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Cherax (*Astaconephrops*) *pulcher*, a new species of freshwater crayfish (Crustacea, Decapoda, Parastacidae) from the Kepala Burung (Vogelkop) Peninsula, Irian Jaya (West Papua), Indonesia

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Abstract

A new species, *Cherax* (*Astaconephrops*) *pulcher* **sp. n.**, from Hoa Creek, close to the village Teminabuan in the southern-central part of the Kepala Burung (Vogelkop) Peninsula, West Papua, Indonesia, is described, figured and compared with the morphologically closest species, *Cherax boesemani* Lukhaup & Pekny, 2008.

Keywords

Crustacea, Decapoda, Parastacidae, *Cherax* (*Astaconephrops*) *pulcher*, new species, freshwater crayfish, Hoa Creek, Teminabuan Region, Irian Jaya, Indonesia, West Papua

Introduction

The crayfishes of the island of New Guinea were extensively studied by Holthuis (1949, 1956, 1958, 1982, 1986, 1996), with recent additions by Lukhaup and Pekny (2006, 2008a) and Lukhaup and Herbert (2008). Nevertheless, over the last decade, there has been an increasing number of colourful crayfish sold in the ornamental fish

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trade in Europe, North America, and Asia under the names *Cherax* "Hoa Creek", "Blue Moon", and "Irian Jaya" presumed to represent a further undescribed species from New Guinea (Lukhaup and Pekny 2008b). The two most common and popular colour forms are: (1) a white, blue and violet morph with blue and white chelae (Fig. 1A–B); and (2) a greenish grey morph with blue and white chelae (Fig. 1C). While they are clearly species of *Cherax*, a large genus of freshwater crayfish occurring in Indonesia (West Papua), Papua New Guinea and Australia (Ahyong 2014), their exact provenances could not be ascertained, with dealers claiming originated from Sorong (West Papua) and other places in the area that could not be confirmed. In the present contribution, this species is described as new to science and shown to be native to the Teminabuan region of the Kepala Burung (Vogelkop) Peninsula West Papua, Indonesia. The new species, *Cherax* (*Astaconephrops*) *pulcher* sp. n. differs from all other crayfish of this subgenus in the shape of its chelae, shape of body and also in its coloration.

Abbreviations used: **RMNH** = Rijksmuseum van Natuurlijke Historie (= Naturalis Biodiveristy Center, Leiden). **TL** = Total length, **CL** = Carapace length.

Systematics

Family Parastacidae Huxley, 1879
Genus *Cherax* Erichson, 1846

***Cherax* (*Astaconephrops*) *pulcher* sp. n.**
http://zoobank.org/C7C4B1F7-E5C3-45B2-ADC3-DE05EF489EE4
Figs 1–5

Type material. Holotype: male (TL) 96 mm) (RMNH.CRUS.D.57217), Hoa Creek, Teminabuan region, Kepala Burung (Vogelkop) Peninsula, West Papua, Indonesia, collector unknown, 5 October 2002. Paratypes: 1 male (TL 94 mm), 1 female (TL 90 mm) (RMNH.CRUS.D.57218), same data as holotype. All animals collected by and exported through Maju Aquarium, Jakarta, Indonesia.

Non-type material. 9 males (TL 83–98 mm), 1 female (TL 83 mm), from Aquarium Dietzenbach in Germany, 5 April 2004.

Description of male holotype (Figs 2–5)**.** Body and eyes pigmented. Eyes not reduced.

Body subovate, slightly compressed laterally. Pleon narrower then cephalothorax (width 17 mm and 20 mm respectively). Rostrum (Fig. 3A) slender, reaching about to end of ultimate antennular peduncle and about three times as long as wide (width 5 mm at base, length 14 mm). Upper surface smooth, few scattered setae present at the tip of the rostrum ; lateral margins of rostrum almost straight in basal part, distally rather strongly tapering towards apex. Margins strongly elevated continuing in rostral carinae on carapax. Lateral rostral margin bearing 3 prominent teeth in distal half, on right side the third distal tooth (from base) is smaller than the others, few short hairs are present on outer margins. Rostral carinae extending as slight elevation

