistatus* as well as other Lamiinae (e.g. Ehara 1954, Nakamine and Takeda 2008).

Investigation of the inflated endophallus in Cerambycidae was considered to have been undertaken for the first time recently (Danilevsky et al. 2005); however, Kuboki (1980, 1981) probably was the first person who investigated several lepturine species and pointed out the taxonomic significance of the structure of the endophallus. Although only an abbreviated word "everted" was presented in the paper, he in fact established a complicated way to evert and inflate the endophallus (Kuboki 2016 pers. comm.). His work has been ignored, as well as the voluminous non-English literature that has never been translated. In contrast, the endophallus in an uninflated condition has been more widely studied (e.g. Lingafelter and Hoebeke 2002).

The previous studies on the inflated endophallus can be subdivided into two paths (Yamasako and Ohbayashi 2012a): Danilevsky et al. (2005), Danilevsky and Kasatkin (2006), Kasatkin (2006), Ohbayashi and Bi (2014), Bi and Ohbayashi (2015), etc. investigated the endophallus in its everted condition; while Yamasako and Ohbayashi (2011, 2012b, 2012c), Yamasako (2014), Yamasako and Chou (2014a, 2014b), Bi and Lin (2014) etc. studied the endophallus in a non-everted condition. Yamasako and Ohbayashi (2012a) compared the advantages and the disadvantages of both conditions and concluded that observation of the endophallus is desirable in the "inflated and everted" condition, but the non-everted condition is useful for many taxa because it shows similar character states when there is no sclerotized structure supporting the membranous parts. In our study on *Pseudoechthistatus* and its relatives, however, the developed internal membrane, the sclerotized apical bulb or the presence of sclerite in apical phallomere make the APH hidden inside the endophallus in the non-everted condition and no critical structures of apical phallomere can be observed (Fig. 58b). Thus, a better comparison of endophallic structure is proposed to be done in the everted condition at least in Lamiini *sensu lato*. Of course, the technique to evert the endophallus still needs improvement, although a preliminary method is provided by Rubenyan (2002).

The endophallic terminology of Cerambycidae has been proposed and applied for various taxa by several authors (e.g. Danilevsky et al. 2005 for Dorcadionini; Kasatkin 2006 modified for family; Yamasako and Ohbayashi 2011 for Mesosini). Even so, the complex and individual structure of the endophallus among the family are still difficult to define congruously. The definition of PB for *Paraleprodera mesophthalma*

(Lamiini-Monochamini) in Bi and Lin (2012) is revised in this paper for a consistent comparison to its congeners and to *Pseudoechthistatus*.

Finally, endophallic structures of twelve species or subspecies of *Paraleprodera* Breuning, 1935 have been investigated for comparison with *Pseudoechthistatus* Pic, 1917 in this study. As a result, *Pseudoechthistatus* can be clearly distinguished from *Paraleprodera* (see generic diagnosis). However, the endophallic diversity of *Paraleprodera* is considerable and the genus may be subdivided into at least two groups: the *triangularis* group containing *Par. bigemmata*, *Par. bisignata*, *Par. diophthalma* with subspecies and *Par. triangularis*, which are characterized by CT less developed (without a distinct swelling) and APH with a pair of U-shaped sclerites (Figs 67-f, 68-g) (*Par. crucifera*, the type species of *Paraleprodera* which is morphologically similar to *Par. triangularis*, probably also belongs to this group); the *carolina* group containing *Par. carolina*, *Par.* cf. *flavoplagiata*, *Par. itzingeri*, *Par. mesophthalma,* and *Par. stephanus*, which are characterized by CT swollen posteroventrally and PB bearing a ventral tubercle (vbt) (Fig. 65). The endophallus of *Par. insidiosa* resembles neither of the above groups. The endophallic structure of the *carolina* group has a much closer resemblance to *Pseudoechthistatus* than to the *triangularis* group, indicating that *Paraleprodera* might be para- or polyphyletic, which is also supported by its variable pronotal structures. However, these considerations are beyond the scope of this paper, and the generic treatment requires a thorough study in the future.

Key to the species of *Pseudoechthistatus*

1	Elytral disk smooth, very finely punctured; elytra distinctly widest at humeri (at least in males) .... ***P. glabripennis* sp. n.**
–	Elytral disk distinctly punctured and/or granulated; elytra widest near middle or subparallel in basal half **2**
2	Pronotal longitudinal pubescent bands reduced, shorter than one-third of pronotal length; elytron strongly pointed apically, preapical stripe absent .... ***P. acutipennis***
–	Pronotal longitudinal pubescent bands well developed, longer than half of pronotal length; elytron rounded or obliquely truncated to subacute apically, with a more or less distinct preapical stripe **3**
3	Elytral humeri distinctly narrower, elytra widened near middle; hindwings strongly reduced, distinctly shorter than elytral length **4**
–	Elytra subparallel in basal half (at least in males); hindwings developed, distinctly longer than elytral length **6**
4	Subbasal tubercle of elytron moderate in size, subequal to or slightly narrower than scutellar width; elytral middle band strongly oblique, more than 40 degrees to transverse axis........ ***P. obliquefasciatus***
–	Subbasal tubercle of elytron large, at least 1.2 times wider than scutellar width; elytral middle band moderately oblique or nearly transverse, less than 30 degrees to transverse axis **5**

5 Elytra long, 2.0 times (in males) or 2.2 times (in females) as long as humeral width; elytral disk sparsely covered with large and raised granules throughout; preapical stripe of elytron reduced, shorter than one-fifth of elytral length........ ***P. granulatus***

– Elytra comparatively short, 1.8 times (in males) or 2.0 times (in females) as long as humeral width; elytral disk sparsely covered with moderately sized granules which become indistinct near apical one-third, and absent beyond apical one-fourth; preapical stripe of elytron developed, subequal to one-fourth of elytral length .... ***P. sinicus* sp. n.**

6 Elytron distinctly granulated, granules reaching at least apical one-fourth; punctures sparse and shallow 7

– Elytron weakly granulated, granules reaching at most basal one-third; punctures distinct and deep, at least reaching middle **8**

7 Elytral granules smaller and dense; middle band narrow, moderately oblique, interrupted or nearly so at middle .... ***P. chiangshunani* sp. n.**

– Elytral granules larger and sparse; middle band broad, nearly transverse, not interrupted or narrowed .... ***P. birmanicus***

8 Elytral punctures moderate, reaching the middle; at least 3rd to 4th antennomeres annulate with light pubescence at base; elytral middle band interrupted or nearly so at middle .... ***P. holzschuhi* sp. n.**

– Elytral punctures deep and coarse, reaching the apex; antennomeres without distinct annular light pubescence; elytral middle band complete .... ***P. pufujiae* sp. n.**

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The morphology of the immature stages of two rare *Lixus* species (Coleoptera, Curculionidae, Lixinae) and notes on their biology

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Abstract

The mature larvae and pupae of *Lixus* (*Ortholixus*) *bituberculatus* Smreczyński, 1968 and *L.* (*Dilixellus*) *neglectus* Fremuth, 1983 (Curculionidae: Lixinae: Lixini) are described and compared with known larvae of 21 other *Lixus* and 2 *Hypolixus* taxa. The mature larva and pupa of *L. bituberculatus* are the first immature stages described representing the subgenus *Ortholixus*. The larva of *L. neglectus*, in the subgenus *Dilixellus*, is distinguished from the known larvae of four species in this subgenus by having more pigmented sclerites on the larval body. All descriptions of mature larvae from the tribe Lixini, as do all known species from the tribe Cleonini, fit the diagnosis of the mature larva of the Lixinae subfamily. Furthermore, new biological information of these species in the Czech Republic, Slovakia and Romania is provided. For *L. bituberculatus,* a chicory, *Cichorium intybus* L. (Asteraceae), is identified as a host plant, and *L. neglectus* is found on dock *Rumex thyrsiflorus* Fingerh. (Polygonaceae). Both species are probably monophagous or oligophagous. Adults of *L. bituberculatus* often inhabit host plants growing in active, dry and sunny pastures with sparse patches without vegetation, being mostly active during the night in April/May and then again in September, when the highest activity levels are observed. Adults of *L. neglectus* inhabit dry grasslands on sandy soils with host plants, being active during the day from May to September, with the highest level of activity in May/June and September. The larvae of both species are borers in the stem and root of the host plant, and they pupate in root or root neck. Adults leave the pupation cells at the end of summer and do not hibernate in the host plants. Finally, Romania is a new geographic record for *L. bituberculatus*.

Keywords

Weevil, mature larva, pupa, larval development, life cycle, host plant, *Cichorium intybus*, *Rumex thyrsiflorus*, Central Europe, Palaearctic region

Introduction

The genus *Lixus* Fabricius, 1801, belongs to the tribe Lixini Schoenherr, 1823 in the subfamily Lixinae Schoenherr, 1823 (family Curculionidae Latreille, 1802), and approximately 500 species have been described globally (Ter-Minasian 1967). Approximately 170 *Lixus* species in 12 subgenera are found in the Palaearctic region; only *Eutulomatus* Desbrochers des Loges, 1893 and *Parileomus* Voss, 1939 do not occur in Europe (Gültekin and Fremuth 2013). The biology of these species is partially known but has primarily only been studied recently (e.g., Nikulina 1989; Volovnik 1994, 2007; Gültekin 2007; Gosik and Wanat 2014; Skuhrovec and Volovnik 2015). The immature stages of *Lixus* species usually develop in the stems (Meregalli 2014) or the roots of plants (Dieckmann 1983) but sporadically develop in the seed capsule (Gültekin 2005) or petiole (Gültekin 2007). Some species from this genus are considered to be agricultural pests (e.g., *Lixus incanescens* Boheman, 1835 in Manole 1990; others in Volovnik 1988; Nikulina 1989), but others could be used for the biological control of selected weeds (e.g., *Lixus filiformis* (Fabricius, 1781) for musk thistle; Gültekin 2004) or have already been used for these purposes (e.g., *Lixus cardui* Olivier, 1807 in Australia; Nikulina and Gültekin 2011). Detailed morphological descriptions have been published for the larvae of 21 *Lixus* species, with detailed descriptions of the pupae being available for only eight species (see Scherf 1964; Lee and Morimoto 1988; May 1994; Nikulina 2001, 2007; Zotov 2009a, b; Nikulina and Gültekin 2011; Gosik and Wanat 2014; Skuhrovec and Volovnik 2015).

Lixus bituberculatus Smreczyński, 1968 belongs to the subgenus *Ortholixus* Reitter, 1916, which includes 18 species in the Palaearctic region (Gültekin and Fremuth 2013). This species is among the rarest of the genus *Lixus*, only distributed in Hungary, Slovakia and Bulgaria (Gültekin and Fremuth 2013; Stejskal and Trnka 2014). The biology and host plant of *L. bituberculatus* were completely unknown, and its immature stages have never been described.

Lixus neglectus Fremuth, 1983 belongs to the subgenus *Dilixellus* Reitter, 1916, which includes 31 species in the Palaearctic region (Gültekin and Fremuth 2013), and the distribution of this central European endemic weevil includes a relatively small area (ca. 5000 km^2) in Austria, the Czech Republic and Slovakia at the confluence of the Dyje and Morava Rivers (Gültekin and Fremuth 2013; Trnka and Stejskal 2014). The biology and plant associations of *L. neglectus* are better known than previously described species, and several authors reported the occurrence of adults on garden sorrel (*Rumex acetosa* L.) (e.g., Fremuth 1983; Koch 1992; Böhme 2001; Trnka and Stejskal 2014). The immature stages of *L. neglectus* have never been described.

Knowledge of the immature stages and life histories of both species is important for taxonomy as well as practical applications and can help to more effectively protect these species. In this paper, we describe the immature stages of both species and provide details of their life history based on field observations in the Czech Republic, Slovakia and Romania.

Materials and methods

The material used to describe the immature stages was collected, and field observations were conducted in the localities mentioned below:

***Lixus* (*Ortholixus*) *bituberculatus* Smreczyński, 1968**

Material examined. ROMANIA: **Caraș-Severin County:** Sfânta Elena env.; 44°40'24.1"N, 21°43'2.0"E; survey dates: 9-VI-2012, 1–2-IX-2012, 18–23-V-2013, 5-VIII-2014 (3 larvae), 6-VIII-2014 (2 larvae, 1 pupa), 8-VIII-2014 (7 larvae, 3 pupae); all leg. & det. F. Trnka, coll. J. Skuhrovec. Habitats: pastures (cattle, sheep, goats), road margins and dry grasslands. Bedrock: limestone. Altitude: 400 m a. s. l. (see Fig. 21). **SLOVAKIA**: **Rimavská Sobota District:** Gemerské Dechtáre env.; 48°15'22.03"N, 20°2'12.44"E; 11-IV-2015. Habitats: pastures (cattle and sheep), road margins and dry grasslands. Bedrock: quaternary eolithic sediments (sand and loess). Altitude: 206 m a. s. l.

***Lixus* (*Dilixellus*) *neglectus* Fremuth, 1983**

Material examined. CZECH REPUBLIC: **Břeclav District:** Lanžhot env.; 48°41'21.04"N, 16°56'3.40"E; survey date: 19-VII-2014. Habitat: dry grassland and blown sand, THG01 *Potentillo heptaphyllae-Festucetum rupicolae* (Chytrý et al. 2010). Bedrock: quaternary alluvial sediments (sand). Altitude: 164 m a. s. l. (see Fig. 41); Kostice env.; 48°45'54.60"N, 16°56'36.54"E; survey date: 9-VI-2015. Habitat: grassy road embankment. Bedrock: artificial structure (sandy gravel). Altitude: 168 m a. s. l. **SLOVAKIA**: **Trnava District:** Sekule env.; 48°37'8.60"N, 16°59'21.03"E; survey dates: 13-VII-2014 (5 mature larvae, 2 younger larvae, 1 pupa) and 25-VII-2014 (2 pupae reared from larvae collected on 13-VII-2014); all leg. R. Stejskal & F. Trnka, det. R. Stejskal & F. Trnka, coll. J. Skuhrovec. Habitat: dry meadow. Bedrock: quaternary alluvial sediments (sand). Altitude: 158 m a. s. l.

Rearing and life cycle observations were conducted during the 2014–2015 vegetation growing seasons. Laboratory observations were conducted in Olomouc (49°35'36"N, 17°15'3"E) and in Znojmo, Czech Republic (48°51'31"N, 16°2'40"E).

Part of the larval and pupal material was preserved in Pampel fixation liquid (4 parts glacial acetic acid, 6 parts 4% formaldehyde, 15 parts 95% ethyl alcohol and 30 parts distilled water) and used for the morphological descriptions. These specimens are now deposited in the Group Function of Invertebrate and Plant Biodiversity in Agrosystems of the Crop Research Institute (Prague, Czech Republic). Plants were identified by the collectors. Slides were prepared following May (1994) as follows: a larva was decapitated, its head was cleared in a 10% potassium hydroxide (KOH) solution and then rinsed in distilled water. After clearing, the mouth parts were separated from the head capsule. The head capsule and the mouth parts were mounted on permanent microscope slides in Euparal. The body parts (thorax and abdomen) were mounted on temporary microscope slides in 10% glycerine.

The observations and measurements were made using a light microscope with calibrated oculars (Olympus BX 40 and Nikon Eclipse 80i), and the following characteristics were measured for each larva: head width, length of the body (larvae fixed in a C-shape were measured in segments), width of the widest part of the body (metathorax or abdominal segments I–IV).The length and width of the widest part of the body was measured for each pupa. The thorax and abdomen were not sclerotised, and it is unlikely that the fixation process altered the weevils' proportions; measurements of these parts are given for comparison purposes only.

Drawings were made with a drawing tube on a light microscope and processed by a computer program (Adobe Photoshop, Corel Photo-Paint 11, GIMP 2). The thoracic spiracle is located on the prothorax near the boundary of the prothorax and mesothorax, as shown in the drawing (see Figs 8, 29), but it is of mesothoracic origin (Marvaldi et al. 2002, Marvaldi 2003). The drawings show the thoracic and abdominal spiracles (see Figs 8–10, 29–31). The numbers of setae are given for one side of the bilateral structures.

We used the terms and abbreviations for the setae of the mature larva and pupa studied in Scherf (1964), May (1977, 1994) and Marvaldi (1998a, 1999).

The count of some of the setae on the epipharynx (especially *ams* and *mes*) have not been completely resolved. According to Marvaldi (1998a, 1999), the standard status of the epipharynx in weevils is 2 *ams* and 3 *mes*, but when the position of the distal *mes* is very close to the anterior margin, they appear as *ams*. The decision was finally made to add this problematic seta to the latter group (*ams*), and the position of this seta is similar to that in other genera, e.g., in *Coniocleonus* Motschulsky or *Tychius* Germar. We did not follow Stejskal et al. (2014) and Skuhrovec et al. (2014), who accepted the standard status in weevils and counted the seta as *mes*, but we followed Trnka et al. (2015) and Skuhrovec et al. (2015), e.g., in *Adosomus* Faust or *Sibinia* Germar.

Results

Lixus (*Ortholixus*) *bituberculatus* Smreczyński, 1968

Description of mature larva. *Measurements* (in mm). Body length: 6.5–10.4 (mean 9.2). The widest part of the body (metathorax and abdominal segments I–II) measuring up to 2.8. Head width: 1.4–1.7 (mean 1.5).

General. Body stocky, slightly curved, rounded in cross section (Fig. 7). Cuticle finely spiculate.

Colouration. Head light brown or brown with a distinct pale pattern around the frontal suture (Figs 7, 19). All thoracic and abdominal segments are white with a light brown, elongate stripe on the dorsum of the pronotum (Fig. 7).

Vestiture. Setae on body thin, relatively short, light yellow or orange.

Head capsule (Fig. 1). Head suboval, flattened laterally, endocarinal line long more than half length of frons. Frontal sutures distinct, extended to the antennae. Single stemma (st) in the form of a slightly pigmented spot located anterolaterally on each side. *Des1* and *des2* located in the upper part of the central part of the epicranium, *des1* near the middle part of epicranium, and *des2* near the side of the epicranium, *des3* located anteriorly near the frontal suture, *des4* located in the central part of the epicranium, *des5* located anterolaterally; all *des* long, subequal in length (Fig. 1). *Fs1* and *fs2* placed medially, *fs3* located anteromedially, *fs4* located anterolaterally, and *fs5* located laterally, close to the epistoma; all setae relatively long, *fs4* slightly longer than *fs1-3* and *fs5* distinctly longer than *fs4* (Fig. 1). *Les1–2* as long as *des1*; *ves1–2* as long as *fs3*. Epicranial area with sensilla undistinct.

Antennae located at the end of the frontal suture on each side, membranous and slightly convex basal article bearing one conical triangular sensorium, relatively long; basal membranous article with 5 sensilla different in both shape and length (Fig. 4).

Clypeus (Fig. 2) approximately 2.1 times as wide as long with 2 relatively long *cls*, almost equal in length, localized posterolaterally and 1 sensillum; anterior margin rounded to the inside.