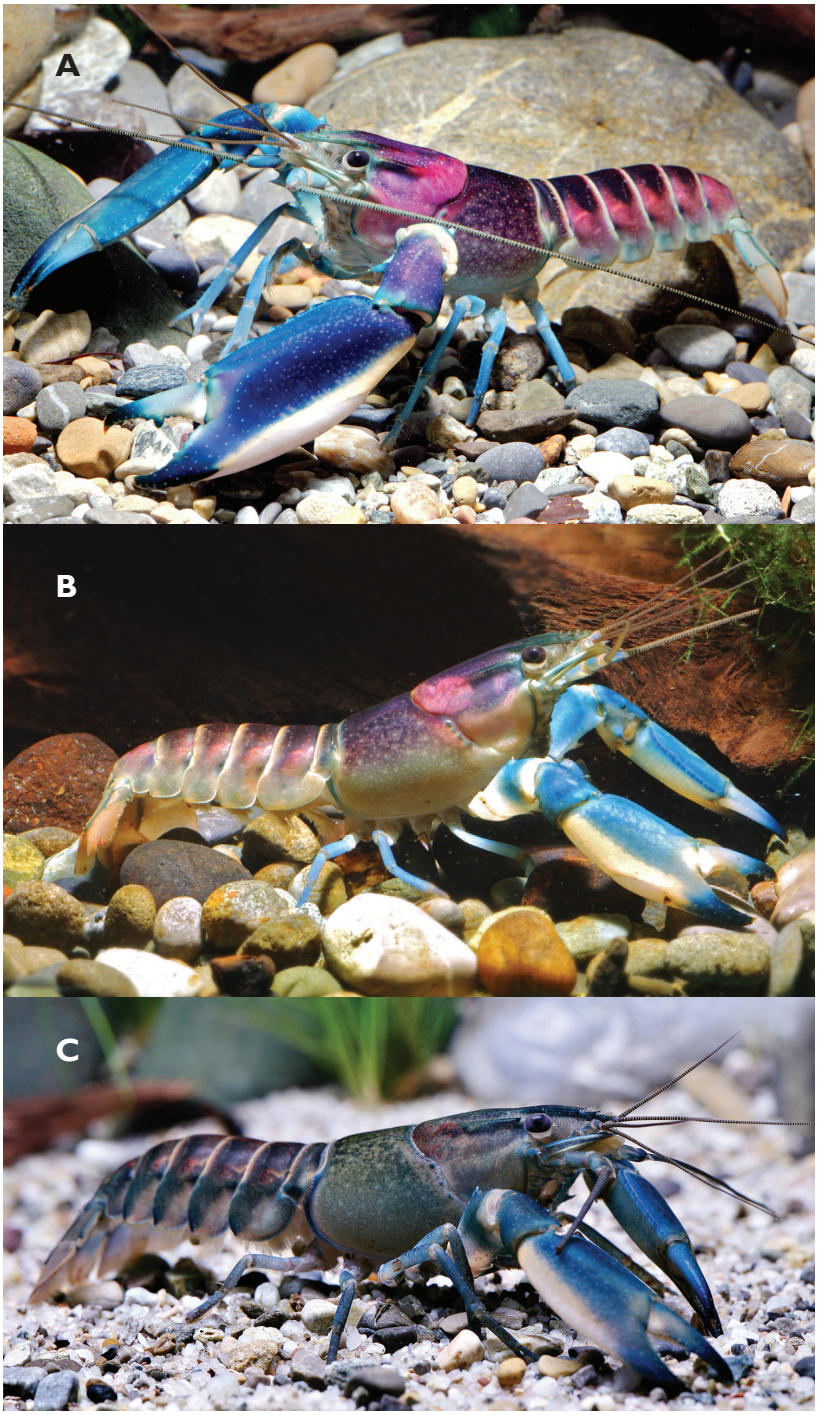

Figure 1. *Cherax* (*Astaconephrops*) *pulcher* sp. n. **A** adult male from Aquarium Dietzenbach **B** immature male from Hoa Creek, West Papua **C** female from aquarium import (not listed in material examined) from Indonesia.

Figure 2. *Cherax* (*Astaconephrops*) *pulcher* sp. n. holotype male (RMNH.CRUS.D.57217).

posteriorly on carapace fading just before reaching cervical groove. Postorbital ridges well developed terminating in slightly upturned corneous spines anteriorly, fading at two-thirds of occipital carapace length, posteriorly. Scaphocerite (Fig. 3B) broadest at midlength, convex in distal part becoming narrower in basal part; thickened lateral margin terminating in large corneous spine. Right scaphocerite 11 mm long and 4 mm wide. Antennulae and antennae typical for the genus. Mouthparts typical for the genus.

Eyes rather large; cornea globular, darkly pigmented, about as long as eyestalk; eyestalk slightly narrower than cornea. Epistome broadly triangular, anteriorly becoming lance-shaped, scattered setae present, with corneous spine at anterior tip, lateral surface with small tubercles; central surface smooth, excavate.

Coxocerite of antennal peduncle with acute tooth anteriorly; basicerite with strong lateral spine. Cervical groove distinct, non-setose. Surface anterior to cervical groove smooth, anterior branchial margin at junction with cervical groove with 3, anteriorly directed, rather closely set spines just posterior to groove, uppermost at level of antennae. Areola length 13 mm narrowest width 9 mm. Length of areola 34.6% of total length of carapace (45 mm).

First pereopods equal in form and size. Right chelae (Fig. 3) 41 mm long and 8 mm high, 17 mm wide, strongly compressed. Fingers shorter than palm (dactylus 16 mm long). Dactylus broad at base, tapering slightly towards tip, becoming about 1/3 as broad as at base. Tip with sharp, corneous, hooked tooth pointing outwards at an angle of 45°. Cutting edge of dactyl with a continuous row of rather small granular teeth and one large prominent tooth at about middle of cutting edge. Ventral and dorsal surface of movable finger with scattered punctuation. Fixed finger triangular, merging gradually into palm, ending in sharp, corneous, hooked tooth, standing almost perpendicular to axis of finger. Upper surface of palm practically smooth, slightly pitted, more densely

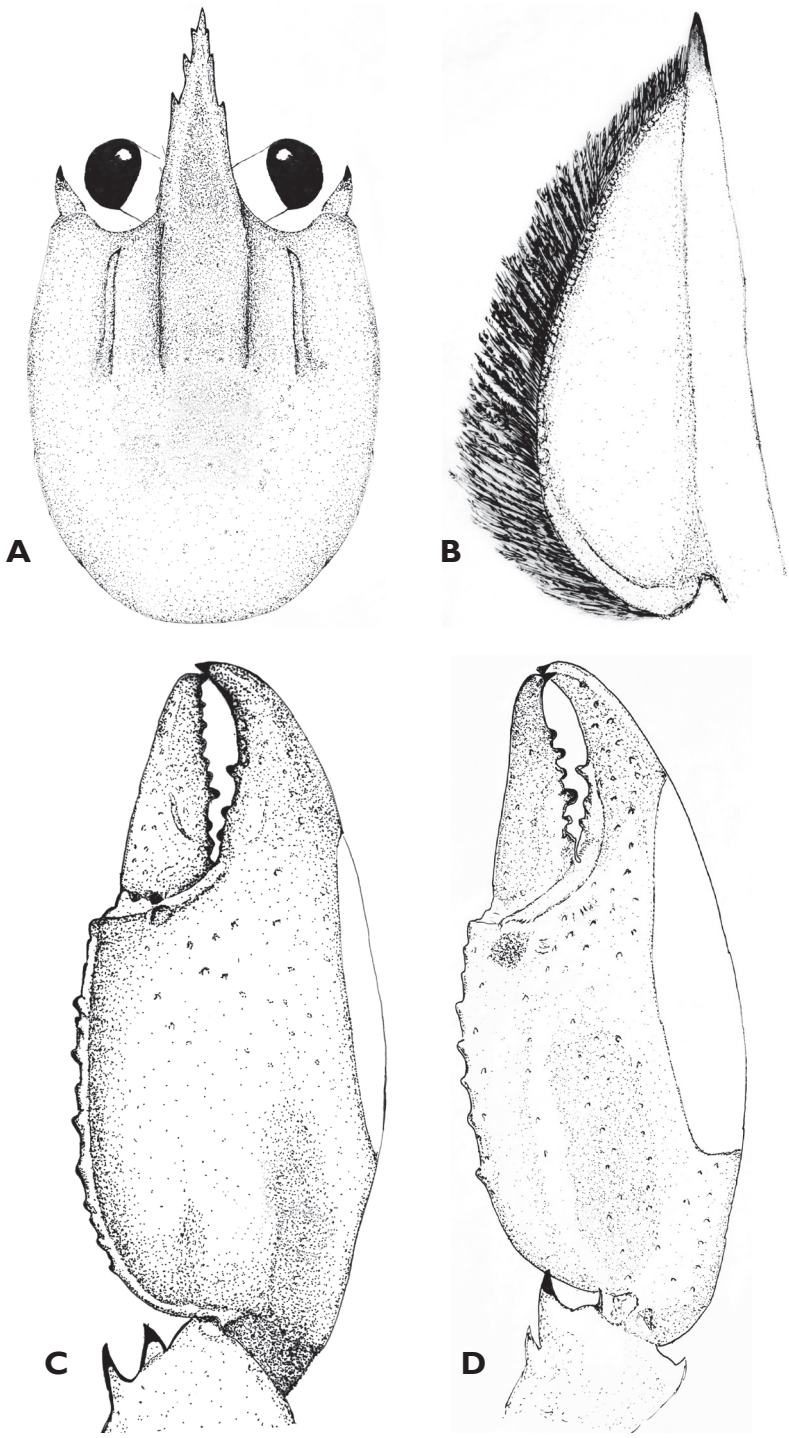

Figure 3. *Cherax* (*Astaconephrops*) *pulcher* sp. n. holotype male (RMNH.CRUS.D.57217) **A** dorsal view carapace **B** scaphocerite **C** dorsal view right chelae **D** ventral view left chelae.

Figure 4. *Cherax* (*Astaconephrops*) *pulcher* sp. n. holotype male (RMNH.CRUS.D.57217) dorsal view of rostrum.

pitted at margins. Chelae non-setose except for ventral cutting edge of fixed fingers. Setae short, present only in posterior part. First cheliped of adult male with soft, decalcified swollen area (Fig. 5A) in distal part of the lower margin,characteristic of the subgenus. Soft area extending from the first third of the fixed finger to the distal third of the fixed finger covering slightly more than half (22 mm) of the distal part of the lower margin. Carpus with slightly elevated part ventral, ending in a corneous spine. Three prominent spines present at the proximal part of the carpus. Ventral surface smooth and pitted but with median portion elevated into a prominent, broad ridge ending in corneous spine. Dorsal surface of merus smooth, with slight excavation in middle part, with a distomesial spine and a tubercle on the dorsolateral surface and dorsodistal margin. Dorsolateral margin with 1 corneous spine. Ventral surface with 3 large corneous spines. Ischium smooth with single spine on ventral surface.

Second pereopod reaching anteriorly about to middle of scaphocerite and a bit further when stretched. Fingers as long as palm, of same height. Short setae present on dactyl and fixed finger . Carpus slightly longer than palm. Merus about 1.5 times longer than carpus. Ischium about half as long as merus.

Third pereopod overreaching second. Fingers shorter than palm.

Fourth pereopod reaching distal margin of scaphocerite. Dactylus with corneous tip. Short scattered setae present. Propodus more than twice as long as dactylus, about 1.5

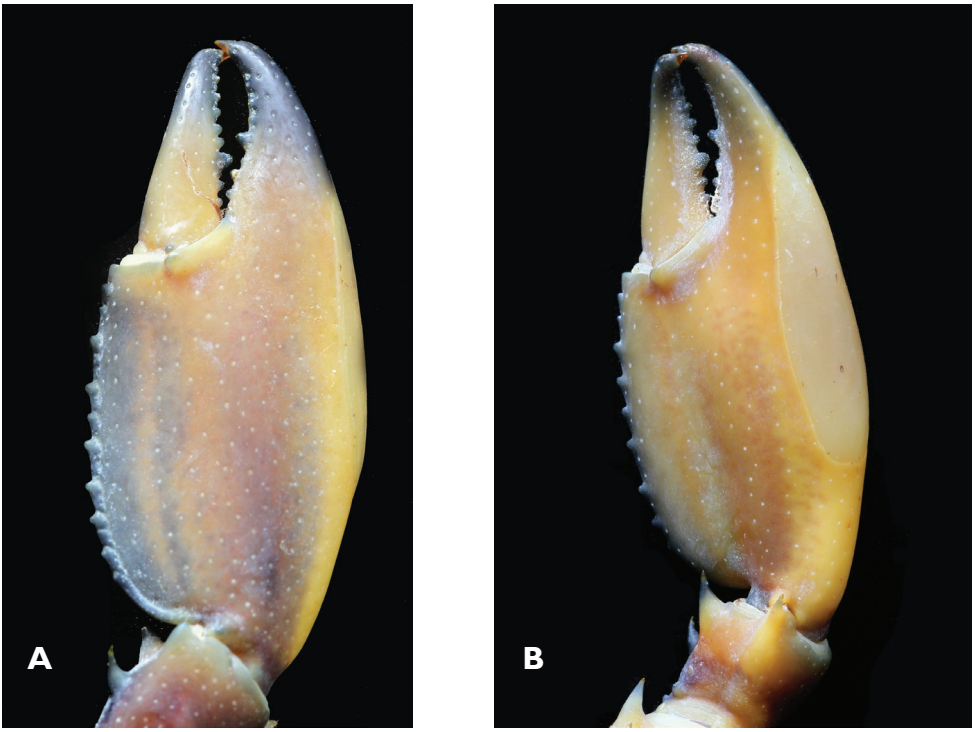

Figure 5. *Cherax* (*Astaconephrops*) *pulcher* sp. n. holotype male (RMNH.CRUS.D.57217) **A** right first chela, dorsal aspect **B** left first chela, ventral aspect.

times as long as carpus; somewhat flattened, carrying many stiff setae on lower margin. Merus just slightly longer than propodus.