Mouth parts. Labrum (Fig. 2) approximately 2 times as wide as long, with 3 pairs of piliform *lms*, of different lengths; *lms3* distinctly shorter than very long *lms1* and long *lms2*; *lms1* located close to the margin with clypeus, *lms2* located anteromedially and *lms3* located anterolaterally; anterior margin double sinuate. Epipharynx (Fig. 3) with 4 pairs of blunt, finger-like *als*, unequal in length, *als1–2* distinctly shorter than *als3–4*; 3 pairs of *ams*, *ams1* and *ams2* distinctly shorter than *ams3*, *ams1* and *ams2* piliform, and *ams3* blunt, finger-like; 2 pairs of short, blunt *mes* and one sensilla close to *mes2*, located close to lr; labral rods (lr) elongated, converging anteriorly. Mandibles (Fig. 5) relatively broad, bifid, teeth of unequal height; slightly truncate; both *mds* relatively long, piliform. Maxilla (Fig. 6) stipes with 1 *stps*, 2 *pfs* and 1 *mbs*; very long *stps* distinctly longer than long *pfs1–2*, *mbs* very short; mala with 12 bacilliform *dms* of two different lengths (6 very long and 6 relatively long); 5 short *vms*, almost equal in length; *vms* distinctly shorter than *dms*. Maxillary palpi with two palpomeres; basal palpomere with 1 very short *mxps* and two sensilla; length ratio of basal and distal palpomeres: 1:0.7; distal palpomere with one sensillum and a group of conical, apical sensorial papillae. Praelabium (Fig. 6) heart-shaped and distinctly elongated, with 1 relatively long *prms*; ligula with sinuate margin and 3 piliform micro *ligs*, unequal in length; premental sclerite well visible. Labial palpi with two palpomeres; length ratio of basal and distal palpomeres: 1:0.7; distal palpomere with one sensillum and short,

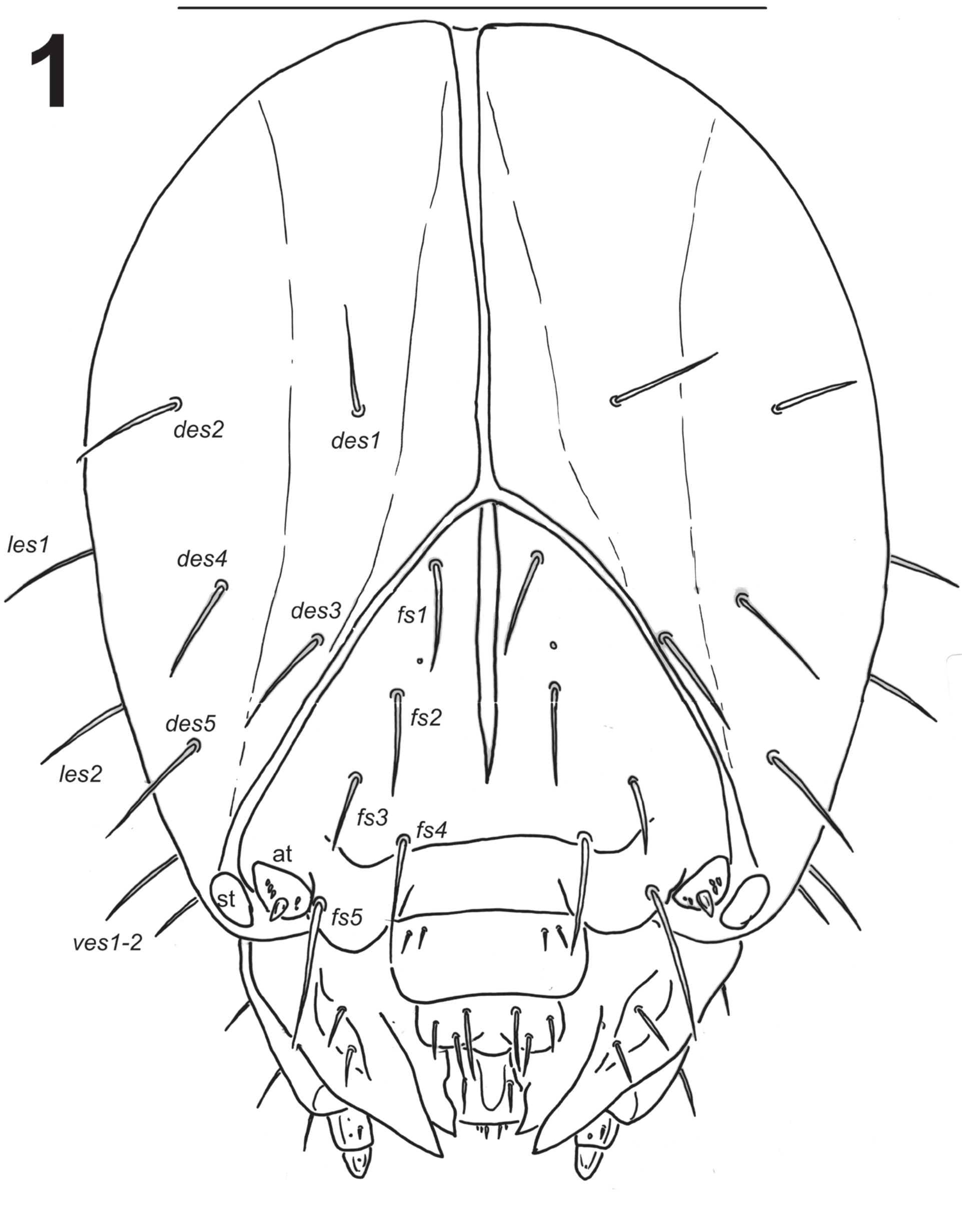
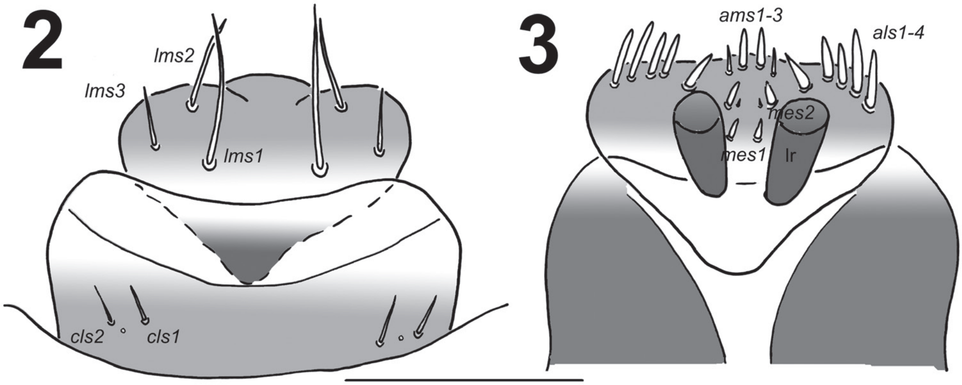


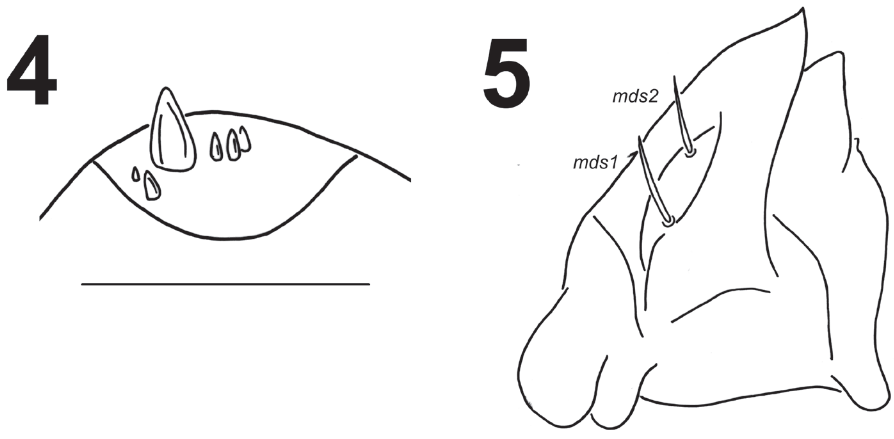
Figure 1. *Lixus bituberculatus* mature larva head, dorsal view. Scale bar: 1 mm.

apical sensorial papillae; basal palpomere with 1 ventral sensillum. Postlabium (Fig. 6) with 3 *pms*, *pms1* located anteriorly, remaining two pairs laterally; relatively long, almost of equal length, *pms3* distinctly shorter than *pms1* and *pms2*; surface of postlabium densely covered by distinct asperities.

Thorax. Prothorax distinctly smaller than meso- and metathorax. Metathorax almost of equal length as abdominal segments I–IV. Spiracle bicameral. Prothorax



Figures 2–3. *Lixus bituberculatus* mature larva. **2** Labrum and clypeus **3** Epipharynx. Scale bar: 0.5 mm.



Figures 4–5. *Lixus bituberculatus* mature larva head. **4** Antenna **5** Right mandible. Scale bars: 0.1 mm (**4**) and 0.2 mm (**5**).

(Fig. 8) with 10 *prns* unequal in length, 8 of them on weakly pigmented premental sclerite, which is subdivided medially into two triangular plates, next two *prns* placed below; 2 *ps* and 2 *eus*. Mesothorax (Fig. 8) with 1 *prs*; 4 *pds* unequal in length, *pds2* distinctly shorter than the remaining three setae; 1 short *as*; 2 short to very short *ss*; 1 *eps*; 1 *ps* and 2 *eus*. Chaetotaxy of metathorax (Fig. 8) identical to that of mesothorax. Each pedal area of the thoracic segments well separated and pigmented, with 7 long *pda*, 6 of which on pigmented area, unequal in length.

Abdomen. Abdominal segments I–IV of almost equal length, subsequent abdominal segments decreasing gradually to the terminal parts of the body. Abdominal segment X reduced to four anal lobes of unequal size, the dorsal being distinctly the largest, the lateral pair equal in size, and the ventral lobe very small. Anus located terminally. Spiracles bicameral, the eight abdominal spiracles located laterally, close to

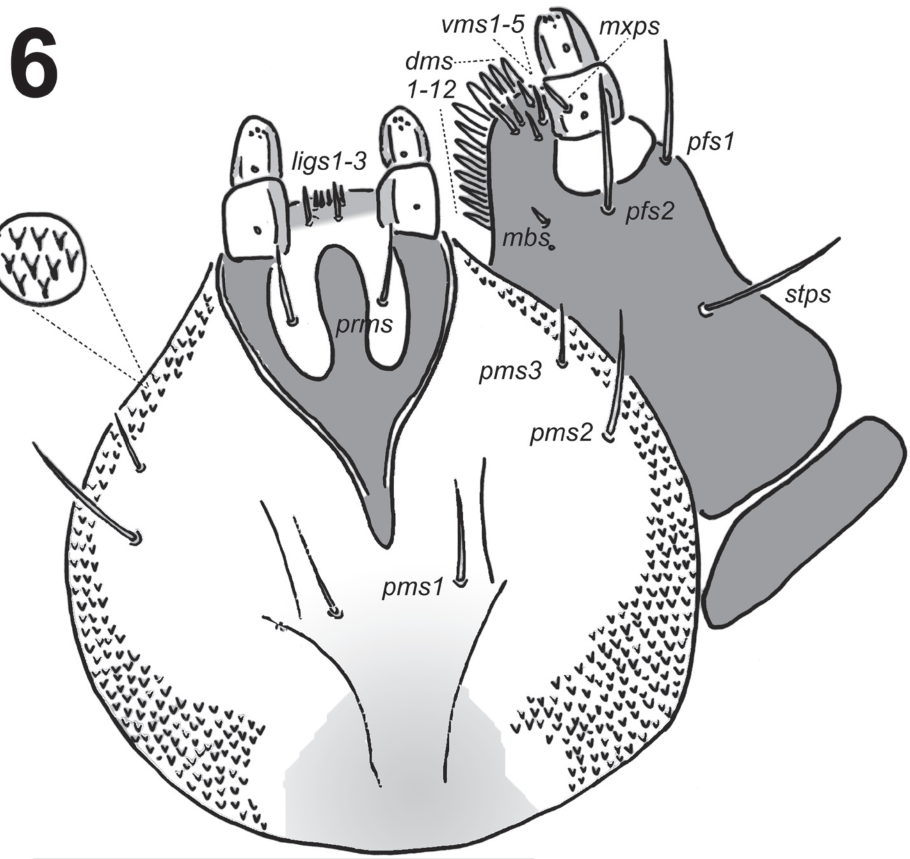


Figure 6. *Lixus bituberculatus* mature larva head, maxillo-labial complex, ventral view. Scale bar: 0.5 mm.

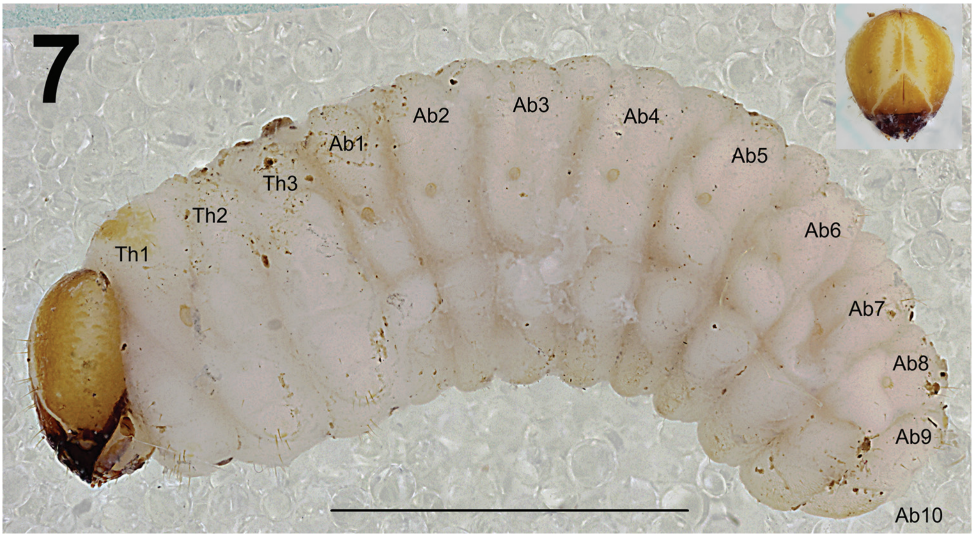
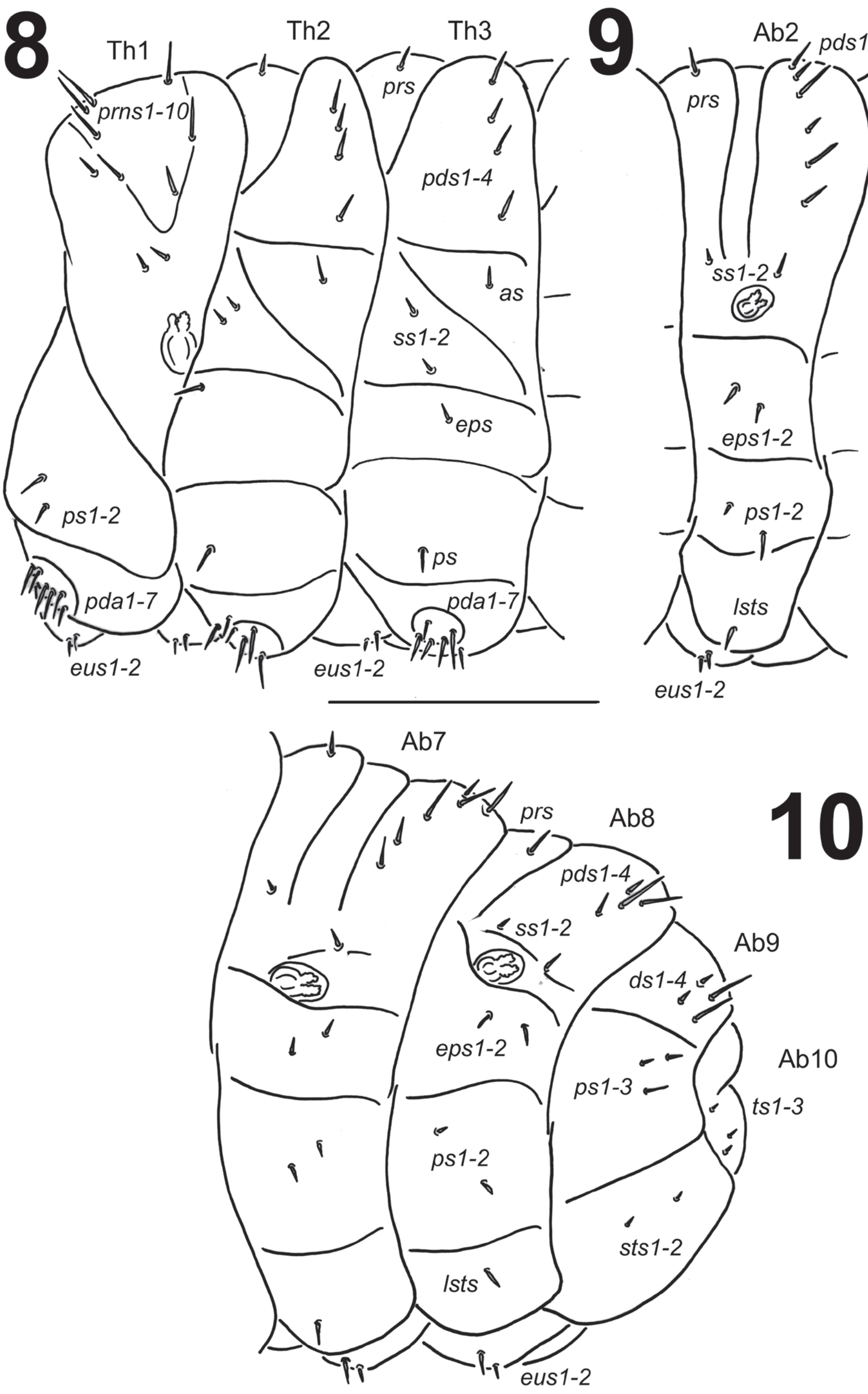


Figure 7. *Lixus bituberculatus* mature larva habitus, lateral view. Scale bar: 3 mm.



Figures 8–10. *Lixus bituberculatus* mature larva habitus. **8** Lateral view of thoracic segments **9** Lateral view of abdominal segment II. **10** Lateral view of abdominal segments VII–X. Scale bar: 1 mm.

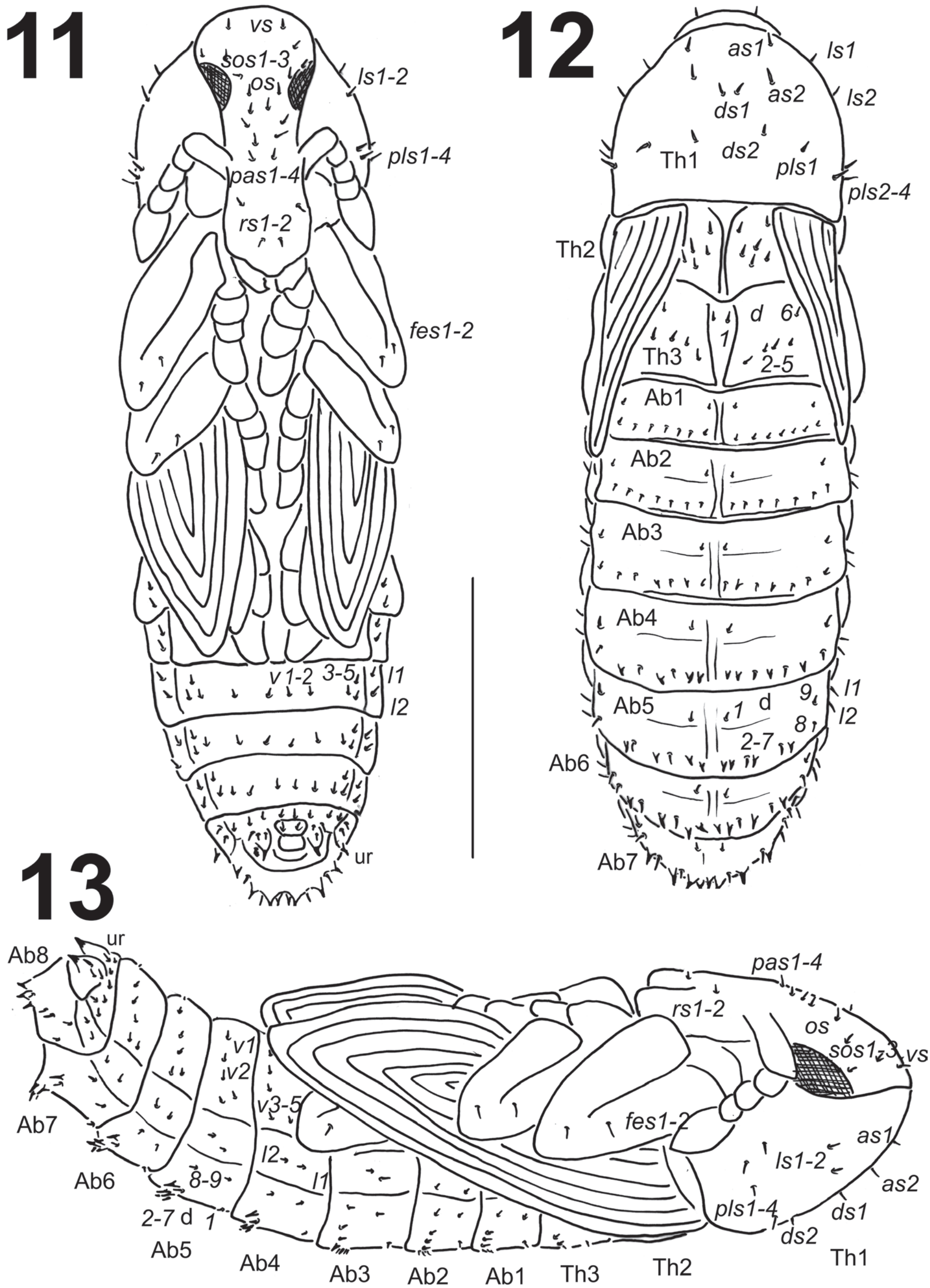
the anterior margin of abdominal segments I–VIII. Abdominal segments I–VII (Figs 9–10) with 1 *prs*; 6 *pds*, *pds3* and *pds5* the longest one; 2 *ss* of unequal length, *ss1* very short, *ss2* as long as *pds6*; 2 *eps* of almost equal length; 2 relatively short *ps* of unequal length, *ps1* very short to minute, *ps2* short; 1 *lsts* and 2 *eus*. Abdominal segment VIII (Fig. 10) with 1 *prs*; 4 *pds*, *pds1* and *pds6* lacking, *pds3* and *pds5* less than half of length of the two remaining setae; 2 *ss* of unequal length, *ss1* very short, *ss2* long as *pds6*; 2 *eps* of almost equal length; 2 short *ps* of equal length; 1 *lsts* and 2 *eus*. Abdominal segment IX (Fig. 10) with 4 *ds* (*ds1* and *ds3* very short, *ds 2* and *ds4* long); 2 short and 1 very short *ps* and 2 very short to micro *sts*. Abdominal segment X (Fig. 10) with 2 microsetae and 1 seta (*ts*) on each lateral anal lobe.

Description of pupa. *Measurements* (in mm). Body length: 8.0–10.4 (♂ 8.0–10.4; ♀ 9.8). The widest part of the body, commonly between the apex of the meso- or metafemora: 2.6–3.5.