Fifth pereopod similar to fourth, slightly shorter.

Dorsal surface of pleon smooth in median region; pleura smooth, slightly pitted becoming densely pitted on sixth somite and telson. Telson with posterolateral spines. Uropodalm protopod with distal spine on mesial lobe. Exopod of uropod with two well defined spines. one distal spine on mesial lobe, with prominent median rib ending in a spine in middle of uropod. Posterior margin of proximal segment of exopod of uropod with row of small spines overlapping diaresis.

Description of paratype female (Fig. 6). Chela of first pereiopods equal, about 3 times as long as broad (30 mm and 11 mm respectively), with no decalcified areas on lower margin. Mesial margin of palm slightly elevated, forming slender serrated ridge with row of 9 small granular teeth. Cutting edge of dactyl with rather small granular teeth in posterior part and one slightly larger tooth in about middle. Cutting edge of fixed finger with small granules and one slightly larger granules. Small scattered short setae visible along ventral cutting edge of chelae, more dense in posterior area. Cervical groove distinct, non setose. 3 spines present on lateral surface of cephalothorax. At level of antenna, two weakly developed anteriorly directed spines present. Pleon just slightly narrower than cephalothorax (widths 16 mm and 17 mm respectively).

Figure 6. *Cherax* (*Astaconephrops*) *pulcher* sp. n., paratype female (RMNH.CRUS.D.57218).

Remarks. In young males, the first chelae resembles those of the female or is slightly broader. A young male of TL 74 mm (non type material)has the decalcified area small, in the process of developing, present on both chelae, about 10 mm long.

Size. The males examined have a carapace length of 35–47 mm, and a total length of 75–98 mm (n = 11); the females have a carapace length of 37–39 mm and a total length of 83–90 mm (n = 2).

Coloration. The living animals (Fig. 1) are coloured as follows: Chelae light blue to dark blue, decalcified swollen area in distal part of the lower margin white or cream coloration, rostrum greenish blue. Anterior part of the cephalothorax pinkish to striking pink fading laterally to a greenish grey. Walking legs light blue to dark blue. Dorsal pleon dark blue to black becoming pinkish grey and cream coloured to the margins. Some individuals greenish-grey with few pinkish spots on pleon. Chela light blue with cream coloured margins. Walking legs bluish. Distal margin of tail-fan cream to pinkish.

Systematic position. The presence of a decalcified area on the lower margin of the chelae of the first pereiopods in adult males shows that the new species belongs to the subgenus *Astaconephrops*. Seven species/subspecies are known from New Guinea: *Cherax* (*Astaconephrops*) *lorentzi lorentzi* Roux, 1911; *C.*(*A.*) *lorentzi aruanus* Roux, 1911; *C.* (*A.*) *minor* Holthuis, 1996; *C.* (*A.*) *monticola* Holthuis, 1950; *C.* (*A.*) *misolicus* Holthuis, 1949; *C.* (*A.*) *albertisii* (Nobili, 1899) and *C.* (*A.*) *boesemani* Lukhaup & Pekny, 2008.

Etymology. The name is derived from the Latin "pulcher" meaning beautiful, alluding to the colourful appearance of the species.

Ecology. Known only from the Hoa Creek and the general Hoa Creek Drainage area. The water is clear, and has pH 6.6. Currents are strong in the narrower parts of the creek, including the upper reaches. The substrate of the creek is rocky, and mostly covered with sand, stones and large rocks. To improve the knowledge of the distribution of the species more collecting trips are necessary.

Discussion

With the current description of the new species of *Cherax* from the Teminabuan Region, Kepala Burung, West Papua, Indonesia, 19 species of *Cherax* are now known from Indonesia (Lukhaup and Pekny 2008b). Other than the very distinctive and different colour pattern, the new species is morphologically very similar to *Cherax boesemani* Lukhaup & Pekny (2008a). *Cherax boesemani* differs from *C. pulcher* sp. n. in size, coloration, the shape of the chelae and the shape of the cephalothorax. *Cherax boesemani* reaches a TL up to 25 cm while *C. pulcher* sp. n. reaches a maximum length up to 12 cm body length (Lukhaup and Pekny 2014). The body colour of *C. boesemani* is usually a dark red to brown, some individuals orange red, greenish gray. The chelae of *C. boesemani* are variable in colour but mostly red to black with pinkish margins and black tips, sometimes beige, olivaceous beige, olivaceous brown, olivaceous green, reddish brown, purplish. The chelae coloration of *C. pulcher* sp. n. is light blue to dark blue and cream or white distally. The chelae of *C. boesemani* are 5.4 times as long as high, while in contrast in *C. pulcher* sp. n. they are 5.1 times as long as high.

Cherax boesemani is a species having a narrower areola, thus better adapted to bodies of standing, warmer water, like pools or lakes. In contrast, *C. pulcher* sp. n. has a wider areola and the body shape compared to *C. boesemani* is more slender, thus it is adapted to fast flowing water with higher dissolved oxygen levels. In general, lake crayfish also get bigger in size then the creek or river species.

The type localities of *C. boesemani* (see Lukhaup and Pekny 2008a) and *C. pulcher* sp. n. are relatively close, although they are in separate valleys. *Cherax boesemani* was found about 22 km east of the type locality of *C. pulcher* sp. n. The habitat of *C. pulcher* sp. n. is clear, fast flowing creeks while *C. boesemani* is found only in Ajamaru Lake and the Ajamaru River.

It is also necessary to briefly comment on the possible threats faced by the new species. As *C. pulcher* sp. n. is collected in large numbers for the global aquarium trade, as well as for food for the growing local population, the crayfish population will invariably be adversely impacted. According to local collectors in the area and the city of Sorong, the populations of the species have been decreasing in the last few years. Clearly, the continued collection of these crayfish for the trade is not a sustainable practice, and if the popularity of the species continues, a conservation management plan will have to be developed, including a captive breeding program.

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References

Ahyong ST (2014) Diversity and distribution of Australian freshwater crayfish with a check-list of the world Parastacidae and a key to the genera (Decapoda, Astacidea, Parastacoidea). Advances in Freshwater Crustacean Systematics and Biology. Crustaceana Monographs 19: 245–271.