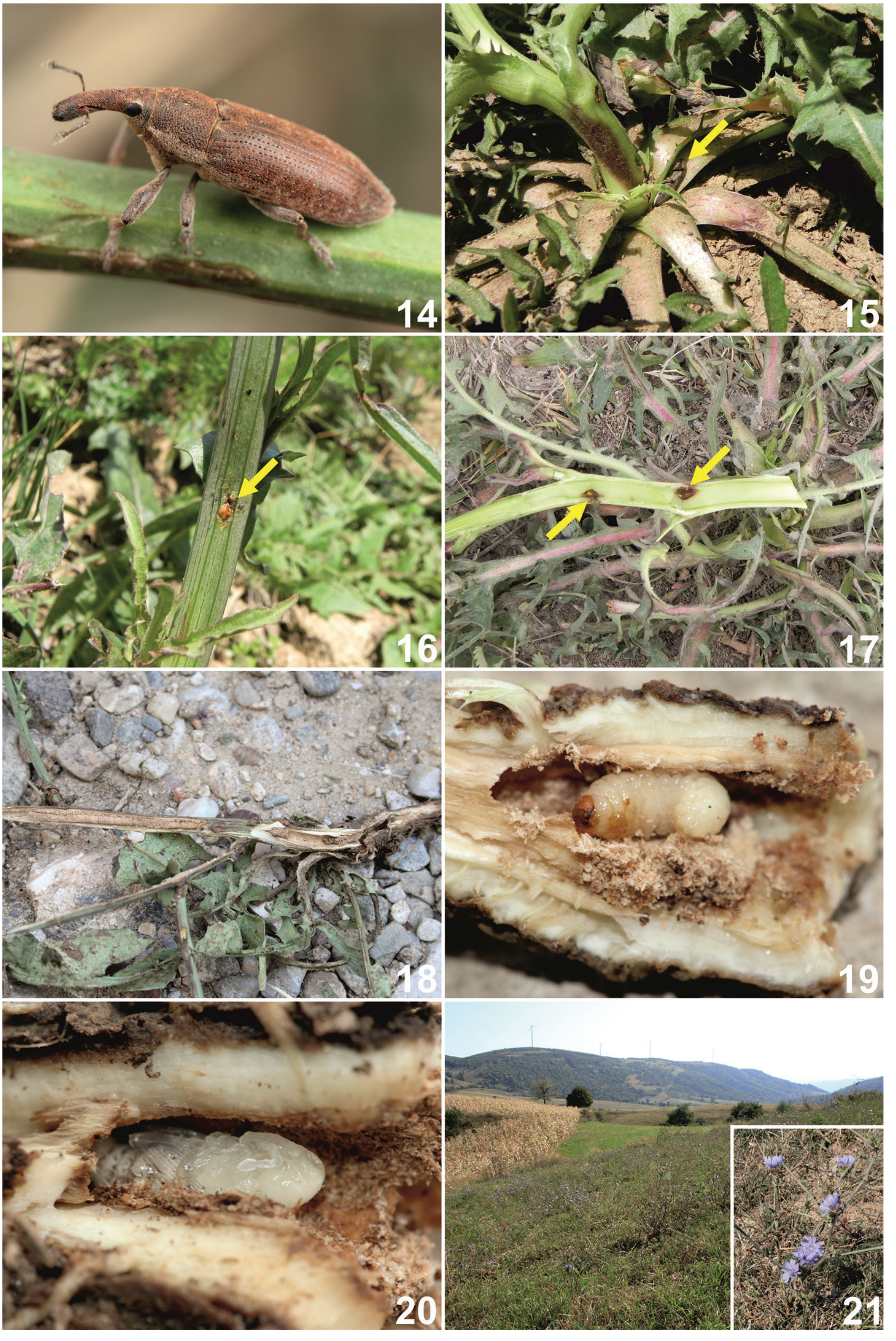
Colouration. Body white to yellowish (Fig. 20).

Morphology (Figs 11–13, 20). Body stocky, elongated, white or yellowish. Cuticle smooth. Rostrum relatively long, approximately 2.7 to 3.0 times as long as wide, extending beyond the mesocoxae; females with slightly thinner rostrum than males. Antennae relatively long and stout. Pronotum from 1.2 to 1.3 times as wide as long. Mesonotum and metanotum of almost equal length. Abdominal segments I–III of almost equal length; abdominal segment VI semicircular and subsequent abdominal segments diminish gradually to the end of the body. Abdominal segments VII–IX distinctly smaller than other abdominal segments. Gonotheca (abdominal segment IX) in females (1 specimen) bilobed.

Chaetotaxy (Figs 11–13). Setae relatively short, unequal in length, light yellow or orange, some setae on abdominal segments III–VIII distinctly stronger and located on protuberances. Setae well visible. Head capsule includes 1 *vs*, 3 *sos*, 1 *os* and 4 *pas*. Rostrum with 2 *rs*, *rs1* located below antenna, *rs2* placed on the anterior margin. Setae on head capsule and rostrum straight, both *rs* and all *pas* distinctly shorter than the remaining setae on head, thoracic and abdominal segments. Pronotum with 2 *as*, 2 *ds*, 2 *ls* and 4 *pls*. Dorsal parts of mesothorax with 1 seta located posteromedially, 1 seta located posterolaterally and 4 setae located along its anterior margin. Chaetotaxy of metathorax identical to that of mesothorax. Each femoral apex with 2 *fes*. Dorsal parts of abdominal segments I–VIII each with 2 pairs of setae located posteriorly (*d1*, *d9*) and 7 pairs (*d2–8*) located along their anterior margins. Setae *d2–3, d5* and *d7* (on abdominal segments IV–VIII) short, thorn-like, located on protuberances; on abdominal segment III only setae *d3* and *d5*. Remaining setae short to very short, hair-like; all setae very short on abdominal segments I–II. Abdominal segments I–VII with groups of 2 lateral setae and 5 pairs of ventral setae. Dorsal part of abdominal segment VIII with 1 seta located posteriorly (*d9*) and 7 pairs (*d2–8*) located along its anterior margin; *d3, d5* and *d7* thorn-like, located on protuberances; remaining setae elongated. Abdominal segment VIII with groups of 2 lateral setae and 5 short ventral setae. Abdominal segment IX with 2 pairs of ventral microsetae and 1 pair of short, thin setae. Urogomphi elongated, triangular.



Figures 11–13. *Lixus bituberculatus* pupa habitus. **11** Ventral view **12** Dorsal view **13** Lateral view. Scale bar: 3 mm.



Figures 14–21. Habitats, adults, immature stages and life cycle of *Lixus bituberculatus*. **14** Adult **15** Adult hiding in host plant rosette **16** Ovipositional mark **17** Eggs in the host plant stem **18** Feeding marks in the stem **19** Mature larva in the root crown **20** Pupa and pupation cell **21** Habitat in Romania and *Cichorium intybus* host plant.

Biology and ecology. *Habitats.* Adults (Fig. 14) prefer dry and sunny habitats such as dry grasslands, meadows often with grazing or mowing (Fig. 21), and road margins with specific disturbance regimes (trampling by movement of cattle or vehicles, etc.).

Adult behaviour. During the day, adults stay among the rosette leaves of the host plant (Fig. 15) near the stem base. Adults were usually observed by sweeping the host plants at night. Data were collected from April to September with the exception of July. The maximum number of records occurred in late summer.

Host plants. Adults and larvae were observed feeding on chicory *Cichorium intybus* L. (Asteraceae), in the studied localities (Fig. 21). Nevertheless, J. Krátký and J. Pelikán (in litt.) also found adult *L. bituberculatus* on *Crepis* sp. and *Picris* sp. during night sweeping and a pupa in the root of *Picris* sp. in Slovakia (Hajnáčka env. and Bajtava env.).

Life cycle. Lixus bituberculatus is an univoltine species. Adults feed on leaves, but larval development occurs in the basal part of the stem and in the root (Figs 18–19). Females of *L. bituberculatus* bite the lower part of the stem of the host plant near the ground and lay one egg in the hole (Figs 16–17). Usually, only one larva was found to occupy a plant, but rarely, there were two (one in the stem and another in the root crown). Mature larvae were found from July to August. Pupation occurs in the root neck or root (Fig. 20), and fresh adults can be found (inside plants) from middle of August. The exit hole is situated in the upper part of the pupation cell. Adults do not hibernate in the host plants. Most likely, hibernation occurs in the leaf litter, among dry plant debris or in the topsoil.

Rearing of the larvae. For laboratory breeding, 10 mature larvae were collected on August 8th, 2014, but only three pupated under our laboratory conditions. The remaining seven larvae primarily died due to drying of the host plants. The first fresh adult hatched on September 12th and the other two on September 15th, 2014.

Lixus (*Dilixellus*) *neglectus* Fremuth, 1983

Description of mature larva. *Measurements* (in mm). Body length: 10.5–13.5 (mean 12.5). The widest part of the body (metathorax and abdominal segments I–II) measuring up to 3.3. Head width: 1.8–2.1 (mean 2.0).

General. Body stocky, slightly curved, rounded in cross section (Fig. 28), densely covered by distinct asperities (mainly dorsal and ventral parts). Cuticle finely spiculate.

Colouration. Head light brown or brown (Figs 28, 38). All thoracic and abdominal segments are white with a light brown elongate stripe on the dorsum of the pronotum (Fig. 28).

Vestiture. Setae on body thin, relatively long to very long, light yellow or orange.

Head capsule (Fig. 22). Head suboval, flattened laterally, endocarinal line long more than half length of frons. Frontal sutures distinct, extended to the antennae. Single stemma (st) in the form of a slightly pigmented spot, located anterolaterally on each

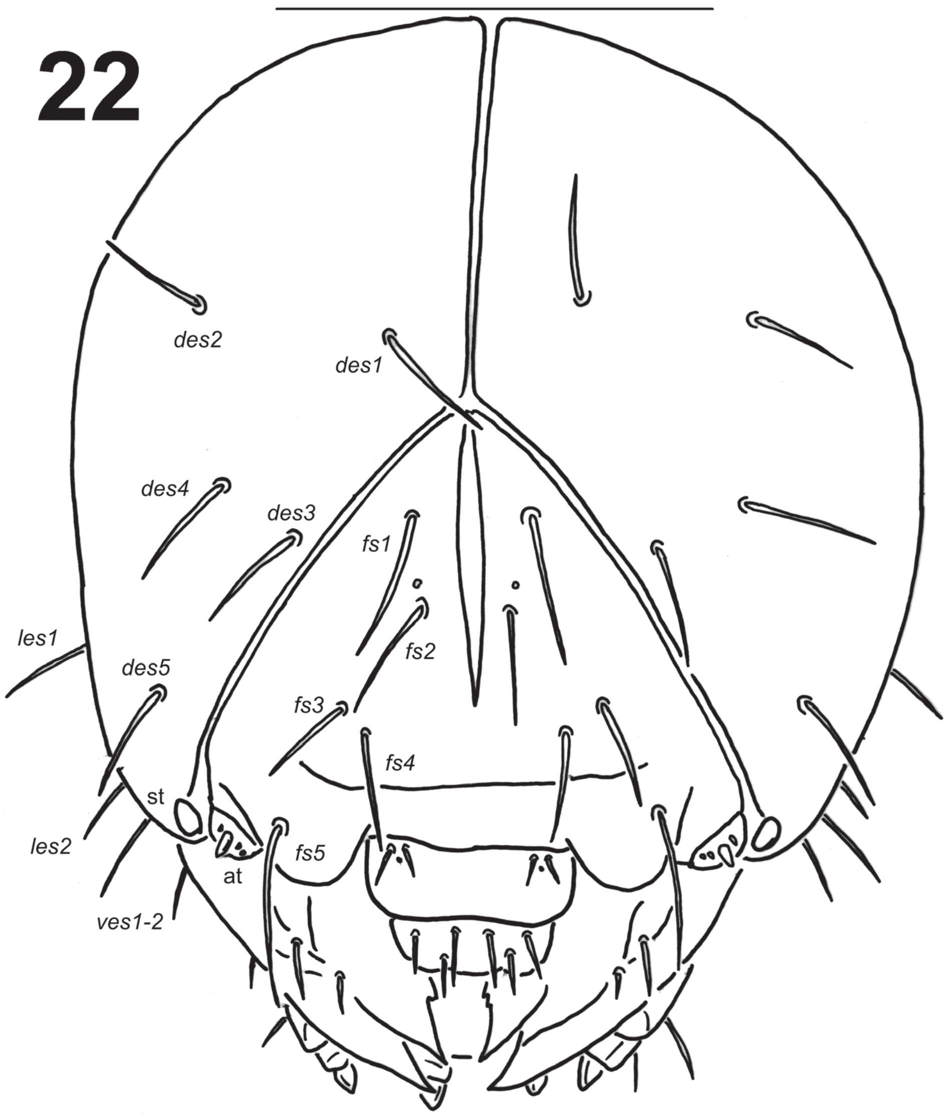


Figure 22. *Lixus neglectus* mature larva head, dorsal view. Scale bar: 1 mm.

side. *Des1* and *des2* located in the upper part of the central part of the epicranium, *des1* near the middle part of the epicranium, and *des2* near the side of the epicranium, *des3* located anteriorly near the frontal suture, *des4* located in the central part of the epicranium, *des5* located anterolaterally; all *des* long, subequal in length (Fig. 22). *Fs1* and *fs2* placed medially, *fs3* located anteromedially, *fs4* located anterolaterally, and *fs5* located laterally, close to the epistoma; all setae long to extremely long, *fs1* extremely long, *fs4* and *fs5* very long, distinctly longer than *fs2* and *fs3*, but shorter than *fs1* (Fig. 22). *Les1–2* as long as *des1*; *ves1–2* as long as *fs3*. Epicranial area with sensilla undistinct.

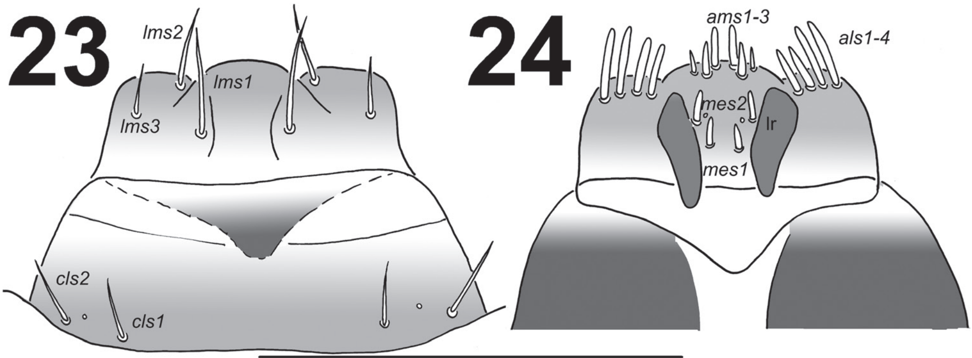
Antennae located at the end of the frontal suture on each side, membranous and slightly convex basal article bearing one conical triangular sensorium, relatively long; basal membranous article with 3 sensilla different in both shape and length (Fig. 25).

Clypeus (Fig. 23) approximately 2.5 times as wide as long with 2 long *cls*, almost equal in length, localized posterolaterally and 1 sensillum; anterior margin rounded to the inside; median part covered by thorn-shaped asperities.

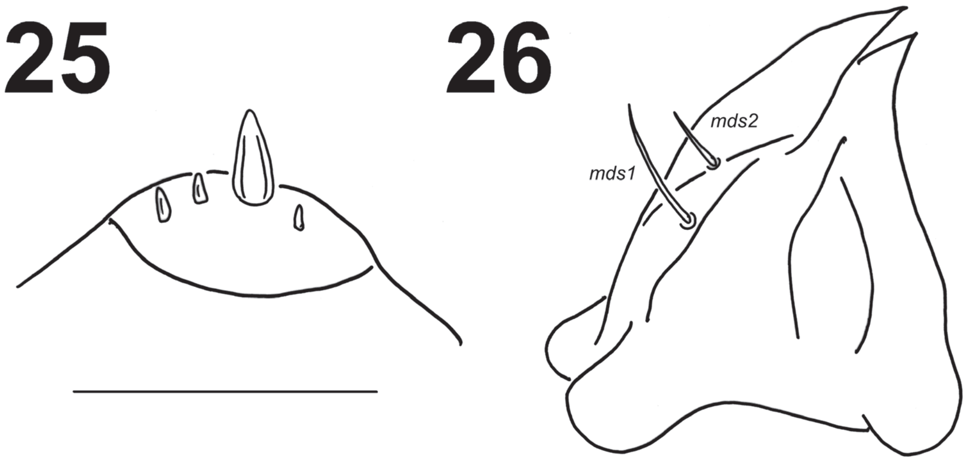
Mouth parts. Labrum (Fig. 23) approximately 3 times as wide as long, with 3 pairs of piliform *lms*, of different lengths; *lms3* distinctly shorter than very long *lms1* and long *lms2*; *lms1* placed close to the margin with clypeus, *lms2* located anteromedially and *lms3* located anterolaterally; anterior margin double sinuate. Epipharynx (Fig. 24) with 4 pairs of blunt, finger-like *als*, unequal in length, *als1–2* distinctly shorter than *als3–4*; 3 pairs of *ams*, *ams1* and *ams3* distinctly shorter than *ams2*, *ams1* and *ams3* piliform, and *ams2* blunt, finger-like; 2 pairs of short, blunt *mes* and one sensilla close to *mes2*; labral rods (lr) elongated, converging anteriorly, distinctly pigmented. Mandibles (Fig. 26) relatively broad, bifid, teeth of unequal height; slightly truncate; *mds1* very long, *mds2* distinctly short, piliform. Maxilla (Fig. 27) stipes with 1 *stps*, 2 *pfs* and 1 *mbs*; *stps* and *pfs1–2* very long, almost equal in length, *mbs* very short; mala with 14 bacilliform *dms* in two different lengths (1–4 long, blunt and 5–14 very long and blunt, with a tendency to be longer and less blunt); 5 relatively long *vms*, almost equal in length; *vms* distinctly shorter than *dms*. Maxillary palpi with two palpomeres; basal palpomere with 1 very short *mxps* and two sensilla; length ratio of basal and distal palpomeres: 1:0.8; distal palpomere with one sensillum and a group of conical, apical sensorial papillae. Praelabium (Fig. 27) heart-shaped and distinctly elongated, with 1 relatively long *prms*; ligula with sinuate margin and 3 piliform micro *ligs*, unequal in length; premental sclerite well visible. Labial palpi with two palpomeres; length ratio of the basal and distal palpomeres: 1:0.6; distal palpomere with one one sensillum and short, apical sensorial papillae; basal palpomere with 1 ventral sensillum, and pigmented in the basal part, and the connection with the premental sclerite seems as next palpomere. Postlabium (Fig. 27) with 3 *pms*, *pms1* located anteriorly, remaining two pairs laterally; long, almost of equal length, *pms3* distinctly shorter than *pms1* and *pms2*; surface of postlabium densely covered by distinct asperities.

Thorax. Prothorax distinctly smaller than meso- and metathorax. Metathorax almost of equal length as abdominal segments I–IV. Spiracle bicameral. Prothorax (Fig. 29) with 10 *prns* unequal in length, of which 8 on distinctly pigmented dorsal sclerite that is subdivided medially into two triangular plates, next two *prns* placed below; 2 long *ps* located on pigmented sclerite, and 1 *eus*. Mesothorax (Fig. 29) with 1 long *prs*; 4 long to very long *pds*, *pds2* distinctly shorter than the remaining three setae (both on weakly pigmented sclerites); 1 very short *as*; 2 short *ss*; 1 *eps*; 1 *ps* (*eps* and *ps* on weakly pigmented sclerites) and 1 *eus*. Chaetotaxy of metathorax (Fig. 29) identical to that of mesothorax. Each pedal area of the thoracic segments well separated and pigmented, with 7 long *pda*, of which 4–6 on distinctly pigmented area, unequal in length.

Abdomen. Abdominal segments I–V of almost equal length and subsequent abdominal segments decreasing gradually to the terminal parts of the body. Abdominal



Figures 23–24. *Lixus neglectus*mature larva. **23** Labrum and clypeus **24** Epipharynx. Scale bar: 0.5 mm.



Figures 25–26. *Lixus neglectus* mature larva head. **25** Antenna **26** Right mandible. Scale bars: 0.1 mm (**25**) and 0.5 mm (**26**).

segment X reduced to four anal lobes of unequal size, the dorsal being distinctly the largest, the lateral pair equal in size, and the ventral lobe very small. Anus located terminally. Spiracles bicameral, the eight abdominal spiracles located laterally, close to the anterior margin of abdominal segments I–VIII. Abdominal segments I–VII (Figs 30–31) with 1 *prs*; 5 relatively short *pds*, *pds2* and *pds4* on abdominal segment VII less than half of length of the three remaining setae which are twice as long as *pds* on the previous six abdominal segments; 2 *ss* of unequal length, *ss1* very short, *ss2* as long as *pds5*; 2 *eps* of unequal length; 2 relatively short *ps* of equal length; 1 long *lsts* (*eps*, *ps* and *lsts* on weakly pigmented sclerites) and 2 relatively long *eus*. Abdominal segment VIII (Fig. 31) with 1 relatively long *prs*; 2 long to very long *pds, pds1–2* and *pds4* lacking; 2 *ss* of unequal length, *ss1* very short, *ss2* as long as *prs*; 2 *eps* of unequal length, *eps1* relatively long, *eps2* long to very long; 2 relatively short *ps* of equal length;

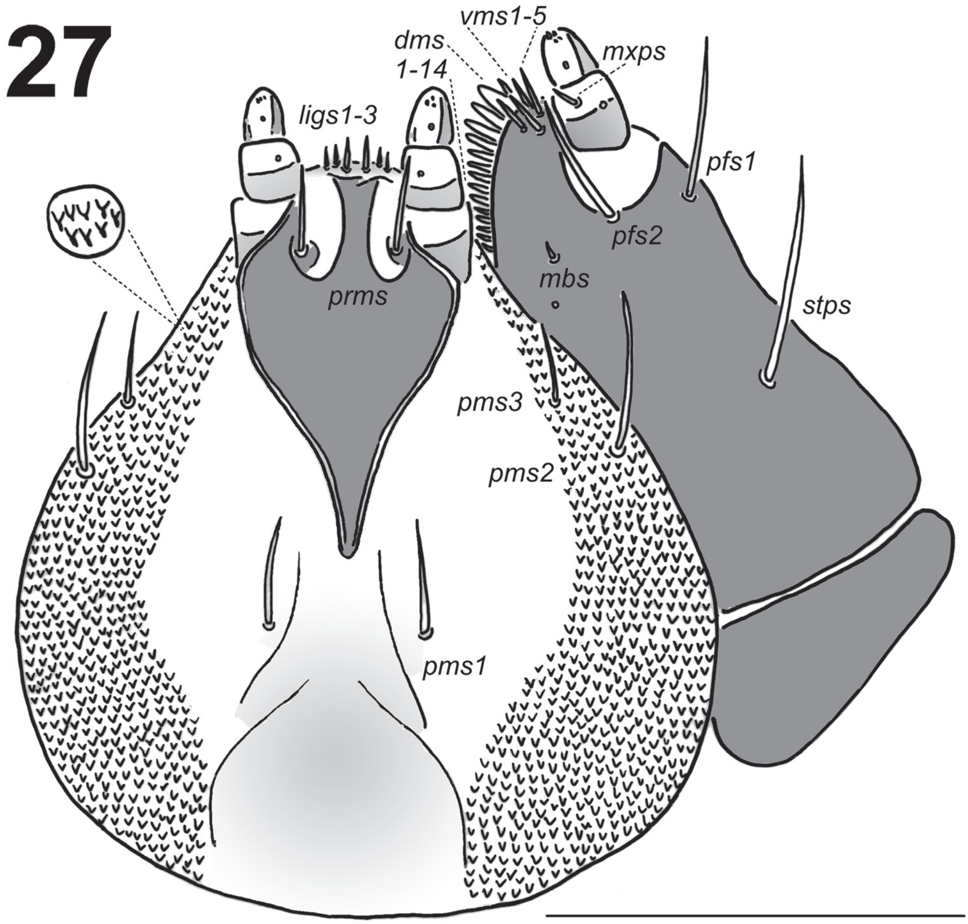


Figure 27. *Lixus neglectus* mature larva head, maxillo-labial complex, ventral view. Scale bar: 0.5 mm.