Erichson WF (1846) Übersicht der Arten der Gattung *Astacus*. Archiv fur Naturgeschichte 12: 86–103, 375–377.

Holthuis LB (1949) Decapoda Macrura with a revision of the New Guinea Parastacidae. Zoological results of the Dutch New Guinea Expedition 1939. No. 3. Nova Guinea (n. ser.) 5: 289–330, pls. 2–9.

Holthuis LB (1956) Native fisheries of freshwater Crustacea in Netherlands New Guinea. Contributions to New Guinea Carcinology. I. Nova Guinea (n. ser.) 7(2): 123–137, figs 1–3, pls. 1–8.

Holthuis LB (1958) Freshwater Crayfish in Netherlands New Guinea Mountains. South Pacific Commission Quarterly Bulletin 8(2): 36–39, 7 figs.

Holthuis LB (1982) Freshwater Crustacea Decapoda of New Guinea. In: Gressitt JL (Ed.) Biogeography and ecology of New Guinea, vol. 2. Monographiae Biologicae 42: 603–619, figs 1–5. doi: 10.1007/978-94-009-8632-9_28

Holthuis LB (1986) The freshwater crayfish of New Guinea. Freshwater Crayfish 6: 48–58, figs 1–8.

Holthuis LB (1996) *Cherax* (*Astaconephrops*) *minor* new species, a parastacid from the mountains of Irian Jaya (W. New Guinea) Indonesia (Crustacea: Decapoda: Parastacidae). Zoologische Mededelingen Leiden 70(24): 361–366, figs 1–2.

Lukhaup C, Pekny R (2006) *Cherax* (*Cherax*) *holthuisi*, a new species of crayfish (Crustacea: Decapoda: Parastacidae) from the centre of the Vogelkop Peninsula in Irian Jaya (West New Guinea), Indonesia. Zoologische Mededelingen Leiden 80–1(7): 101–107, figs 1–4.

Lukhaup C, Pekny R (2008a) *Cherax* (*Astaconephrops*) *boesemani*, a new species of crayfish (Crustacea: Decapoda: Parastacidae) from the centre of the Vogelkop Peninsula in Irian Jaya (West New Guinea), Indonesia. Zoologische Mededelingen Leiden 82(33): 331–340, figs 1–8.

Lukhaup C, Pekny R (2008b) Süßwasserkrebse aus aller Welt Gebundene Ausgabe. Dähne Verlag, Ettlingen.

Lukhaup C, Pekny R (2014) Wirbellose - Garnelen, Krebse, Krabben & Schnecken im Süßwasseraquarium. Gebundene Ausgabe. Dähne Verlag, Ettlingen, 300 pp.

Lukhaup C, Herbert B (2008) *Cherax* (*Cherax*) *peknyi* sp. nov., a new species of crayfish (Crustacea: Decapoda: Parastacidae) from the Fly River Drainage, Western Province, Papua New Guinea. Memoirs of the Queensland Museum 52(2): 213–219.

Huxley TH (1879) The Crayfish: an Introduction to the Study of Zoology. C. Kegan Paul & Co., London.

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RESEARCH ARTICLE

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Significance of hind wing morphology in distinguishing genera and species of cantharid beetles with a geometric morphometric analysis

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Abstract

There remain some difficulties in delimitation of related genera or sibling species for cantharid beetles, because the traditionally taxonomic method and morphological characters have not been updated or introduced. In the present study, we firstly use the landmark-based geometric morphometrics to analyze and compare the hind wings of nine species belonging to three genera of Cantharinae to ascertain whether this approach may be used as a reliable method in the study of the taxonomy of this group. The results show that the shape differences of the hind wings among genera seem more variable than that within each genus, and the variations for each species are different from one another, as shown in the principal component analyses. And the canonical variates analyses show that there are significant differences among the genera and the species of each genus, which demonstrates that the hind wing shape can be diagnostic for both generic and specific identification of the cantharid beetles. This study sheds new light into clarifying the taxonomic uncertainties of Cantharidae, and lays a foundation for further studies on the evolution of the cantharid hind wing shape.

Keywords

Geometric morphometrics, hind wing morphology, Cantharidae, taxonomy

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Introduction

The Cantharinae represents a subfamily of beetles belonging to the family Cantharidae (Bouchard et al. 2011). To date, it has approximately 2000 species belonging to 43 genera (Yang 2010, Švihla 2011), which are widely distributed in the Holoarctic and Oriental regions (Brancucci 1980). Traditionally, the taxonomy of this group is mainly based on the structure of male genitalia and tarsal claws. However, it is impossible to accurately identify all species by only using these characters, especially for the morphologically similar sibling species, such as *Falsopodabrus himalaicus* species complex (Yang et al. in press). Moreover, it is not easy to clarify the status of some species among the related genera, such as *Habronychus* (*Monohabronychus*) *multilimbatus* (Pic, 1910), which was transferred several times (Okushima 2003, Švihla 2004, Brancucci 2007) in the *Stenothemus* genera complex (Švihla 2004). These difficulties underline the need for further studies to clarify the taxonomy of cantharid beetles either by searching for new morphological characters of high diagnostic value or applying alternative effective methods.

It is well-known that wing shape of insects exhibits a high heritability in nature (Bitner-Mathé and Klaczko 1999, Moraes et al. 2004), wing morphology is of a primary importance to entomologists interested in systematics. It was Comstock (1893) who first popularized the use of insect wing venation for traditional classification (Kunkel 2004). Since the 1970's, several authors have begun to use the insect wings especially 2D morphometrical studies in systematics and phylogeny (Plowright and Stephen 1973, Rohlf 1993, Klingenberg 2003, Gumiel et al. 2003). Geometric morphometrics utilizes powerful and comprehensive statistical procedures to analyze shape differences of a morphological feature, using either homologous landmarks or outlines of the structure (Rohlf and Marcus 1993, Marcus and Corti 1996, Adam et al. 2004), and it is considered to be the most rigorous morphometric method (Gilchrist et al. 2000, Debat et al. 2003). Wings are excellent structure for studying morphological variation because they are basically 2-dimensional and the venation provides many well-defined morphological landmarks (Gumiel et al. 2003), the interactions of the veins, which are easy for identification and able to capture the general shape of the wing (Bookstein 1991). Among insects, the use of geometric morphometric analysis to study wing venation has been useful in identification at the individual level (Baylac et al. 2003, Dujardin et al. 2003, Sadeghi et al. 2009), in distinguishing sibling species (Matias et al. 2001, De la Riva et al. 2001, Villegas et al. 2002, Klingenberg and Savriama 2002, Roggero and Dentrèves 2005, Aytekin et al. 2007, Francuski et al. 2009, Tüzün 2009) and in delimitation among the genera (Baracchi et al. 2011). However, this modern effective methodology has not been applied in the studies of cantharid beetles until now.