1 relatively long *lsts* (*eps*, *ps* and *lsts* on weakly pigmented sclerites) and 2 relatively long *eus*. Abdominal segment IX (Fig. 31) with 3 *ds* (*ds1–2* long, *ds3* short); 2 very short *ps* and 2 very short to micro *sts*. Abdominal segment X (Fig. 31) with 2 microsetae (*ts*), on each lateral lobe.

Description of pupa. *Measurements* (in mm). Body length: 9.4–12.7 (♂ 9.4–12.7; ♀ 10.0) and the widest part of the body, commonly between the apex of the meso- or metafemora: 2.8–3.8.

Colouration. Body yellow (Fig. 39).

Morphology (Figs 32–34, 39). Body stocky, elongated, white or yellowish. Cuticle smooth. Rostrum relatively long, approximately 3.1 to 3.5 times as long as wide and extending beyond the mesocoxae. Antennae relatively long and stout. Pronotum from 1.2 to 1.3 times as wide as long. Mesonotum and metanotum of almost equal length. Abdominal segments I–V of almost equal length; abdominal segment VI semicircular and subsequent abdominal segments diminish gradually to the end of the body. Ab-

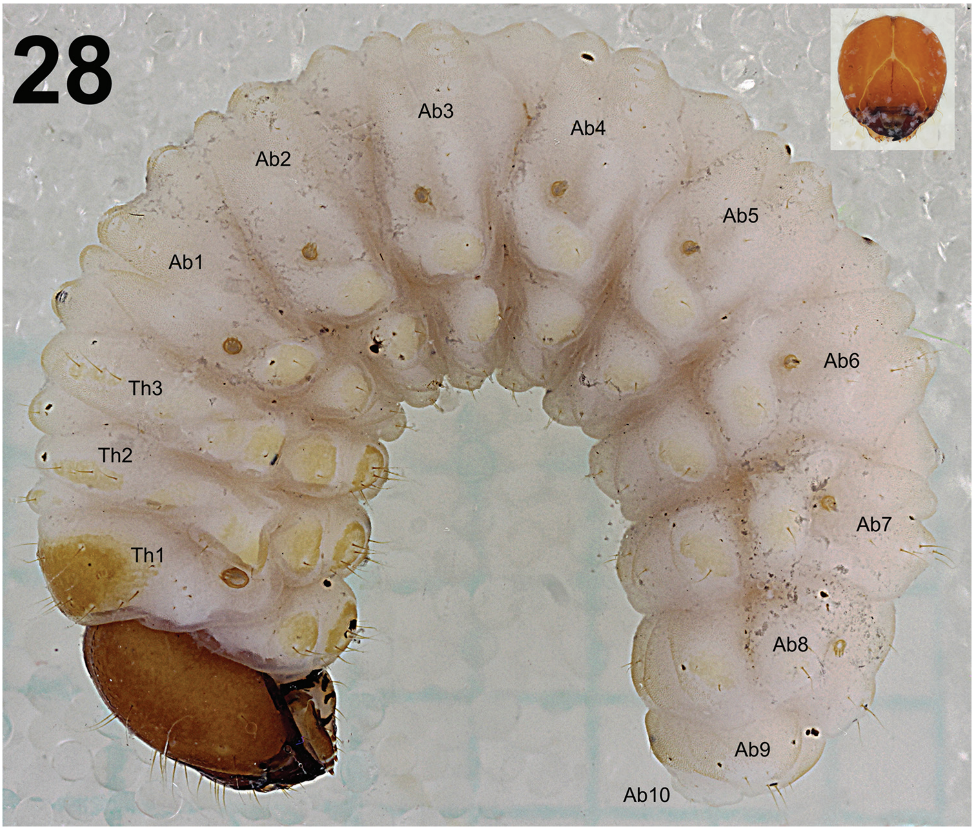
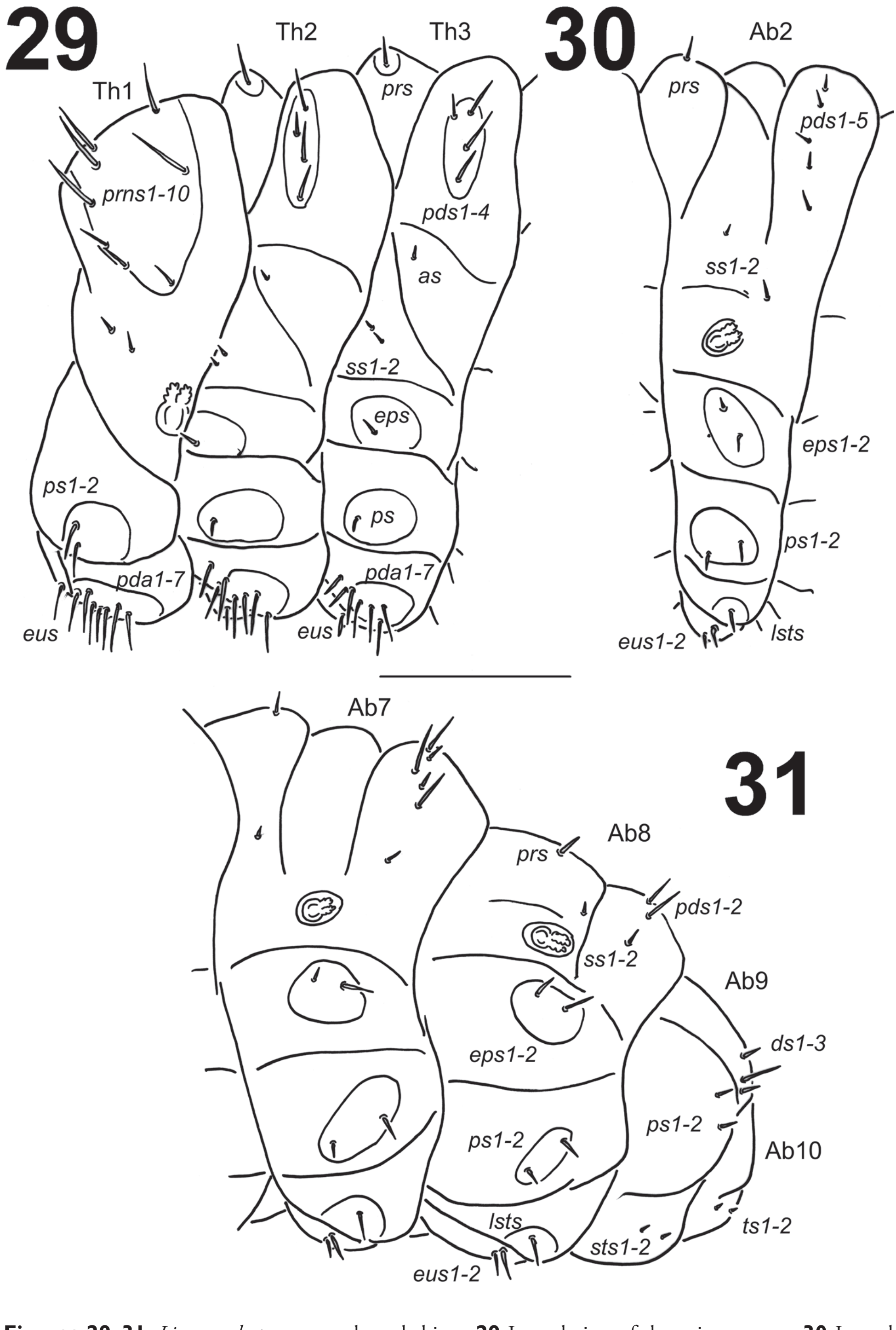


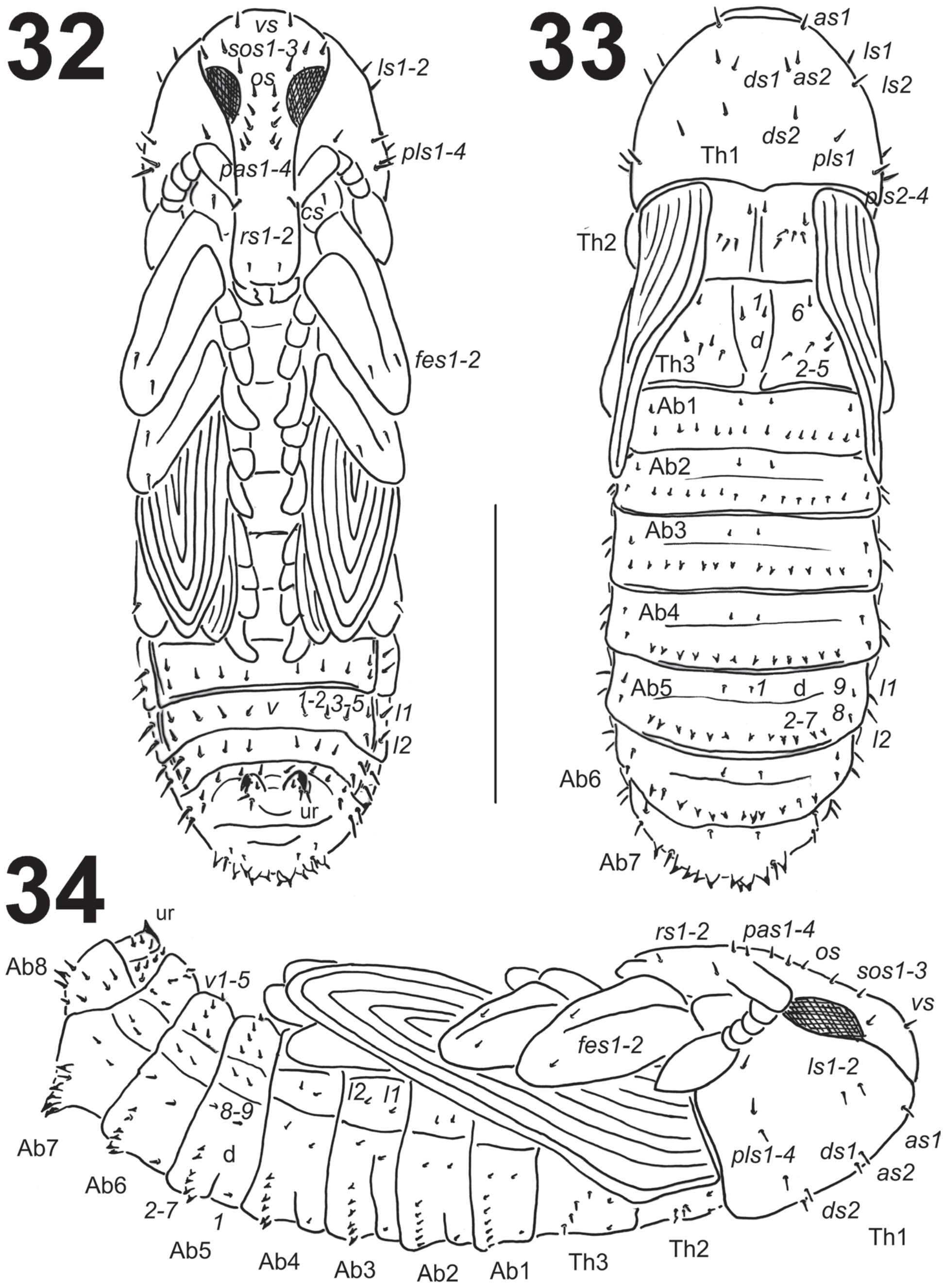
Figure 28. *Lixus neglectus* mature larva habitus, lateral view. Scale bar: 3 mm.

dominal segments VII–IX distinctly smaller than other abdominal segments. Gonotheca (abdominal segment IX) in females (1 specimen) bilobed.

Chaetotaxy (Figs 32–34). Setae relatively short, unequal in length, light yellow or orange, some setae on abdominal segments III–VIII distinctly stronger and located on protuberances. Setae well visible. Head capsule includes 1 *vs*, 3 *sos*, 1 *os* and 4 *pas*. Rostrum with 2 *rs*, *rs1* placed below antenna, *rs2* on the anterior margin. Setae on head capsule and rostrum straight, both *rs* and all *pas* distinctly shorter than the remaining setae on head, thoracic and abdominal segments. Pronotum with 2 *as*, 2 *ds*, 2 *ls* and 4 *pls*, and 1 short seta on ventral side (probably *pls5*). Dorsal parts of mesothorax with 1 seta located posteromedially, 1 seta located posterolaterally and 4 setae located along the anterior margin. Chaetotaxy of metathorax identical to that of mesothorax. Coxa with 1 very short *cs*. Each femoral apex with 2 *fes*. Dorsal parts of abdominal segments I–VIII each with 2 pairs of setae located posteriorly (*d1*, *d9*) and 7 pairs (*d2–8*) located along the anterior margins. Setae *d2–7* (on abdominal segments III–V) and setae *d2–5* and *d7* (on abdominal segments VI–VII) short, thorn-like, located on protuberances. Protuberances on abdominal segment VII distinctly prolongated. Remaining setae relatively short, hair-like. Abdominal segments I–VII with groups of 2 lateral setae and 5 pairs of



Figures 29–31. *Lixus neglectus* mature larva habitus. **29** Lateral view of thoracic segments **30** Lateral view of abdominal segment II. **31** Lateral view of abdominal segments VII–X. Scale bar: 1 mm.



Figures 32–34. *Lixus neglectus* pupa habitus. **32** Ventral view **33** Dorsal view **34** Lateral view. Scale bar: 3 mm.

Figures 35–42. Habitats, adults, immature stages, host plants and life cycle of *Lixus neglectus*. **35** Adult **36** Adult hiding in host plant rosette **37** Ovipositional mark and larva feeding marks (frass) **38** Mature larva **39** Pupa **40** Fresh, not fully coloured adult **41** Habitat in Czech Republic with host plant, *Rumex thyrsiflorus* **42** Detail of host plant rosette.

ventral setae. Dorsal part of abdominal segment VIII with 1 seta located posteriorly (*d9*) and 5 pairs (*d3–7*) located along its anterior margin; *d7* thorn-like, located on protuberances; remaining setae short. Abdominal segment VIII with groups of 2 lateral setae and 5 short ventral setae. Abdominal segment IX with 2 pairs of ventral microsetae and 1 pair of short, thin setae. Urogomphi distinctly elongated, hooked, triangular.

Biology and ecology

Habitats. Adults live in dry grasslands and meadows with sandy substrates (wind-blown river sand) (Fig. 41).The meadows are often managed for hay production. Numerous specimens were also found on grassy embankments along roads.

Adult behaviour. Adult beetles (Fig. 35) exhibit diurnal as well as nocturnal activity. During sunny days, they spend almost all of their time hiding among the leaves of the host plant near the ground (Figs 36, 42) and rarely climb to the higher parts of the plant.

Host plants. Adults and their immature stages were observed exclusively on dock, *Rumex thyrsiflorus* Fingerh. (Polygonaceae) (Figs 41–42), in all of our localities. In the past, this species was only recorded from garden sorrel (*Rumex acetosa*) L. (e.g., Fremuth 1983).

Life cycle. *Lixus neglectus* is an univoltine species. Adults feed on leaves, and larvae are stem and root borers (Fig. 38). Females of *L. neglectus* bite the lower part of the stem and lay one egg in the hole (Fig. 37). Larvae feeding in the root produce orange feeding frass (Fig. 37), which is thrown out of the host plant, and its presence is a reliable indication that the plant root is occupied by a larva. One plant is most likely occupied by only one larva. Mature larvae were found from July to August. Pupation takes place in the root neck (Fig. 39), and freshly hatched individuals can be found (inside plants) beginning in the middle of August (Fig. 40). Adults do not hibernate in the host plants, so hibernation most likely occurs in the leaf litter, among dry plant debris or in the topsoil.

Rearing of the larvae. For laboratory breeding, 15 mature larvae were collected on July 13th, 2014, but only two of them pupated in our laboratory conditions. The remaining larvae died primarily due to drying of the host plants. Both of the adults hatched on July 30th.

Discussion

Comparison with larvae of other *Lixus* species. To date, larvae of 21 *Lixus* and two *Hypolixus* species have been described (Scherf 1964; Lee and Morimoto 1988; May 1994; Nikulina 2001, 2007; Zotov 2009a, b; Nikulina and Gültekin 2011; Gosik and Wanat 2014; Skuhrovec and Volovnik 2015), but a detailed description of the pupae is known for only 8 *Lixus* species (Scherf 1964; May 1994; Zotov 2009a, b; Gosik and Wanat 2014; Skuhrovec and Volovnik 2015).

The precise general description of the larvae of the genus *Lixus*, which can be summarized by 19 character sets, has been presented by May (1994) and more in detail by Nikulina (2001) (for details, see Nikulina 2001 and Gosik and Wanat 2014). The larvae of *L. bituberculatus* and *L. neglectus* possess all of these characters, with only a few exceptions that partly result from differences in terminology (for details, see Gosik and Wanat 2014). Nikulina (2001) also published the only comprehensive and known larval key for this genus. The larva of *L. bituberculatus* has the closest affinity to the larva of *L. kiritshenkoi* Ter-Minasian, 1985 (abdominal segment X with two setae on the ventral side, lateral sides without setae, and dorsal side with less than three setae, see Table 1). The main differences are as follows (see Table 1): prothoracic tergite with 10 *prn* (vs. 13 *prn*); maxilla stipes with short 1 *mbs* (vs. without *mbs*, which could also be easily overlooked because it is very often minute); prodorsum on abdominal segment IX with only 4 *ds* (vs. 3 *ds*), and 3 short *ps* (vs. 1 *ps*). The larva of *L. bituberculatus* is the first of the immature stages described for the subgenus *Ortholixus*, but the larva of *L. neglectus* does not fit the description of any larva in the key (Nikulina 2001) because the first step provides no option for abdominal segment X to be without setae on the dorsal side (see Fig. 31). An interesting characteristic of *L. neglectus* is the presence of more pigmented sclerites on the larval body (see Figs 28–31, Table 1), which is similar to the description of *L. filiformis* (Nikulina and Gültekin 2011). In the subgenus *Dilixellus*, to which *L. neglectus* belongs, the larvae of four species have already been described: *L. bardanae* (Fabricius, 1787) (in Scherf 1964); *L. desbrochersi* Hoffmann, 1957 (in Lee and Morimoto 1988 as *L. impressiventris* Desbrochers des Loges, 1904); *L. probus* Faust, 1887 (in Nikulina 2001); and *L. punctiventris* Boheman, 1835 (in Gosik and Wanat 2014) (see Table 1). The creation of a precise key and a detailed subgeneric study of the genus *Lixus* is currently limited due to the lack of knowledge of the immature stages (see Table 1). The main problem is that we are unable to divide with certainty the morphological characteristics of this group into (i) characteristics that are useful for phylogenetics and (ii) characteristics that are useful only for species identification. Once this categorization is complete, it will be possible to apply it for future cladistics analysis, which are planned for the near future. All these morphological data should be compared and correlated with known biological data of the host plant families for the different groups of *Lixus* and also related genera, because some subgenera of *Lixus* are probably composed of different probably unrelated groups developing on quite different families of plants (Skuhrovec, Gosik, Stejskal, Trnka, Volovnik, Gültekin, unpublished data).

May (1993) considered the increased number of *pds* on the meso- and metathorax and abdominal segments I–VII and the increased number of setae on the epipharyngeal lining (*als*) (i.e., higher than the most frequent number of setae in weevils) as diagnostic of the mature larva of the Lixinae subfamily, and the descriptions of mature larvae from the tribe Lixini (*Larinus* species: Zotov 2009a, 2010; Gosik and Skuhrovec 2011; *Lixus* species: Scherf 1964; Lee and Morimoto 1988; May 1994; Nikulina 2001, 2007; Zotov 2009a, b; Nikulina and Gültekin 2011; Gosik and Wanat 2014; Skuhrovec and Volovnik 2015; *Rhinocyllus conicus*: May 1994) fit this diagnosis, as do all known

Table 1. Differential diagnosis of mature larvae of both described species and the most similar or relative species.