In Cantharidae, the venation of hind wings was suggested to be of diagnostic value in the subfamily level based on the comparative morphology by Brancucci (1980). But within the subfamily, the variables of the veins are shown to be quantitative in metric properties, which can not be studied well by the traditional morphometrics, so it remains unknown whether the hind wing morphology contributes to the delimitation of genera or species or not. Thus in the present study, we apply the landmark-based

geometric morphometric method to quantify and analyze wing morphological features in nine species belonging to three genera of Cantharinae, including *Lycocerus* Gorham, 1889 (sensu Okushima 2005, more than 300 species in the world), *Prothemus* Champion, 1926 (60 species in total), and *Themus* Motschulsky, 1838 (approximately 250 species worldwide), which are all mostly distributed in the Oriental region. The central aim of the study is to evaluate wing shape variation and test the possible use of wing shape patterns for generic or specific taxonomy of Cantharinae.

Material and method

Sample collections

Hind wings of the following Cantharinae species (Table 1) are used in this study. Prior to geometric morphometric analysis, identification of specimens was performed using other morphological characters of adults (Yang 2010). The materials of the representative species are deposited in the Museum of Hebei University, Baoding, China (**MHBU**) and Institute of Zoology, Chinese Academy of Sciences, Beijing, China (**IZAS**) respectively. The left hind wing of each specimen (215 wings in total) was removed from the body and mounted in neutral balsam between a microscope slide and a cover slip. For each species, the chosen male and female specimens are subequal in number.

Data acquisition

The images of hind wings were captured using a stereomicroscope Nikon SMZ1500 and attached video camera Canon 450D connected to a HP computer. They were annotated using the TpsUtil software (Rohlf 2010a). The coordinates of the landmarks (13 landmarks in total, Table 2) were digitized by the TpsDig2.16 software (Rohlf 2010b) as shown in Fig. 1.

Table 1. The number of specimens of each species used in the GM analysis.

Specific name	Number of specimens	
	male	female
Lycocerus asperipennis (Fairmaire, 1891)	9	11
Lycocerus metallescens (Gorham, 1889)	12	15
Lycocerus orientalis (Gorham, 1889)	13	13
Prothemus kiukiangensis (Gorham, 1889)	10	11
Prothemus limbolarius (Fairmaire, 1900)	10	10
Prothemus purpuripennis (Gorham, 1889)	11	14
Themus (*Telephorops*) *coelestis* (Gorham, 1889)	14	18
Themus (*Telephorops*) *impressipennis* (Fairmaire, 1886)	10	12
Themus (*Haplothemus*) *licenti* Pic, 1938	12	10

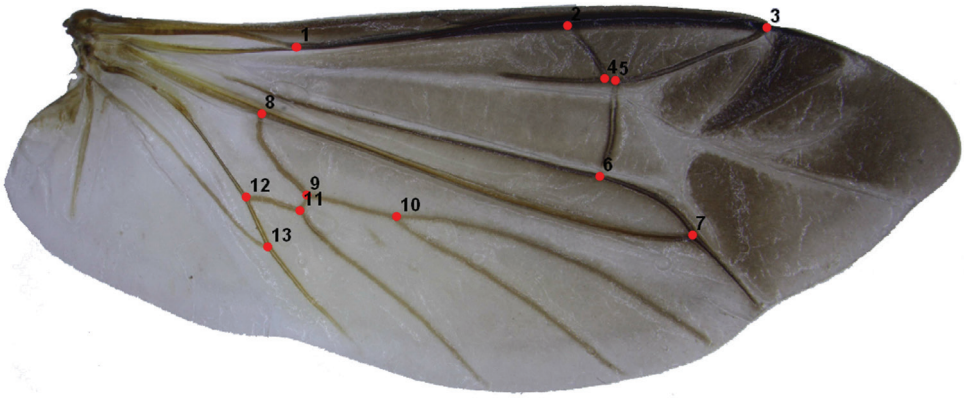

Figure 1. Hind wing of *Lycocerus asperipennis* showing digitizing landmarks.

Table 2. Landmarks of hind wing (according to veins nomenclature system by Kukalová-Peck and Lawrence (1993).

No.	Junctions of veins	No.	Junctions of veins
1	ScP (Subcosta Posterior) and RA	8	MP_{1+2} and MP_{3+4}
2	RA (Radius Anterior) and RA_{3+4}	9	MP_{3+4} and CuA_1 (Cubitus Anterior)
3	RA_{1+2} and RA_{3+4}	10	MP_4 and MP_3
4	RA_{3+4} and r3 (radial crossvein)	11	CuA_1 and CuA_2
5	RA_{3+4} and r4	12	CuA and CuA_{1+2}
6	r4 and RP (Radius Posterior)	13	AA (Anal Anterior) and CuA_{3+4}
7	RP and MP_{1+2} (Media Posterior)		

Geometric morphometric analyses

To examine the wing shape variation, the digitized landmark data is analyzed using MorphoJ software (Klingenberg 2011). The variability in the shape space is assessed using a Principal Component Analysis (PCA). To better visualize the shape variation, we present the average configuration of landmarks for each genus or species. Deformation grids are used to portray the resulting shape variations.

The relative similarity and discrimination of the genera or species is analyzed using Canonical Variates Analysis (CVA). CVA finds shape values that maximize group means relative to variation within groups, by assuming that covariate matrices are identical (Klingenberg 2010). This is an effective method for detecting differences among taxa. The statistical significance of pairwise differences in mean shapes is determined using permutation tests (10 000 replications) with Procrustes and Mahalanobis distances. Both tests are used to assess significance because *p*-values can differ due to the anisotropy (direction dependency) of shape variation (Klingenberg and Monteiro 2005).