	***L.* (*Dilixellus*) *bardanae* (Fabricius, 1787)**	***L.* (*Dilixellus*) *desbrochersi* Hoffmann, 1957**	***L.* (*Dilixellus*) *neglectus* Fremuth, 1983**	***L.* (*Dilixellus*) *probus* Faust, 1886**	***L.* (*Dilixellus*) *punctiventris* Boheman, 1835**	***L.* (*Epimeces*) *filiformis* (Fabricius, 1781)**	***L.* (*Eulixus*) *kiritshenkoi* Ter-Minasian, 1985**	***L.* (*Ortholixus*) *bituberculatus* Smreczyński, 1968**
Endocarina	unknown	present, length unknown	more than the half length of frons	short	more than the half length of frons	more than the half length of frons	more than the half length of frons	more than the half length of frons
Number of *des*	unknown	4	5	5	5	5	5	5
Number of *fs*	unknown	5	5	3	5	5	5	5
Number of *les*	unknown	2	2	unknown	3	1	unknown	2
Number of *ves*	unknown	2	2	unknown	2	unknown	unknown	2
Position of *lrms1-3*	in a triangle	only 2 setae	in a triangle	in a triangle	in a triangle	in a triangle	in a line	in a triangle
Number of *als*	unknown	6	4	4	5	3	3 (or 4)	4
Number of *ligs*	2	2	3	3	2	2	1	3
Number of *mbs*	1	unknown	1	1	2 ?	1	0	1
More pigmented sclerites on larval body, not only on pronotum	unknown	absent	present	absent	absent	present	absent	absent
Number of *prns*	unknown	8	10	10	10	10	13	10
Number of *pds* on Abd. seg I- VII	unknown	5	5	unknown	6	6	unknown	6
Number of *ds* on Abd. seg IX	unknown	unknown	3	unknown	6	2	3	4
Number of *ps* on Abd. seg IX	unknown	unknown	2	unknown	3	2	1	3
Number of *ts* on dorsal lobe on Abd. Seg. X	unknown	unknown	0	7 *	0	0	2 *	0
Number of *ts* on ventral lobe on Abd. Seg. X	unknown	unknown	0	2 *	0	0	2 *	0
Number of *ts* on lateral lobe on Abd. Seg. X	unknown	unknown	2	0 *	3	3 (dorsoventral)	0 *	3

* Nikulina (2001) listed number of *ts* on sides, not on lobes.

species from the tribe Cleonini (Stejskal et al. 2014, Trnka et al. 2015). Currently, the comparison of both tribes, including key and detailed generic studies, is impossible due to our limited knowledge of the immature stages. A categorization of the morphological characteristics of Cleonini and a comparison of both tribes is planned following a detailed study of the genus *Lixus* (see the previous paragraph). The presence of 5 *vms* in the maxillary mala observed in all Lixinae and also most curculionids could be helpful as differential character from the root feeder larvae in Entiminae which have only 4 *vms* (Marvaldi 1998a, b).

Biology and ecology

The biology and development of these two *Lixus* species are very similar as both species are stem and root (crown) borers. In the genus *Lixus*, root borers, such as *L.* (*Ortholixus*) *angustus* (Herbst, 1795); *L.* (*Compsolixus*) *ochraceus* Boheman, 1842; *L.* (*Dilixellus*) *punctirostris* Boheman, 1842; *L.* (*Dilixellus*) *punctiventris* Boheman, 1835; and *L.* (*Ortholixus*) *vilis* (Rossi, 1790) (Dieckmann 1983) have not been identified as frequent. The prevailing nocturnal activity of the adults and the species hidden life habits are probably the main reasons why these species have not been found elsewhere, and it is very difficult to confirm them at a locality. The majority of the Central European Lixinae species require a specific habitat disturbance regime that results in sparse vegetation cover (Stejskal and Trnka 2013, 2014). In both species, it seems that adults and the immature stages prefer places with pasture vegetation or meadows that are managed for hay production.

This is the first report of *L. bituberculatus* from Romania, and it probably has a larger area of distribution including Bulgaria, Hungary, Romania and Slovakia (Gültekin and Fremuth 2013; Stejskal and Trnka 2014). Based on our observations *L. bituberculatus* appears to be oligophagous on Asteraceae; all of our specimens were only found on *Cichorium intybus*, which originates from the Mediterranean but has been introduced to North America, southern Africa and New Zealand (Dvořáková 2005). It seems that this weevil is not specialized on only one plant species because it was found on *Crepis* sp. as well as *Picris* sp. in Slovakia, so its suitability as a candidate for the biological control of *C. intybus* is questionable. Only a host plant choice test can help us to determine all of the host plant species and the preferences of this species.

Lixus neglectus has been found exclusively on *Rumex thyrsiflorus*, but the distribution of its host plant covers the majority of Europe (Kubát 1990). However, this beetle is only known from a very small and specific area. The sorrel *R. thyrsiflorus* is considered to be a naturalized neophyte in Central Europe (Danihelka et al. 2012), but its origin remains unknown (Kubát 1990). This *Lixus* species seems to be monophagous, and its only host plant, *R. thyrsiflorus*, is not considered to be harmful and has not yet been introduced to other continents or countries. Therefore, it is not necessary to utilize this weevil to regulate its host plant despite its suitability as a biological control agent, but this must be validated by future studies. The distribution of *L. neglectus* has to be confirmed, especially across the wider area of distribution of *R. thyrsiflorus*. This weevil can be easily overlooked due to its cryptic way of life, but the easiest way to confirm its presence in the field is to search for frass at the root crown of the host plant. This frass is a very unique behaviour within the genus *Lixus*. To date, this weevil has only been recorded from *R. acetosa* (e.g., Fremuth 1983; Koch 1992; Böhme 2001), which is likely due to misidentification as occurred in our case (Trnka and Stejskal 2014). It is possible that *L. neglectus* historically lived on *R. acetosa* but has recently come to occupy a new available ecological niche on expanding *R. thyrsiflorus* (from ca 15th century). However, because each of the host plants prefer different habitats, this explanation is quite unlikely. The common sorrel, *R. acetosa*, prefers wet habitats, whereas the compact dock, *R. thyrsiflorus*, prefers dry ones (Kubát 1990). Both sorrels are also known as host plants for some other weevils, but there does not seem to be any competition among the species. Development on *R. acetosa* is also known in one other *Lixus* species, *L. bardanae* (Fabricius, 1787), but this weevil is a typical stem borer. Thus there is no competition between it and *L. neglectus* (Dieckmann 1983). A similar situation occurs in the development of some Apionids (e.g., *Apion cruentatum* Walton, 1844 or *Perapion oblongum* (Gyllenhal, 1839)), whose larvae also feed only in the stems (Dieckmann 1977). Furthermore, both plants host the oligophagous weevil species *Marmaropus besseri* Gyllenhal, 1837 (Dieckmann 1972) in their stems and roots, and this species has been recently expanding along with *R. thyrsiflorus* (Rheinheimer and Hassler 2010). Both of these weevils belong to the same guild (stem and root (crown) borers), so there could be some competition. However, this requires more information on the timing of their development as well as some of the other abiotic and/or biotic effects inside the plant. Thus, the complete switch in host plant by *L. neglectus* seems unlikely, mainly due to its rarity despite the recent expansion of its host plant. It is more probable that its preference for *R. thyrsiflorus* as a host plant is recent, but this could only be resolved through a host plant choice test.

Knowledge of the immature stages and life histories of insects can help protect endangered species (including the species presented here) more effectively. The detailed descriptions of the larva and pupa and their comparison with known descriptions reported here demonstrates the possibility of identifying species in their immature stages. Future detailed biological and morphological studies can yield unique information on the factors determining host specificity in this insect group and will provide useful background information for planning efficient biocontrol of invasive plant species. The issue of using some insects as biological control agents is a key topic in both the basic and applied research on invasive plants. Our results will significantly contribute to basic research but will also have practical implications for conservation biology and/or biological control.

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RESEARCH ARTICLE

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New species of *Medetera* from Inner Mongolia, China (Diptera, Dolichopodidae, Medeterinae)

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Abstract

Only three species of *Medetera* Fischer von Waldheim were known from Inner Mongolia. Here the following ten new species of *Medetera*, of which three species belong to *M. apicalis* group and seven belong to *M. diadema-veles* group, are added to the fauna of Inner Mongolia: *M. albens* **sp. n.**, *M. bisetifera* **sp. n.**, *M. flava* **sp. n.**, *M. ganshuiensis* **sp. n.**, *M. lihuae* **sp. n.**, and *M. transformata* **sp. n.**, *M. triseta* **sp. n.**, *M. shiae* **sp. n.**, *M. shuimogouensis* **sp. n.**, and *M. xiquegouensis* **sp. n.** A key to the species of *Medetera* from Palaearctic China is provided.

Keywords

Diptera, Dolichopodidae, Inner Mongolia, Medeterinae, *Medetera*, new species

Introduction

Medetera Fischer von Waldheim is a large genus with nearly 360 known species around the world (Negrobov and Naglis 2015, Tang et al. 2015). Most of them are small, dark metallic green or even black, with thin pollinosity. The genus can be separated from other genera of Medeterinae by the following features: first flagellomere rounded with apical or subapical arista, occiput concave, proboscis heavily sclerotized, mesoscutum strongly flattened, vein M_{1+2} strongly convergent to vein R_{4+5} beyond discal crossvein, and the large and pedunculate male genitalia tightly flexed to ventral surface of abdomen (Masunaga and Saigusa 1998, Bickel 1985, 1987). *Medetera apicalis* species group and *M. diadema-veles* species group can be separated into clades by molecular evidence (Pollet et al. 2011). The species diversity of *Medetera* is extremely rich in the Palaearctic region, which has 178 described species and comprises more than half of the whole genus (Yang et al. 2006, Naglis and Negrobov 2015). The latest comprehensive taxonomic work on the Palaearctic species is the revision of the subfamily Medeterinae by Negrobov and Stackelberg (1971-1977). Since then 27 new Palaearctic species of *Medetera* have been described: one species from Great Britain (Allen 1976), one from Poland (Negrobov and Capecki 1977), six from Russia (Negrobov 1979, Negrobov and Golubtzov 1991, Negrobov and Naglis 2015), one from Spain (Rampini and Canzoneri 1979), four from Japan (Masunaga and Saigusa 1998), one from China (Yang 1999), one from Morocco (Grichanov and Vikhrev 2009), one from Tunisia (Grichanov 2010), three from Turkey (Naglis 2013), seven from Switzerland (Naglis and Negrobov 2014a, b), and one species from Mongolia (Negrobov and Naglis 2015).

Species of *Medetera* have some interesting behavioral characteristics such as their stance on tree trunks or walls which resembles that of woodpeckers, in fact they have been referred to as "woodpecker flies" (Bickel 1985). *Medetera* species are predators of bark beetles (Coleoptera: Curculionidae) and some other pests like aphids, psychodids and myriapods (Beaver 1966, Ulrich 2005). Ulrich (2005) also mentioned that the strongly developed labium of *Medetera* is able to crack hard parts, for example the exoskeleton of prey, into small fragments. It is suggested that the genus may have potential use in biological control. Most species of Medeterinae recorded, including *Medetera*, occur in dry and relatively cold environments. Species from tropical areas are relatively poorly described. However, in China the reverse is true with only four species of *Medetera* recorded in the Palaearctic but 20 species recorded in the Oriental (Yang et al. 2011, Tang et al. 2015), which means more species are known in the Oriental region than the Palaearctic region. It is suspected that the circumstance is due to the incomplete investigation of Palaearctic China.

Inner Mongolia is a large province of China, which stretches from northeast to northwest of China. Most of its international border is with Mongolia while a small portion is with Russia. The temperate continental climate leads to the specific vegetation. The plain is cold and arid, usually only grass can grow and herding of goats is common. The environments where we collected all the specimens are in small moist areas surrounded by dry land, or dry land near rivers. Specimens of *Medetera* were found in and among tall grasses like *Stipa*. Here ten new species are added to *Medetera* from Inner Mongolia, of which seven belong to *M. diadema-veles* group, including *M. flava* sp. n., *M. ganshuiensis* sp. n., *M. lihuae* sp. n., *M. shiae* sp. n., *M. shuimogouensis* sp. n., *M. transformata* sp. n. and *M. xiquegouensis* sp. n.; three belong to *M. apicalis* group, including *M. albens* sp. n., *M. bisetifera* sp. n. and *M. triseta* sp. n. It is the first report of *M. apicalis* group in Palaearctic China. A key to species of *Medetera* in Palaearctic China is provided.

Material and methods

The specimens on which this study is based were collected from Inner Mongolia from 2010 to 2014 by sweeping nets in grassland. All specimens are deposited in the Entomological Museum of China Agricultural University (CAU), Beijing. Morphological terminology for adult structures mainly follows McAlpine (1981). Terms for the structures of the male genitalia follow Cumming and Wood (2009). The following abbreviations are used: **acr** = acrostichal bristle (s), **ad** = anterodorsal bristle (s), **av** = anteroventral bristle (s), **dc** = dorsocentral bristle (s), **pd** = posterodorsal bristle (s), **pp** = propleuron, **pv** = posteroventral bristle (s), **v** = ventral bristle (s), **sa** = supraalar bristle (s), **sc** = scutellars, **CuAx ratio** = length of crossvein dm–cu / length of distal portion of vein CuA, **LI** = fore leg, **LII** = mid leg, **LIII** = hind leg.

Taxonomy

Key to species (males) of *Medetera* in Palaearctic China

1 Epandrium almost as long as wide, surstylus short and wide; hypandrium with two lateral hollows at base.......................... ***M. tuberculata* Negrobov**

– Epandrium distinctly longer than wide, at least 1.5 times longer than wide; surstylus long and thin.. **2**

2 Male hind tarsomere 1 with distinct basal anteroventral tooth; male genitalia pyriform, basally inflated; epandrial lobes fused at least basally; epandrial bristle reduced or lost; hypandrium and phallus elongate, narrow, tapering (Fig. 17) (***diadema-veles* group**) (Bickel 1985) **3**

– Male hind tarsomere 1 without basal tooth; male genitalia subrectangular; epandrial lobes with bases separated; epandrial bristle well-developed; hypandrium elongate, subrectangular, often basally “clasping” the phallus, and often held out at an angle from male genitalia (Fig. 12) (***apicalis* group**) (Bickel 1985)....... **12**

3 Cercus without wide blade-like bristle apically (Figs 25, 29)...................... **4**

– Cercus with one wide blade-like bristle apically **9**

4 Cercus without distinct bristle apically (Fig. 25) ....***M. shuimogouensis* sp. n.**

– Cercus with claw-like bristles(s) apically... **5**

5 M_{1+2} and R_{4+5} both arched towards R_{2+3} (Fig. 10) ... ***M. xiquegouensis* sp. n.**

– M_{1+2} and R_{4+5} normal **6**

6 Hind tarsomere 1 with an incision and one small spur at base ....***M. micacea* Loew**

– Hind tarsomere 1 without incision at base **7**

7 One sa; cercus ventrally with one process near apex ***M. latipennis* Negrobov**

– Two sa; cercus various **8**

8 Antennae brown except scape yellow; basolateral bristle of epandrial lobe feather-like at apical half (Yang et al. 2010, fig. 258); hind 2nd tarsomere three times length of tarsomere 1 .... ***M. plumbella* Meigen**

– Antennae wholly black; basolateral bristle of epandrial lobe wholly feather-like (Fig. 33); hind 2nd tarsomere 2.5 times length of tarsomere 1 .... ***M. flava* sp. n.**

9 Dorsal surstylus U-shaped with two arms that are similar in shape............ **10**

– Dorsal surstylus U-shaped with two asymmetrical arms, with dorsal arm three times wider than ventral arm (Fig. 27) .... ***M. transformata* sp. n.**

10 Arms of dorsal surstylus sharp apically; ventral surstylus narrowed towards tip, with two long strong lateral bristles at apical 1/5 (Fig. 19)..................... .... ***M. ganshuiensis* sp. n.**

– Arms of dorsal surstylus round apically; ventral surstylus simple, only with some simple apical bristles **11**

11 Four uniseriate acr; CuAx ratio 1.00 (Fig. 6); cercus nearly rectangular, six times longer than wide (Fig. 21) .... ***M. lihuae* sp. n.**

– Eight biseriate acr; CuAx ratio 0.61 (Fig. 7); Cercus strip-like, narrowed towards tip, base dilated, three times longer than the widest point (Fig. 23) .... ***M. shiae* sp. n.**

12 Tibiae totally black; arista turning black to pale yellow from base to tip (Fig. 1); apical bristle of cercus somewhat claw-like (Fig. 12) ...... ***M. albens* sp. n.**

– Tibiae yellow or mainly yellow except basal and apical 1/3 of fore tibia black; arista wholly black; apical bristle of cercus various **13**

13 CuAx ratio 0.30 (Fig. 2); cercus strip-like, 6 times longer than wide, apical bristle normal (Fig. 14); phallus with distinct preapical lateral wings in ventral view (Fig. 31) .... ***M. bisetifera* sp. n.**

– CuAx ratio 0.67 (Fig. 3); cercus strip-like, 2.5 times longer than wide, apical bristle blade-like (Fig. 15); phallus normal (Fig. 32) .... ***M. triseta* sp. n.**

Medetera apicalis group

The *apicalis* group is not very well defined. Normally the following features are used to distinguish it from the other groups in Palaearctic China: thorax with three long strong dc; epandrium long, nearly twice longer than wide, sometimes with distinct bristle(s); epandrial lobes distinctly separate at base; hypandrium nearly quadrangle, often covering the phallus and holding out at an angle from the epandrium; cercus usually with flattened apicodorsal claw-like bristles. See discussion about the features of the whole group on Bickel (1985: 139).

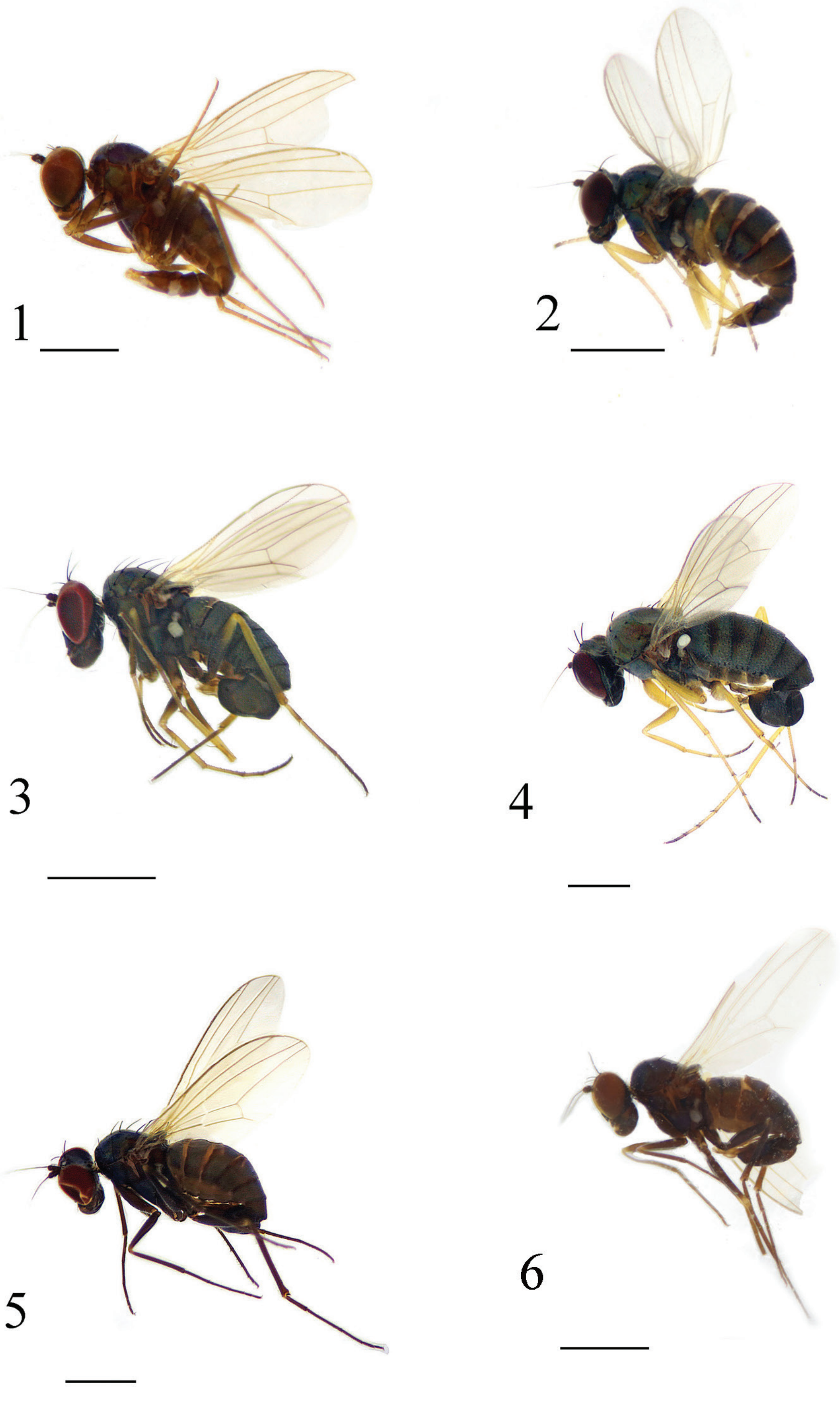
***Medetera albens* sp. n.**
http://zoobank.org/EA7923D9-EF34-4BBA-9C72-4A749DDD17E2
Figs 1, 11–12, 30

Diagnosis. Width of face approximately twice length of first flagellomere. Arista of first flagellomere apical, becoming black to pale yellow from base to tip. Four pairs of dc (anterior one short, posterior three strong). Acr clear and regular. CuAx ratio 0.5. Legs mainly black. Cercus nearly white, strip-like, sharp apically, with one obvious dentation at basal 1/5, five times longer than wide, apical bristle somewhat claw-like.

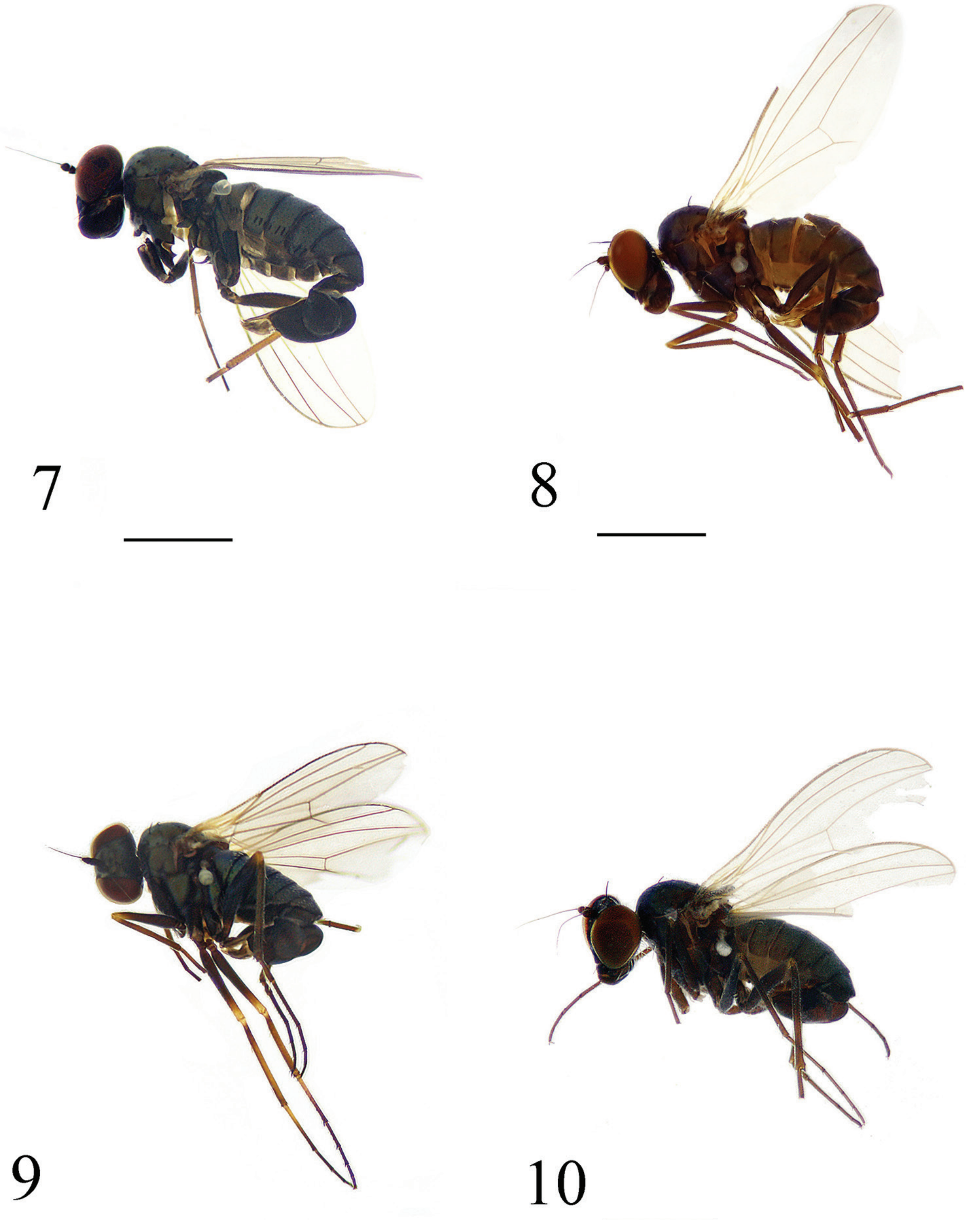
Description. Male (Fig. 1). Body length 2.2 mm, wing length 2.3 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face twice length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna (Fig. 11) black, first flagellomere nearly triangular, almost as long as wide, shortly brown pubescent; arista apical, becoming black to pale yellow from base to tip, bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis brown with pale white apical hairs; palpus brown with pale white apical hairs.

Thorax metallic green with gray pollinosity. Hairs and bristles on thorax black. Four pairs of dc (anterior one short, posterior three strong), four clear regular biseriate acr at anterior portion, two sa. Scutellum with two pairs of sc (median pair long, strong). Legs becoming dark brown to brown from base to tip onward except tip of femora yellow. Hairs and bristles on legs mainly pale yellow. Fore coxa with six dorsal bristles on apical 1/2; mid coxa with three dorsal bristles and one outer bristle at middle. Hind coxa with one outer bristle at middle. Hind trochanter with one outer bristle at middle. Fore femur with two short ventral hairs apically. Mid femur with four ventral bristles at basal half, gradually becoming longer from base to tip onward. Fore tibia with two short black apical bristles. Hind tibia with five short strong apical spurs. Fore tarsomere one with row of 16 short ventral bristles; hind tarsomere 1 with row of 18 short dorsal and 18 short ventral bristles. Relative length of tibiae and five tarsomeres of legs LI: 2.7 : 1.5 : 0.8 : 0.6 : 0.5 : 0.4; LII: 3.5 : 2.0 : 1.0 : 0.7 : 0.4: 0.4 ; LIII: 4.5 : 1.0 :1.5 : 1.0 : 0.5: 0.5. Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. CuAx ratio 0.5. Squama pale white with long white hairs. Halter pale yellow.

Abdomen dark metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Figs 12, 30): Mainly black except epandrial lobes, surstylus and cercus pale to yellow, phallus brown. Hairs and bristles pale yellow. Epandrium longer than wide, epandrial lobes small, fused at base, each with one slender apical bristle. Ventral surstylus long, wide, slightly wide at apex, with three short apical bristles; dorsal surstylus wide and rounded apically, with three short apical bristles. Cercus nearly white, strip-like, narrowed towards tip, with an obvious dentation at basal 1/5; marginal bristles present on weak digitations, five times longer than wide, apical bristle somewhat claw-like. Hypandrium tilted up apically, blunt apically. Phallus thin, hidden within hypandrium.



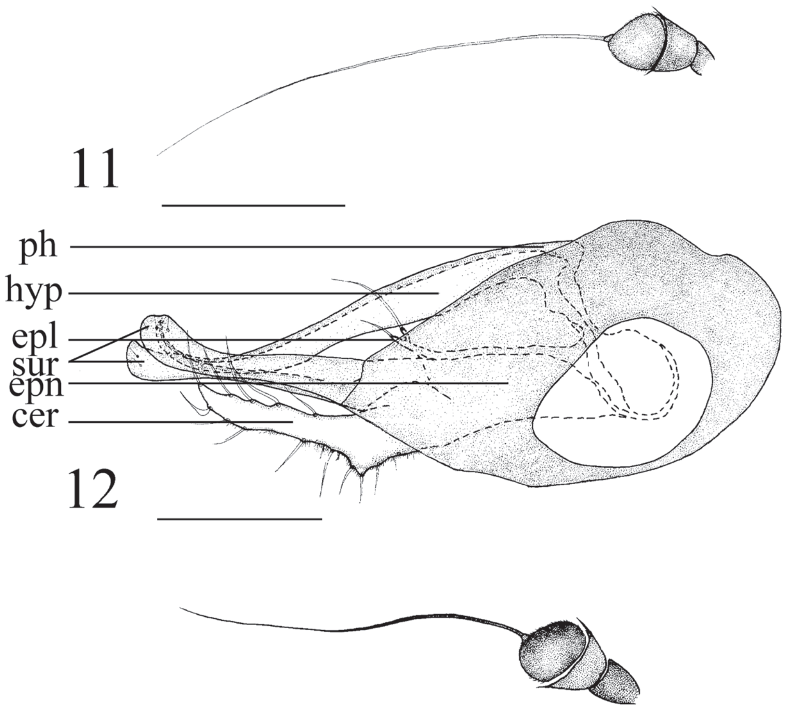
Figures 1–6. Habitus, lateral view (male). **1** *Medetera albens* sp. n. **2** *Medetera bisetifera* sp. n. **3** *Medetera triseta* sp. n. **4** *Medetera flava* sp. n. **5** *Medetera ganshuiensis* sp. n. **6** *Medetera lihuae* sp. n. Scale bars: 1 mm.



Figures 7–10. Habitus, lateral view (male). **7** *Medetera shiae* sp. n. **8** *Medetera shuimogouensis* sp. n. **9** *Medetera transformata* sp. n. **10** *Medetera xiquegouensis* sp. n. Scale bars: 1 mm.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Helan Mountain, Gulaben, Zhonggutian (N39°09'51.29", E106°05'82.66''), 1892 m altitude, collected by



Figures 11–12. *Medetera albens* sp. n., male. **11** Antenna **12** genitalia, lateral view. Abbreviations: epl = epandrial lobe, epn = epandrium, hyp = hypandrium, ph = phallus, sur = surstylus, cer = cercus. Scale bar: 0.2 mm

sweeping nets in grass, 2014.VII.13, Yanan Lv (CAU). Paratype: one male, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

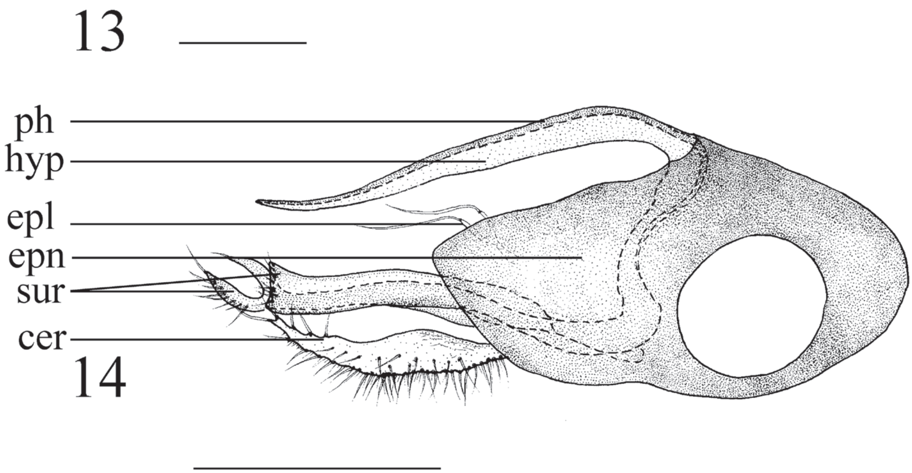
Remarks. This new species is quite unique due to its special arista and the simple shape of the surstylus. It is easily distinguished from the other species of the *M. apicalis* group.

Etymology. The specific name refers to the color of the arista, which becomes black to pale yellow gradually from base to tip.

Medetera bisetifera sp. n.

http://zoobank.org/A7CFE77C-B8E2-44EB-8EC3-BDC9EA6B7E3F
Figs 2, 13–14, 31

Diagnosis. Width of face about 1.5 times length of first flagellomere. Three pairs of long strong dc in same length, six biseriate acr. Legs mainly yellow, mid femur yellow except narrow blackish dorsal portion. CuAx ratio 0.3. Cercus strip-like, six times longer than wide, ventral margin with three bristles at apical 1/5; tip with two digitations each with one apical bristle. Phallus with distinct preapical lateral wings in ventral view.



Figures 13–14. 13 Antenna **14** genitalia, lateral view. Abbreviations: epl = epandrial lobe, epn = epandrium, hyp = hypandrium, ph = phallus, sur = surstylus, cer = cercus. Scale bar: 0.2 mm

Description. Male (Fig. 2). Body length 1.8 mm, wing length 1.5 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face approximately 1.5 times length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna (Fig. 13) black; first flagellomere flat, shortly brown pubescent; arista apical, black, bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis black with black apical hairs; palpus black with black apical bristle.

Thorax metallic green with gray pollinosity. Hairs and bristles on thorax black. Three pairs of long strong dc in same length, six hair-like biseriate acr, two sa. Scutellum with two pairs of sc (median pair long, strong). Legs mainly yellow but coxae, trochanters and all tarsomere 5 black, fore and hind femora dark yellow to yellow except mid femur with narrow blackish portion dorsally. Hairs and bristles on legs mainly pale white. Fore coxa with seven strong anterior bristles; mid coxa with three strong anterior bristles and one outer bristle; hind coxa with one outer bristle at middle and single apical bristle. Mid femur with 12 short dorsal bristles in a row. Mid tibia with one brown paired ad-pd at basal 1/3. Hind tibia with four ventral bristles in apical half and three black apical bristles. Relative length of tibiae and five tarsomeres of legs LI: 2.0 : 1.0 : 0.5 : 0.4 : 0.2 : 0.3; LII: 2.5 : 1.0 : 0.5 : 0.4 : 0.3: 0.3; LIII: 2.5 : 0.6 : 1.0 : 0.5 : 0.3: 0.2. Wing nearly hyaline, tinged brown; veins light brown, R_{4+5} and M_{1+2} convergent apically. M_{1+2} somewhat curve. CuAx ratio 0.3. Squama pale white with short pale hairs. Halter pale yellow.

Abdomen dark metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Figs 14, 31): Mainly black except epandrial lobes, surstylus and cercus yellow. Hairs and bristles yellow to white. Epandrium longer than wide, epandrial lobes thin finger-like, each with single long thin apical bristle. Ventral surstylus widened towards tip, straight at apex, with row of eight short apical bristles; dorsal surstylus wide and U-shaped apically, straight and thin, ventral lobe with one short apical bristle, dorsal lobe with nine bristles. Cercus strip-like, long, narrowed towards tip, six times longer than wide, base slightly dilated; ventral margin with three bristles at apical 1/5, dorsal margin with dense marginal bristles, tip with two digitations each with one apical bristle. Hypandrium simple. Phallus with distinct preapical lateral wings in ventral view.

Female. Body length 1.9 mm, wing length 1.7 mm. Similar to male except the narrow blackish dorsal portion of mid femur is nearly indistinct.

Types. Holotype male, CHINA, Inner Mongolia, Tongliao, Daqinggou (N42°49'16.6", E122°10'58.0"), 180 m alt., collected by sweeping nets in grass, 2014.VII.6, Ding Yang & Ning Wang (CAU). Paratypes: three females, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. gussakovskii* Negrobov, 1966 because they both have three dc of same length, they both have two sa, their legs are both mainly yellow and their CuAx ratio are similar (in latter it is 0.32), but can be distinguished from the latter by the color of the antenna and the mid femur as well as the apical bristle of cercus. In *M. gussakovskii*, the scape and the pedicel of antenna are yellow and the mid femur is wholly yellow, the cercus has one strong peg-like apical bristle instead of the two digitations with bristles (Negrobov and Stackelberg 1972: p 304, figs 555–557).

Etymology. The specific name refers to the two digitations of the cercus which each has an apical bristle.

Medetera triseta sp. n.

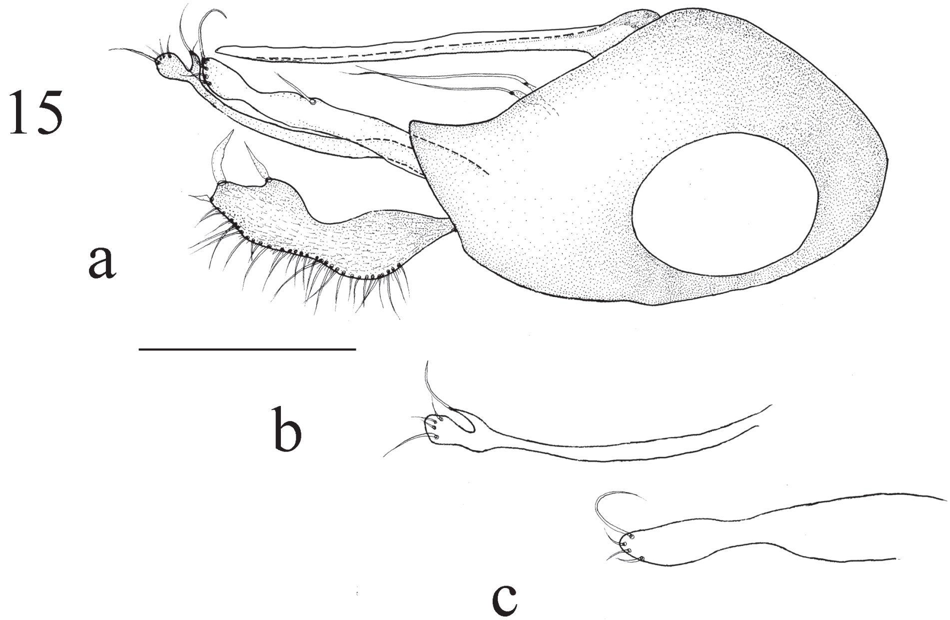
http://zoobank.org/0F5082BC-63AD-4501-A50C-C1A893B4DBF4

Figs 3, 15, 32

Diagnosis. Width of face approximately twice length of first flagellomere. Three pairs of long strong dc in same length, four hair-like biseriate acr. CuAx ratio 0.67. Legs mainly black. Ventral surstylus with one external bristle at apical 1/3 on ventral margin, one long apical bristles; dorsal lobe of dorsal surstylus dilated. Cercus strip-like, 2.5 times longer than wide, with blade-like bristles at apex and ventral apical 1/4 point. Phallus and hypandrium both normal in lateral and ventral view.

Description. Male (Fig. 3). Body length 2.0–2.3 mm, wing length 1.75–1.9 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face nearly twice length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna black, first flagellomere oval, 1.2 times longer than wide, shortly brown pubescent; arista apical, black, bare, with basal segment short, nearly 0.1 times length of apical segment. Proboscis black with black apical hairs; palpus black with black apical hairs and one black apical bristle.

Thorax dark metallic green with gray pollinosity. Hairs and bristles on thorax black except pp with three pale white spine-like bristles. Three pairs of long strong dc in same length, four hair-like biseriate acr, two sa. Scutellum with two pairs of sc (median pair long



Figures 15. *Medetera triseta* sp. n., male. a genitalia, lateral view **b** dorsal surstylus, lateral view **c** ventral surstylus, lateral view. Scale bar: 0.2 mm.

strong). Legs black except apical half of femora, middle 1/3 of fore tibia, mid tibia and main portion of hind tibia, basal half of fore and mid tarsomere 1 yellow. Hairs and bristles on legs mainly pale yellow. Fore coxa with row of 12 short dorsal bristles; mid and hind coxae each with one strong outer bristle at middle and one apical bristle. Mid and hind trochanters each with one spine-like outer bristle at middle. Hind femur with six dorsal bristles and eight short ventral bristles at basal 1/2. Fore tibia with three short apical bristles. Mid tibia with one paired black strong ad-pd at basal 1/5 and two black strong apical bristles. Hind tibia with row of six weak ad at apical 1/3 and two short apical bristles. Hind tarsomere 1 with row of short ventral bristles and two apical bristles. Hind tarsomere 2 with six short av. Relative length of tibiae and five tarsomeres of legs LI: 3.5 : 2.0 : 1.2 : 0.8 : ? : ?; LII: 5.0 : 3.0 : 1.5 : 1.0 : 0.7: 0.6; LIII: 5.0 : 1.3 : 3.0 : 1.3 : 0.5: 0.4 (fore tarsomeres 4-5 missing). Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. CuAx ratio 0.67. Squama pale white with long pale white hairs. Halter pale yellow.

Abdomen dark metallic green with thick gray pollinosity. Hairs and bristles pale white. Male genitalia (Figs 15, 32): Mainly black except epandrial lobes, surstylus, hypandrium and cercus dark yellow; phallus dark brown. Hairs and bristles yellow to pale white. Epandrium longer than wide; epandrial lobes forming two digitations each with one long thin apical bristle. Ventral surstylus nearly straight, slightly narrower at apical 1/6, blunt at tip, with one external bristle at apical 1/3 on ventral margin, one long and three short apical bristles; dorsal surstylus thin, dilated and U-shaped apically, straight and thin, with ventral lobe thin, sharp at tip, with one long apical bristle, dorsal lobe dilated with three normal apical bristles and one long apical bristle. Cercus strip-like, 2.5 times longer than wide, invaginated at basal 1/3 to apical 1/3 on ventral margin, thick at apical 1/4 to apical 1/3, with dense thin marginal bristles at dorsal margin, one long blade-like apical bristle, one blade-like bristle at apical 1/4 on ventral margin. Hypandrium thin and simple, sharp apically. Phallus thin and normal, hidden within hypandrium.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Shuimogou (N49°34'44.8", E125°11'30.1"), 2130 m, collected by sweeping nets in grass, 2014.VII.5, Li Shi (CAU). Paratypes: one male, same data as holotype (CAU); five males, CHINA, Inner Mongolia, keerqinhan, (N46°10'32.8", E122°03'20.5"), 460m, collected by sweeping nets in grass, 2008.VII.19, Gang Yao (CAU); one male, CHINA, Inner Mongolia, Xilinguole (N44°63'69.4", E117°54'35.7"), 1000.4 m, collected by sweeping nets in grass, 2014.VII.13, Yanan Lv (CAU); one male, CHINA, Inner Mongolia, Aergeqihamula (N48°46'42.3", E117°25'21.5"), 598.2 m, collected by sweeping nets in grass, 2014. VII.17, Yanan Lv (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. turkestanica* Stackelberg, 1926 because they both have three strong dc of similar length, their legs are both mainly black, their CuAx ratio are both 0.67 and their face both have gray pollinosity, but can be distinguished from the latter by the color of legs. In *M. turkestanica*, legs are all dark metallic green, nearly brown. There is no detailed description of male genitalia of *M. turkestanica*, but we are sure they are different species (Negrobov and Stackelberg 1974: 349).

Etymology. The species is named for the three claw-like bristles on the cercus.