To evaluate the role of wing size in discrimination among different genera or species, the centorid size (CS) was compared. In the absence of allometry, the CS is the only size measure uncorrelated with all the shape variables (Bookstein 1991). The CS

values are compared for genera and species respectively, because as a measurement of overall size variation of wings, they are far more sensitive than conventional measurements (Klingenberg et al. 1998). One-way analysis of variance (ANOVA) and Tukey HSD pairwise comparisons are employed to determine significant differences among genera or species. For visualizing size differences among groups, a 95% confidence intervals of the mean is computed using SPSS 13.0 and plotted in EXCEL.

Results

The shape variations of the hind wings in the genera *Lycocerus*, *Prothemus* and *Themus* is shown by the first two principal components of PCA (Fig. 2A). The thin plate spline visualizations show that the medial area (around by junctions Nos 9−13) contributes most to the shape differences among the genera, especially the situation of the junction of MP_4 and MP_3 (No. 10) is most variable in *Themus*, while least in *Lycocerus*, and similar for the junction of ScP and RA (No. 1). Also, the junctions of r4 and RP (No. 6) and RP and MP_{1+2} (No. 7) appear more variable in *Themus* than in *Lycocerus* or *Prothemus*. Besides, the hind wing shape is more elongate in *Themus* than the other two genera. The centroid size (Fig. 6A, Table 7) is significantly different among the three genera (all $p<0.05$). The CVA scatterplot of shape differences for these genera (Fig. 2B) shows that each genus occupies different area. Mahalanobis distances among the three genera are significantly different in all pairwise comparisons ($p<0.05$), and Procrustes distances ($p<0.05$) are similar (Tables 3).

In *Lycocerus* (Fig. 3A), the thin plate spline visualizations show that the junction of MP_4 and MP_3 (No. 10) is less variable in *L. orientalis* than in *L. asperipennis* or *L. metallescens*, and MP_{3+4} and CuA_1 (No. 9) is more variable in *L. asperipennis* than the other two. In *Prothemus* (Fig. 4A), the junction of MP_4 and MP_3 (No. 10) is most variable in *P. kiukiangensis*, while least in *P. purpuripennis*, and AA and CuA_{3+4} (No. 13) is less variable in *P. chinensis* than the other two. In *Themus* (Fig. 5A), the junction of ScP and RA (No. 1) is most variable in *T. licenti*, while least in *T. impressipennis*. The centroid size (Fig. 6B, Table 7) is significantly different between *L. asperipennis* and *L. orientalis* ($p=0.001$) or *L. metallescens* ($p=0.001$), *P. chinensis* and *P. kiukiangensis* ($p=0.005$) or *P. purpuripennis* ($p=0.002$), but others are not ($p>0.05$). The CVA scatterplots of shape differences for each genus (Fig. 3B, 4B, 5B) all show that each species occupies different area. Mahalanobis distances among the three species of each genus are significantly different in all pairwise comparisons ($p<0.05$), and Procrustes distances are similar ($p<0.05$) (Tables 4, 5, 6).

Table 3. Difference in the hind wing shapes among the genera *Lycocerus*, *Pothemus* and *Themus*. Mahalanobis distances (left) & Procrustes distances (right): *p*-values (above); distances between populations (below).

	Lycocerus	***Pothemus***	***Themus***	***Lycocerus***	***Pothemus***	***Themus***
Lycocerus	—	<.0001	<.0001	—	<.0001	<.0001
Pothemus	4.6396	—	<.0001	0.0456	—	<.0001
Themus	10.8932	10.446	—	0.1323	0.1088	—