Medetera diadema-veles group

The *diadema-veles* group is one of the most well-defined and characterized group of Medeterinae. For a detailed discussion about the characters used to distinguish the group with other species see Bickel (1985: p 164). The most recognizable feature for species in Palaearctic China would be the epandrial lobes which form one long digitation with two long apical bristles. Species of the group vary on the reduction of hypopygial structures, and mostly differ in the surstylus.

Medetera flava sp. n.

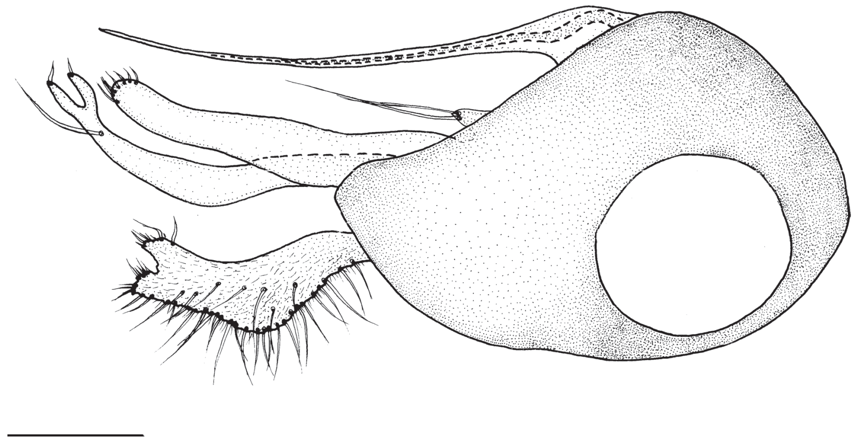
http://zoobank.org/9348B212-23C5-4623-AF98-EDB98B449342

Figs 4, 16–17, 33

Diagnosis. Width of face about 1.7 times length of first flagellomere. First flagellomere somewhat rectangular, 0.4 times as long as wide. Four pairs of dc of which posterior three pairs long strong, Five hair-like biseriate acr. Pp with three pale yellow spine-like

16

17



Figures 16–17. *Medetera flava* sp. n., male. **16**. Antenna **17** genitalia, lateral view. Scale bar = 0.2 mm.

bristles in equal length. CuAx ratio 0.8. Legs almost entirely yellow. Basolateral bristle of epandrial lobe wholly feather-like. Cercus strip-like, tip depressed at middle, margin on invagination slightly raised at middle, with one short blade-like apical bristle.

Description. Male (Fig. 4). Body length 2.8 mm, wing length 2.5 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about 1.7 times length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna (Fig. 16) black; first flagellomere somewhat rectangular, 0.4 times as wide as long; arista apical, black and bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis black with pale yellow apical hairs; palpus black with black apical hairs.

Thorax dark metallic green with gray pollinosity. Hairs and bristles on thorax black except pp with three pale yellow spine-like bristles in equal length. Four pairs of dc of which posterior three pairs long strong, five hair-like biseriate acr, two sa. Scutellum with two pairs of sc (median pair long, strong). Legs mainly yellow, but base of fore coxa, mid and hind coxae, extreme base of hind tarsomere 1, apical half of tarsomere 3 and tarsomeres 4–5 black. Hairs and bristles on legs mainly pale yellow. Fore coxa with three apical bristles; mid and hind coxae each with one strong outer bristle at middle and one outer bristle at apical 1/2. Mid femur with six pairs of weak av-pv.

Hind femur with six dorsal bristles and eight short ventral bristles, all very thin. Mid tibia with one black ad-pd pair at basal 1/4 and two apical bristles. Hind tibia with eight short ad at apical 1/4 and three apical bristles. Fore and mid tarsomeres 2-4 each with three short black apical bristles. Hind tarsomere 2 with row of 12 short spine-like bristles. Relative length of tibiae and five tarsomeres of legs LI: 2.5 : 1.3 : 1.0 : 0.5 : 0.4 : 0.4; LII: 3.5 : 2.0 : 1.0 : 0.6 : 0.5: 0.3; LIII: 4.0 : 0.8 : 2.0 : 1.0 : 0.5: 0.4. Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. CuAx ratio 0.8. Squama pale white with long pale hairs. Halter pale yellow.

Abdomen dark metallic green with thick gray pollinosity. Hairs and bristles pale yellow. male genitalia (Figs 17, 33): Mainly black except epandrial lobes, surstylus and cercus brown. Hairs and bristles yellow to pale white. Epandrium longer than wide, epandrial lobes forming one digitation with two long and slender apical bristles, of which basolateral bristle of epandrial lobe wholly feather-like. Ventral surstylus narrowed towards tip, almost straight except one wave near base, tip blunt, with row of six apical bristles; dorsal surstylus wide and U-shaped apically, thin, bent at middle, with one long bristle at apical 1/10, ventral and dorsal lobes each with one short apical bristle. Cercus strip-like, raised at middle on dorsal margin, three times longer than wide; dorsal margin with dense marginal bristles, tip depressed at middle, margin on depression slightly raised at middle, with short dense bristles and one short blade-like bristle apically. Hypandrium simple. Phallus thin, hidden within hypandrium.

Female. Body length 3.0 mm, wing length 2.5 mm. Similar to male.

Types. Holotype male, CHINA, Inner Mongolia, Tumujinur Nur (N46°17'17.6", E122°10'58.0"), 220 m, collected by sweeping nets in grass, 2014.VII.23, Yanan Lv (CAU). Paratypes: 3 females, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. diadema* Linnaeus, 1767 because they both have black antenna, yellow tibia and one ad, one pd on mid tibia, their bristles on pp are nearly in same length, but can be distinguished from the latter by the CuAx ratio and the color of legs and the bristles on epandrial lobe and cercus. In *M. diadema*, the CuAx ratio is 0.56, the coxae and the tarsi are brown, the bristle on epandrial lobe is normal, the cercus has a claw-like apical bristle and one long apical process ventrally (Negrobov and Stackelberg 1972: 296, figs 505–506).

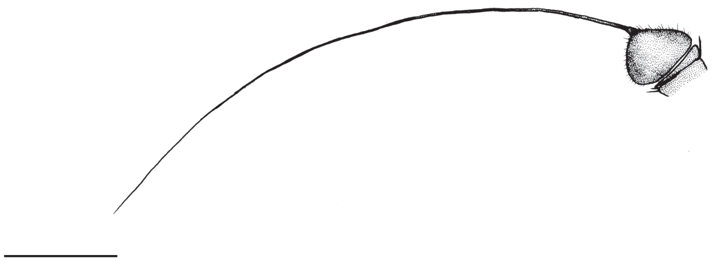
Etymology. The specific name refers to the nearly entirely yellow color of the legs.

Medetera ganshuiensis sp. n.

http://zoobank.orgF2E6F401-63D5-4413-B052-9A8CB7B49B87
Figs 5, 18–19, 34

Diagnosis. Width of face about two times length of first flagellomere. Four pairs of dc, anterior two weak and posterior two strong, one biseriate acr. CuAx ratio 1.4. Hind tibia slightly expanded at apex, with five short black apical spurs. Ventral surstylus with two long strong bristles at apical 1/5. Hypandrium narrowed towards tip, sharp api-

18



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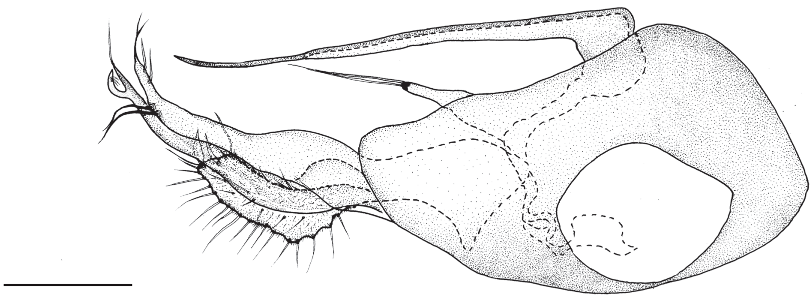


Figures 18–19. *Medetera ganshuiensis* sp. n., male. **18** Antenna **19** genitalia, lateral view. Scale bar = 0.2 mm.

cally, thin and simple in lateral and ventral view. Cercus nearly rectangular, two times longer than wide, with one blade-like bristle apically.

Description. Male (Fig. 5). Body length 2.5 mm, wing length 2.5 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about twice length of first flagellomere. Hairs and bristles on head black except postocular bristles black and posteroventral hairs pale yellow. Antenna (Fig. 18) all black; first flagellomere pale white pubescent; arista apical, black, thinly pale white pubescent, nearly bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis dark brown with several radial black strips; palpus black with one brown apical bristles.

Thorax dark metallic green with gray pollinosity. Hairs and bristles on thorax black. Four pairs of dc, anterior two weak and posterior two strong, one biseriate acr at anterior portion, two sa. Scutellum with two pairs of sc (median pair long, strong). Legs mainly black except tip of femora dark yellow and extreme base of mid tibia dark yellow. Hairs and bristles on legs mainly pale white. Fore coxa with one anterior bristle at middle and four ventral apical hairs; mid coxa with two outer bristles at middle; hind coxa with one outer bristle at middle. Hind femur with row of three short av at basal 1/3 to apical 1/3. Fore tibia without distinct bristle; mid tibia with one brown apical bristle; hind tibia slightly expanded at apex, without distinct bristle but with five short black apical spurs. Relative length of tibia and five tarsomeres of legs LI: 3.5 : 1.5 : 1.3 : 1.0 : 0.5 : 0.4; LII: 5.0 : 2.2 : 2.0 : 1.0 : 0.4 : 0.5; LIII: 5.5 : 1.0 : 2.5 : 1.5

: 0.6: 0.6. Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. CuAx ratio 1.4. Squama pale white with pale hairs. Halter pale yellow.

Abdomen dark metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Tergite 2 with one circulate of bristles apically. Male genitalia (Figs 19, 34): Mainly black. Hairs and bristles mainly pale white except two long strong bristles at apical 1/5 of ventral surstylus black. Epandrium longer than wide; epandrial lobes forming one digitation with two long slender apical bristles. Ventral surstylus long, narrowed towards tip, almost straight, dilated at basal 1/2, with two long strong bristles at apical 1/5 portion (one bristle at apical 1/8, one bristle at apical 1/10); dorsal surstylus thin, slightly narrowed towards tip, wide and U–shaped apically, dorsal lobe with three short weak bristles, ventral lobe with one long, straight bristle at tip; lobes both sharp at apex. Cercus nearly rectangular, somewhat wave-like at base, nearly two times longer than wide, with one blade-like bristle apically; covered with thin bristles, but marginal bristles distributed averagely. Hypandrium narrowed towards tip, sharp apically, thin and simple in lateral and ventral view. Phallus hidden in hypandrium.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Helan Mountain, Gulaben, Ganshu Bay (N38°59.165', E106°02.255'), 2300 m, collected by sweeping nets in grass, 2010. VIII.9, Lihua Wang (CAU). Paratype: one male, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. mongolica* Negrobov, 1966 because their legs are both mainly black, they both almost do not have acr and their cercus both have one strong apical bristle, but can be distinguished from the latter by the bristle of surstylus and the shape of cercus. In *M. mongolica*, one of the apical bristles of dorsal surstylus is flagellate and the cercus has a ventral process (Negrobov and Stackelberg 1972: p 319, figs 669–672).

Etymology. The species is named for the type locality, Ganshu.

Medetera lihuae sp. n.

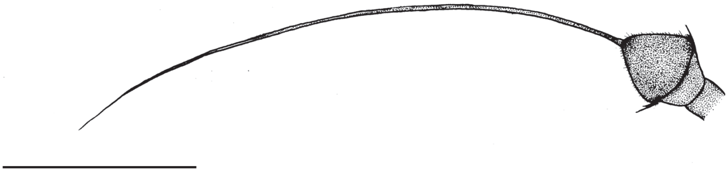
http://zoobank.org/ECF80C42-DED0-474E-A457-949F9B407839

Figs 6, 20–21, 35

Diagnosis. Width of face about 1.5 times length of first flagellomere. Four pairs of dc in same length, four uniseriate acr. Vein M_{1+2} bent. CuAx ratio 1.0. Ventral surstylus long, wide, slightly narrow at apex, with row of ten ventral bristles at apical 1/4 and six thin apical bristles; dorsal surstylus wide and U-shaped apically, ventral lobe with row of six bristles, dorsal lobe with one preapical bristle. Cercus nearly rectangular, with one blade-like apical bristle, six times longer than wide.

Description. Male (Fig. 6). Body length 2.1 mm, wing length 2.3 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about 1.5 times length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna

20



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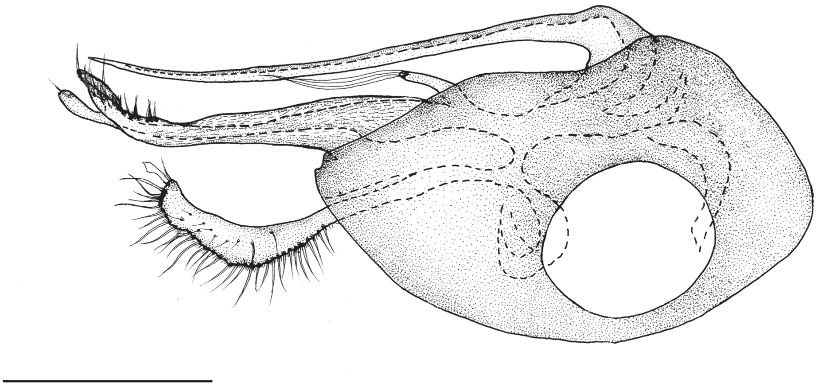


Figures 20–21. *Medetera lihuae* sp. n., male. **20** Antenna **21** genitalia, lateral view. Scale bar: 0.2 mm.

(Fig. 20) black; first flagellomere nearly triangular, nearly as long as wide, with shortly brown pubescent; arista apical, black, bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis brown with pale white apical hairs; palpus wide, brown with 1 pale white apical bristle.

Thorax dark metallic green with gray pollinosity. Hairs and bristles on thorax black. Four pairs of dc in same length, four uniserate acr, two sa. Scutellum with two pairs of sc (median pair long strong). Legs all black except tips of mid and hind femora dark yellow. Hairs and bristles on legs mainly pale yellow. Fore coxa with six anterior bristles; mid and hind coxae each with one outer bristle at middle. Hind trochanter with one outer bristle at middle. Mid femur with six ventral bristles at basal half, of which middle three relatively long. Hind tibia expanded apically, with three short black apical bristles. Fore tarsomere 1 with row of 12 short ventral bristles; hind tarsomere 1 with row of 12 short dorsal and 12 short ventral bristles. Relative length of tibiae and five tarsomeres of legs LI: 2.7 : 1.2 : 1.0 : 0.7 : 0.4 : 0.3; LII: 3.7 : 2.5 : 1.0 : ? : ?: ?; LIII: 4.0 : 1.0 :1.8 : 1.0 : 0.5: 0.5 (mid tarsomeres 3-5 missing). Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. M_{1+2} somewhat bent. CuAx ratio 1.0. Squama pale white with short pale white hairs. Halter pale yellow.

Abdomen dark metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Figs 21, 35): Mainly black except epandrial lobes, surstylus and cercus dark yellow to brown, phallus dark brown. Hairs and bristles yellow to pale white. Epandrium longer than wide; epandrial lobes forming one long digitation with two long thin apical bristles. Ventral surstylus long, wide, slightly narrow at apex, with row of ten ventral bristles at apical 1/4 and six thin apical bristles; dorsal surstylus wide and U-shaped apically, ventral lobe with row of six bristles, dorsal lobe with one preapical bristle. Cercus nearly rectangular, with one blade-like apical bristle, with long marginal bristles and external bristles, six times longer than wide. Hypandrium simple. Phallus thin, hidden within hypandrium.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Helan Mountain, Shuimogou (N38°96'36.29", E105°85'78.64"), 1300 m, collected by sweeping nets in grass, 2010. VIII.4, Lihua Wang (CAU). Paratype: one male, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. ussuriana* Negrobov, 1977 because they both have legs which are mainly black, they both have four strong dc of the same length and their CuAx ratio are both 1.0, but can be distinguished from the color and bristles of/on legs and the bristles on cercus. In *M. ussuriana*, the legs are all black except the trochanters yellow, the mid tibia has a pd and the cercus has one claw-like apical bristle (Negrobov and Stackelberg 1977: p 350–351).

Etymology. The species is named after the collector Lihua Wang.

Medetera shiae sp. n.

http://zoobank.org/9379B921-5DCB-4C8D-B953-F2D214F77B1A

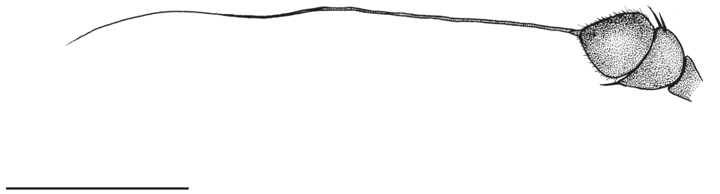
Figs 7, 22–23, 36

Diagnosis. Width of face about 1.5 times length of first flagellomere. First flagellomere rounded, nearly 0.8 times longer than wide. Four pairs of dc in same length, eight biseriate acr. M-Cu somewhat curved. CuAx ratio 0.61. Cercus strip-like, narrowed towards tip, base dilated, with one apically dilated blade-like apical bristle. Hypandrium thin, tilted back at tip. Phallus thin and sharp at tip, almost totally separate from hypandrium.

Description. Male (Fig. 7). Body length 3.0 mm, wing length 2.5 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about 1.5 times length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna (Fig. 22) black; first flagellomere rounded, nearly 0.8 times longer than wide, shortly brown pubescent; arista apical, black, bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis extremely wide, black with pale white apical hairs; palpus black with pale white apical bristle.

Thorax metallic green with gray pollinosity. Hairs and bristles on thorax black. Four pairs of dc in same length, eight biseriate acr, two sa. Scutellum with two pairs of sc, median pair long strong. Legs all black, but brown to yellow at apical 1/3 of femora, dark yellow at tibiae except extreme base and tip, yellow at apical half of tarsomere 1. Hairs

22



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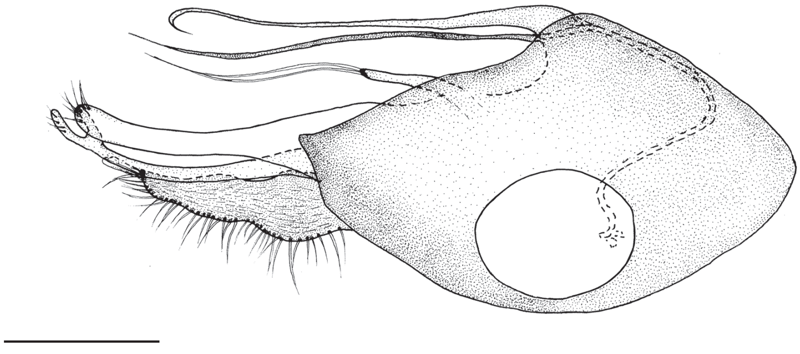

Figures 22–23. *Medetera shiae* sp. n., male. **22** Antenna **23** genitalia, lateral view. Scale bar = 0.2 mm.

and bristles on legs mainly black, but pale yellow on tarsus. Fore coxa with four ventral bristles at apical half; mid and hind coxae each with one outer bristle at middle. Fore trochanter with two bristles at middle. Hind tibia with two short apical bristles. Relative length of tibiae and five tarsomeres of legs LI: 3.0 : 1.3 : 1.0 : 0.6 : 0.3 : 0.3; LII: 4.5 : 2.2 : 1.3 : 0.7 : 0.5: 0.5 ; LIII :5.0 : 1.2 :2.1 : 1.2 : 0.5: 0.5. Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. M-Cu somewhat curved. CuAx ratio 0.61. Squama pale white with long pale white hairs. Halter pale yellow.

Abdomen dark metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Figs 23, 36) Mainly black except epandrial lobes, surstylus and cercus dark yellow, phallus black. Hairs and bristles yellow to pale white. Epandrium longer than wide; epandrial lobes forming one long digitation with two long and slender apical bristles. Ventral surstylus straight, round at apex, with row of six long apical bristles; dorsal surstylus wide and U-shaped apically, straight and thin, ventral lobe with one preapical long spine-like bristle, dorsal lobe with four short bristles. Cercus strip-like, three times longer than the widest point, narrowed towards tip, base dilated, ventral and dorsal margins each invaginated at basal 1/3 and dorsal 1/3, with long and dense marginal bristles at dorsal margin, with one apically dilated blade-like apical bristle. Hypandrium thin, tilted back at tip. Phallus thin and sharp at tip, almost entirely separate with hypandrium.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Helan Mountain, fork of the main peak (N38°51'02.5", E105°49'09.4"), 2247 m, collected by sweeping nets in grass, 2014.VII.6, Li Shi (CAU). Paratypes: three males, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. paralamprostoma* Negrobov, 1974 because they share the similarity in dc and the color of legs and the size, but can be distinguished from the latter by the bristles on legs, the CuAx ratio and the shape of hypandrium. In *M. paralamprostoma*, the CuAx ratio is 1.625, hind femur has one long ad at base and hind tibia has one long preapical pd. The hypandrium is thin and wedge-like (Negrobov and Stackelberg 1974: 327).

Etymology. The species is named after the collector Li Shi.

Medetera shuimogouensis sp. n.

http://zoobank.org/247B6A5F-A8BC-40E2-B879-73A32A753439
Figs 8, 24–25, 37

Diagnosis. Width of face approximately twice length of first flagellomere. Four pairs of dc (anterior one short, posterior three strong), four biseriate acr. CuAx ratio 0.8. Phallus thin with big and round apex. Ventral surstylus long, wide, slightly narrowed towards tip, with three short apical bristles; dorsal surstylus thin, narrowed towards tip, wide and rounded apically, with three short apical bristles. Cercus nearly oval, 1.8 times longer than wide, without specialized bristles, covered with thin bristles (marginal bristles distributed averagely).

Description. Male (Fig. 8). Body length 2.4–2.5 mm, wing length 3.5 mm. Head: vertex, frons and face metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about twice length of first flagellomere. Hairs and bristles on head black except postocular bristles black and posteroventral pale yellow. Antenna (Fig. 24) all black; first flagellomere 0.8 times longer than wide; arista apical, thinly black pubescent, nearly bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis dark brown with radius dark brown strips, and with short pale apical hairs; palpus black with one strong black apical bristles.

Thorax metallic green with gray pollinosity. Hairs and bristles on thorax dark yellow. Four pairs of dc (anterior one short, posterior three strong), four regular biseriate acr at anterior portion, two sa, pp with two yellow bristles not in equal length. Scutellum with two pairs of sc (median pair long strong). Legs black except tips of femora yellow. Hairs and bristles on legs mainly pale. Fore coxa with two rows of four paired ad-pd at apical 1/2; mid coxa with two outer bristles at middles; hind coxa with one outer bristle at middle. Mid trochanter with three short bristles apically. Hind femur with two rows of four short paired ad-pd at basal 1/3. Fore tibia with three short ventral apical bristles. Mid tibia with one brown ad at basal 2/5, one pd at basal 1/10 and two short ventral apical bristles; hind tibia without distinct bristles. Relative length of tibia and five tarsomeres of legs LI: 5.0 : 1.0 : 1.5 : 1.0 : 0.7 : 0.5; LII: 6.5 : 3.0 : 2.0 :

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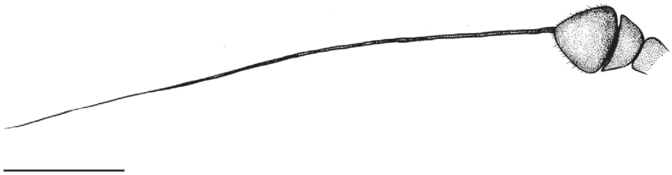

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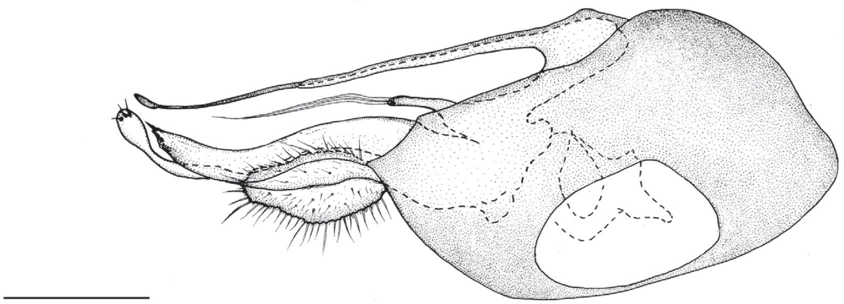


Figures 24–25. *Medetera shuimogouensis* sp. n., male. **24**. Antenna **25** genitalia, lateral view. Scale bar = 0.2 mm.

1.6 : 0.6 : 0.7; LIII: 7.5 : 1.5 : 4.0 : 1.6 : 0.8: 0.7. Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. CuAx ratio 0.8. Squama pale white with pale white hairs. Halter pale yellow.

Abdomen metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Figs 25, 37): Mainly black except epandrial lobes, surstylus and cercus dark yellow, phallus dark brown. Hairs and bristles yellow to pale white. Epandrium longer than wide; epandrial lobes forming one digitation with two slender apical bristles. Ventral surstylus long, wide, slightly narrowed towards tip, with three short apical bristles; dorsal surstylus thin, narrowed towards tip, wide and rounded apically, with three short apical bristles. Cercus nearly oval, 1.8 times longer than wide, without specialized bristles, covered with thin bristles (marginal bristles distributed averagely). Hypandrium narrowed towards tip, blunt apically, thin and simple in lateral view. Phallus thin with big and round apex.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Helan Mountain, Shuimogou (N38°96'42.40", E105°85'82.60"), 1270 m, collected by sweeping nets in grass, 2010. VIII.6, Yan Li (CAU). Paratypes: two males, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is unique for the cercus as it has no obvious bristle. The other parts of the species are somewhat like *M. feminina* Negrobov, 1967 as they have similar dc and the bristles on pp, the halter and the color and the bristles of/on legs, but can be distinguished from the latter by the shape of phallus, in *M. feminina*, the phallus is curved like the beak of an eagle apically. (Negrobov and Stackelberg 1972: 299, figs 527–529, 535).

Etymology. The species is named for the type locality, Shuimogou.

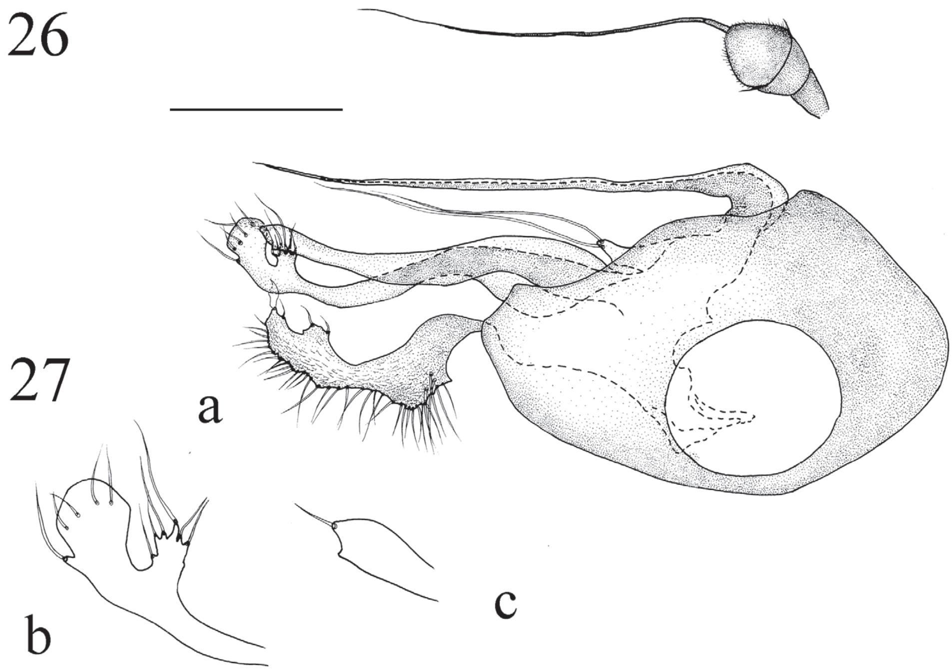
***Medetera transformata* sp. n.**
http://zoobank.org/2B4F6BD4-4DC9-4898-B4B5-243E4539413F
Figs 9, 26–27, 38

Diagnosis. Width of face about 2.5 times length of first flagellomere. Four pairs of long strong spine-like dc, seven short weak hair-like biseriate acr. CuAx ratio 1.0. Ventral surstylus nearly straight, wide at basal 1/3, sharp apically, with a small preapical protuberance, with one spine-like apical bristle; dorsal surstylus thin, but dilated and U-shaped apically. Cercus strip-like, with dense marginal bristles and three long external bristles at basal 1/4. Hypandrium slightly expanded preapically in ventral view.

Description. Male (Fig. 9). Body length 2.5 mm, wing length 2.2 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about 2.5 times length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna (Fig. 26) black; first flagellomere nearly triangular, 1.1 times longer than wide, blunt at tip, shortly brown pubescent; arista apical, black, bare, basal segment short, nearly than 0.15 times length of apical segment. Proboscis black with black apical hairs; palpus black with black apical bristle.

Thorax metallic green with gray pollinosity. Hairs and bristles on thorax black except pp with three pale yellow spine-like bristles in same length. Four pairs of long strong spine-like dc, seven short weak hair-like biseriate acr, two sa. Scutellum with two pairs of sc (median pair long strong). Legs black except trochanters, tip of femora, mid tibia and basal half of mid tarsomere 1 yellow; hind tibia brown. Hairs and bristles on legs mainly pale yellow. Fore coxa with some short dorsal hairs and five-six short apical bristles; mid coxa with one strong outer bristle at middle and one relatively weak bristle at apical 1/3, hind coxa with one outer bristle at middle. Hind femur with five dorsal bristles and six short ventral bristles at basal 1/2. Fore tibia with two short brown apical bristles. Mid tibia with paired black strong ad-pd at basal 1/3 and two black strong apical bristles. Hind tibia with paired ad-pd at apical 1/6 and two short apical bristles. Fore tarsomere 1 with row of short ventral bristles. Hind tarsomere 1 with four short and thick black ventral bristles. Relative length of tibiae and five tarsomeres of legs LI: 2.5 : 1.0 : 0.8 : 0.5 : 0.3 : 0.4; LII: 3.5 : 2.0 : 1.0 : 0.7 : 0.3: 0.4; LIII: :3.5 : 0.5 : 1.7 : ? : ?: ? (hind tarsomeres 3-5 missing). Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. CuAx ratio 1.0. Squama pale white with long pale white hairs. Halter pale yellow.

Abdomen dark metallic green with thick gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Fig. 22): Mainly black except epandrial lobes, surstylus and hypandrium dark yellow; cercus and phallus dark brown. Hairs and bristles yellow to pale white. Epandrium longer than wide; epandrial lobes forming one digitation with two long thin apical bristles. Ventral surstylus nearly straight, wide at basal 1/3, sharp apically, with a small preapical protuberance, with one spine-like apical bristle; dorsal surstylus thin, but dilated and U-shaped apically, ventral lobe short and wide, with six digitations each with one apical bristle, dorsal lobe dilated with one small digitation



Figures 26–27. *Medetera transformata* sp. n., male. **26** Antenna **27 a** genitalia, lateral view **b** dorsal surstylus, lateral view **c** ventral surstylus, lateral view. Scale bar: 0.2 mm.

bearing one long apical bristles at basal 1/3 on dorsal margin and four preapical external bristles. Cercus strip-like, thick at basal 1/4 to middle on dorsal margin and apical 1/8 to 1/4 on ventral margin, with dense marginal bristles and three long external bristles at basal 1/4, two short bristles on the thick part of ventral margin and one short preapical bristle on ventral margin, and one apical blade-like bristle. Hypandrium thin and simple, sharp apically, slightly expanded preapically in ventral view. Phallus thin, hidden within hypandrium.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Shuimogou (N49°34'44.8", E125°11'30.1"), 2130 m, collected by sweeping nets in grass, 2014.VII.5, Li Shi (CAU). Paratypes: two males, CHINA, Inner Mongolia, Helan Mountain, Xiangchizigou (N38°59'60.2", E105°70'23.0"), 1950 m, collected by sweeping nets in grass, 2013.VIII.30, Xiao Zhang (CAU); two males, CHINA, Inner Mongolia, Helan Mountain, Xilinguole, Dongwuqi (N46°23'42.8", E118°48'28.7"), 870 m, collected by sweeping nets in grass, 2014.VII.14, Yanan Lv (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is unique for the shape of the dorsal surstylus and easily separated from other known species. It is somewhat like *M. murina* Becker, 1917 as they have similar dc, the arista, the bristles on mid tibia, the color of legs and the CuAx ratio; but can be distinguished from the latter by the number of acr, the bristles on fore and mid femora and the shape of cercus. In *M. murina*, thorax has four-five pairs of acr, fore and mid femora each has one av, and the cercus has a deep apical incision. (Negrobov and Stackelberg 1974: p 321–322, figs 693–695).

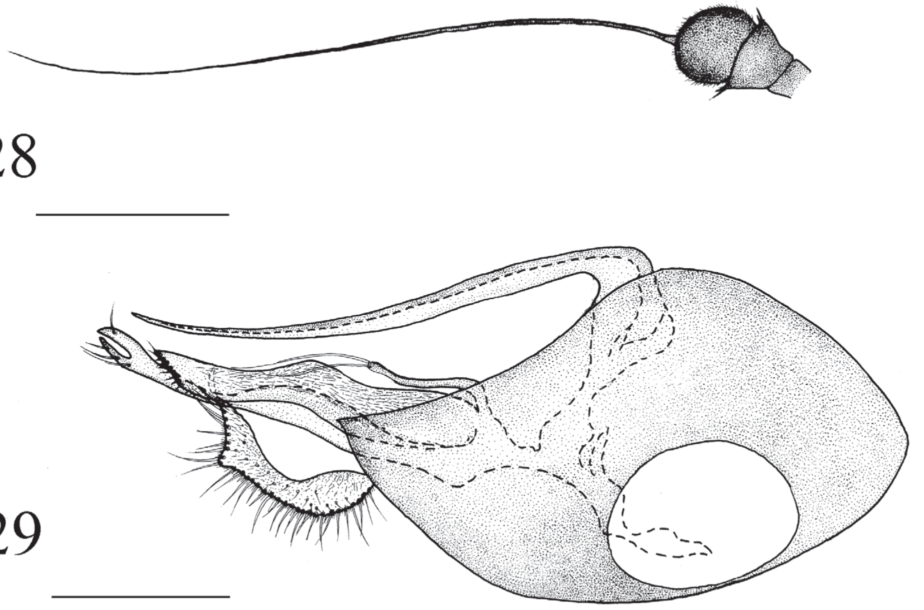
Etymology. The species is named for the shape of the dorsal surstylus.

Medetera xiquegouensis sp. n.

http://zoobank.org/7C7FDB69-EFEA-4872-A28B-BC1D8DA4C794
Figs 10, 28–29, 39

Diagnosis. Width of face about 1.5 times length of first flagellomere. Six biseriate acr. CuAx ratio 1.25. Ventral surstylus slightly waved at middle, straight at apex, dorsal surstylus wide and U-shaped apically, dilated at basal 1/4, thin at middle to apical 1/4, ventral lobe with one preapical bristle, dorsal lobe with three bristles. Cercus strip-like, without specialized bristle, six times longer than wide.

Description. Male (Fig. 10). Body length 2.6 mm, wing length 2.5 mm. Head: vertex, frons and face dark metallic green with gray pollinosity; eyes separated, face nearly parallel, width of face about 1.5 times length of first flagellomere. Hairs and bristles on head black except postocular bristles and posteroventral hairs pale yellow. Antenna (Fig. 28) black, first flagellomere rounded, shortly brown pubescent; arista apical, black, bare, with basal segment extremely short, less than 0.1 times length of apical segment. Proboscis black with black apical hairs; palpus black with one black apical bristle.



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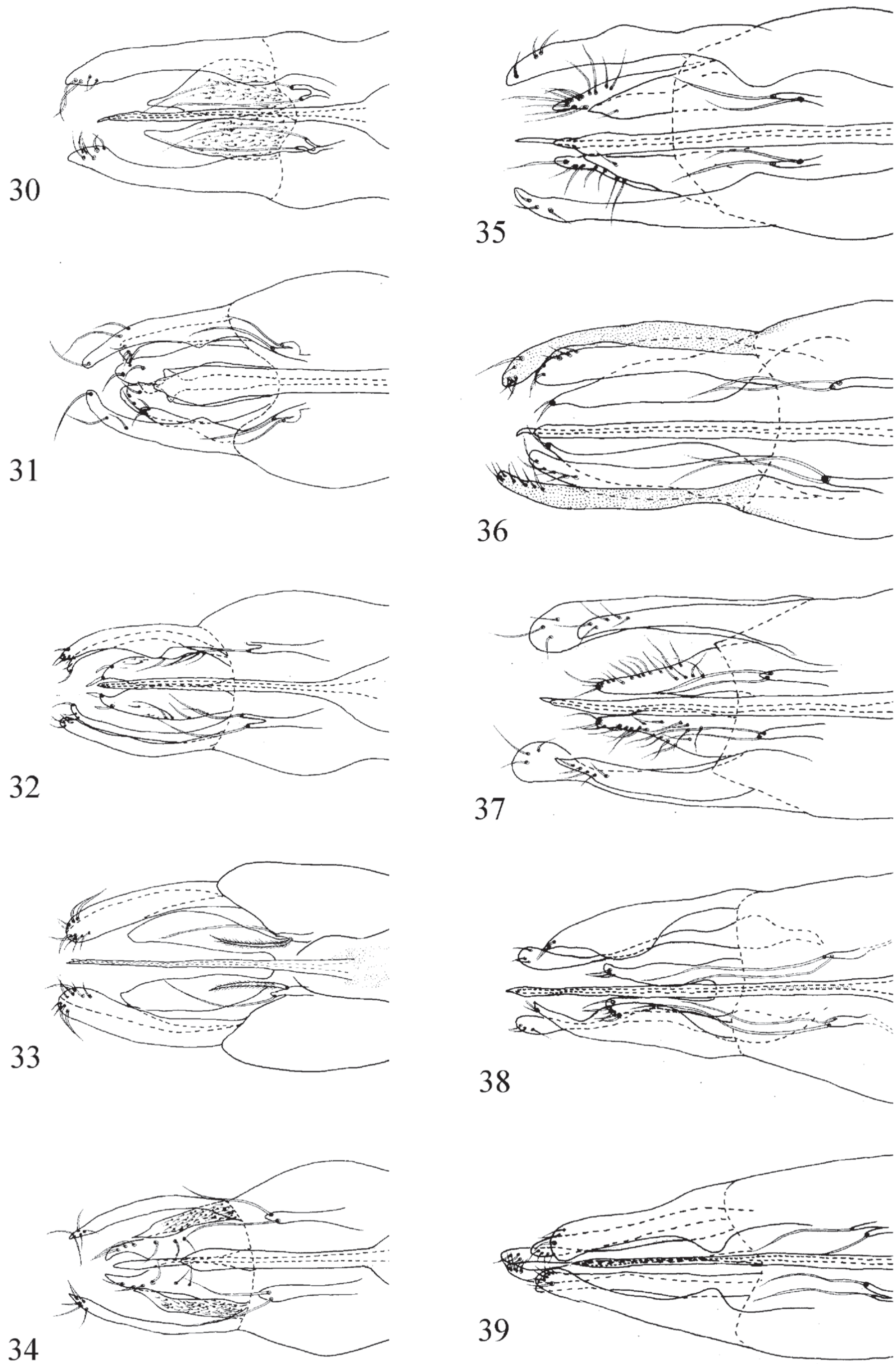
Figures 28–29. *Medetera xiquegouensis* sp. n., male. **28** Antenna **29** genitalia, lateral view. Scale bar: 0.2 mm.



Figures 30–39. Ventral view of apical half of male genitalia (male). **30** *Medetera albens* sp. n. **31** *Medetera bisetifera* sp. n. **32** *Medetera triseta* sp. n. **33** *Medetera flava* sp. n. **34** *Medetera ganshuiensis* sp. n. **35** *Medetera lihuae* sp. n. **36** *Medetera shiae* sp. n. **37** *Medetera shuimogouensis* sp. n. **38** *Medetera transformata* sp. n. **39** *Medetera xiquegouensis* sp. n. Scale bars: 1 mm.

Thorax metallic green with gray pollinosity, two sa. Hairs and bristles on thorax black. With five pairs of dc, six biseriate acr, two sa. Scutellum with two pairs of sc (median long, strong). Legs all black. Hairs and bristles on legs mainly pale yellow. Fore coxa with eight dorsal bristles at apical 1/2; mid and hind coxae each with one outer bristle at middle. Mid femur with four ventral bristles at basal 1/4 to apical 1/4. Hind tibia with four short dorsal bristles at apical 1/5, expanded apically, with five short apical bristles. Relative length of tibiae and five tarsomeres of legs LI: 3.0 : 1.3 : 1.0 : 0.6 : 0.3 : 0.3; LII: 4.5 : 2.2 : 1.3 : 0.7 : 0.5: 0.5; LIII: 5.0 : 1.2 :2.1 : 1.2 : 0.5: 0.5. Wing nearly hyaline, tinged brown; veins brown, R_{4+5} and M_{1+2} convergent apically. R_{4+5} and M_{1+2} arched towards R_{2+3}. CuAx ratio 1.25. Squama pale white with short pale white hairs. Halter pale yellow.

Abdomen dark metallic green with thin gray pollinosity. Hairs and bristles pale yellow. Male genitalia (Figs 29, 39): Mainly black except epandrial lobes, surstylus, cercus and phallus brown. Hairs and bristles yellow to pale white. Epandrium longer than wide; epandrial lobes forming one long digitation with two slender apical bristles. Ventral surstylus slightly waved at middle, straight at apex, with row of eight short apical bristles; dorsal surstylus wide and U-shaped apically, dilated at basal 1/4, thin at middle to apical 1/4, ventral lobe with one preapical bristle, dorsal lobe with three bristles. Cercus strip-like, somewhat invaginated at ventral margin, with a dentation at apical 2/5 on dorsal margin, narrower at tip, without specialized bristle, with long bristles at dorsal margin and short external bristles, six times longer than wide. Hypandrium simple. Phallus thin, hidden within hypandrium.

Female. Unknown.

Types. Holotype male, CHINA, Inner Mongolia, Helan Mountain, Xiquekou of Yao Bay (N38°57'57.5", E105°50'52.0"), 1340 m, collected by sweeping nets in grass, 2010.VIII.1,Yan Li (CAU). Paratype: one male, same data as holotype (CAU).

Distribution. Palaearctic: China (Inner Mongolia).

Remarks. This new species is somewhat similar to *M. infuscata*, 1974 Negrobov because their legs are both mainly black and the shape of their cercus and hypandrium are quite similar, their dc and acr are similar in size but differ in amount, the new species can be distinguished from the latter by the CuAx ratio and the shape of phallus. In *M. infuscata*, the CuAx ratio is 0.75 and the phallus is apically hooked (Negrobov and Stackelberg 1974: p 307, figs 580–584).

Etymology. The species is named for the type locality, Xiquekou.

Acknowledgements

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