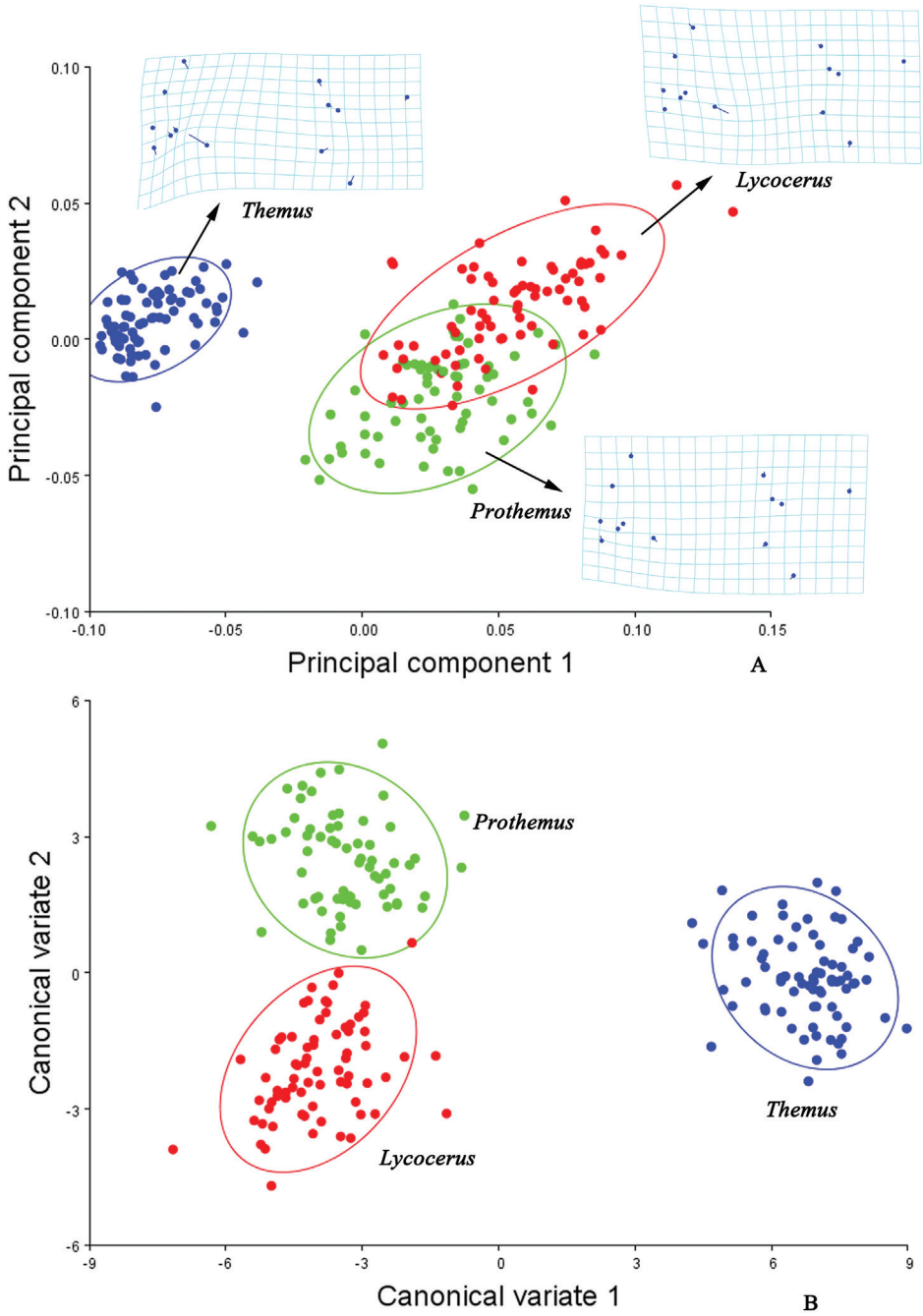

Figure 2. Shape variables of the hind wings in the genera of *Lycocerus*, *Prothemus* and *Themus*. **A** principal component analysis (PCA) of hind wing configuration. Plot of PC1 (74.39% of total variation) and PC2 (8.52% variation) showing 90% confidence ellipses of population means **B** canonical variate analysis (CVA) of same matrix, also showing 90% confidence ellipses of population means. The averaged shape of each genus is depicted as deformations using thin plate splines.

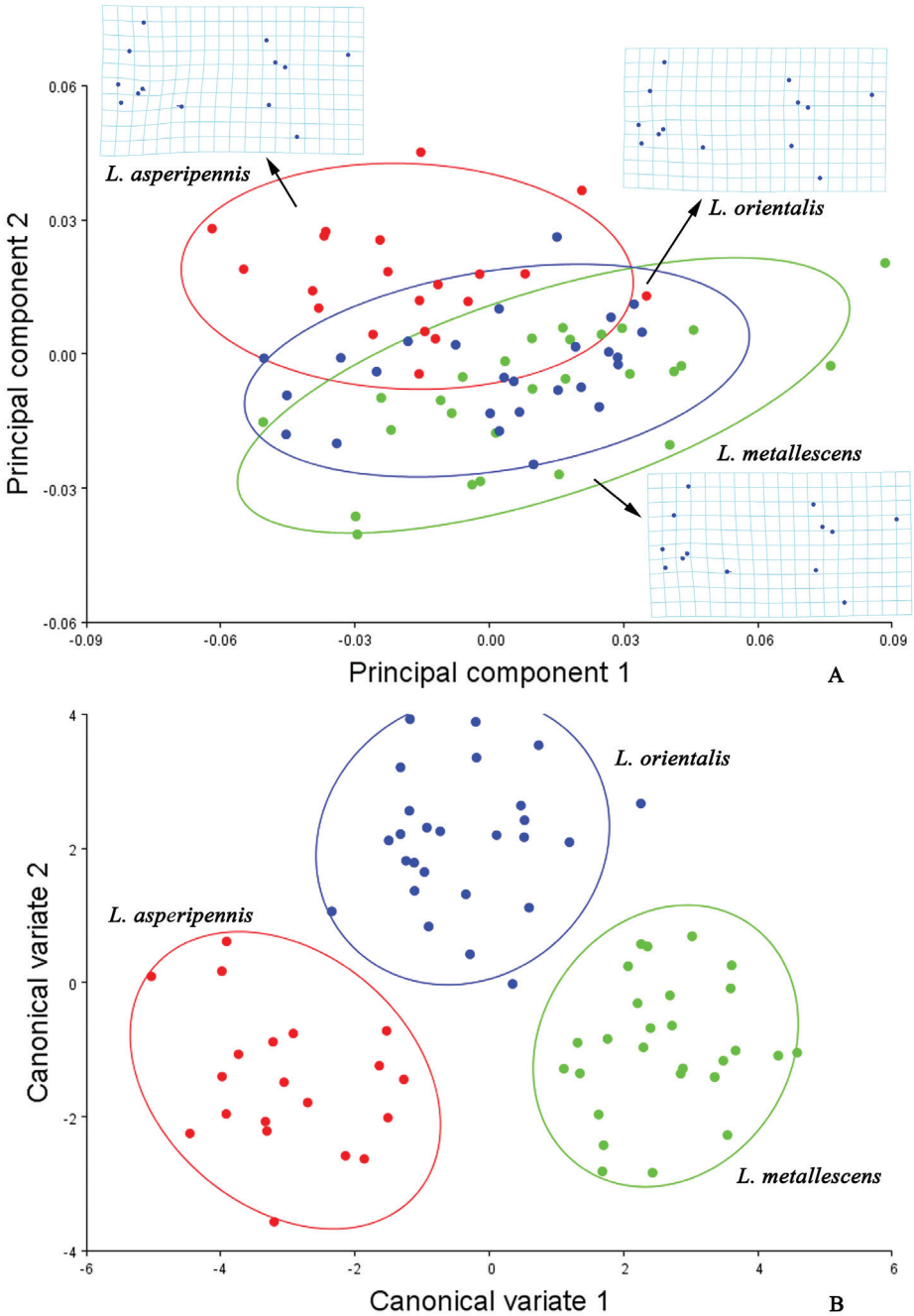

Figure 3. Shape variables of the hind wings in the *Lycocerus* species. **A** principal component analysis (PCA) of hind wing configuration. Plot of PC1 (49.02% of total variation) and PC2 (14.92% variation) showing 90% confidence ellipses of population means **B** canonical variate analysis (CVA) of same matrix, also showing 90% confidence ellipses of population means. The averaged shape of each species is depicted as deformations using thin plate splines.

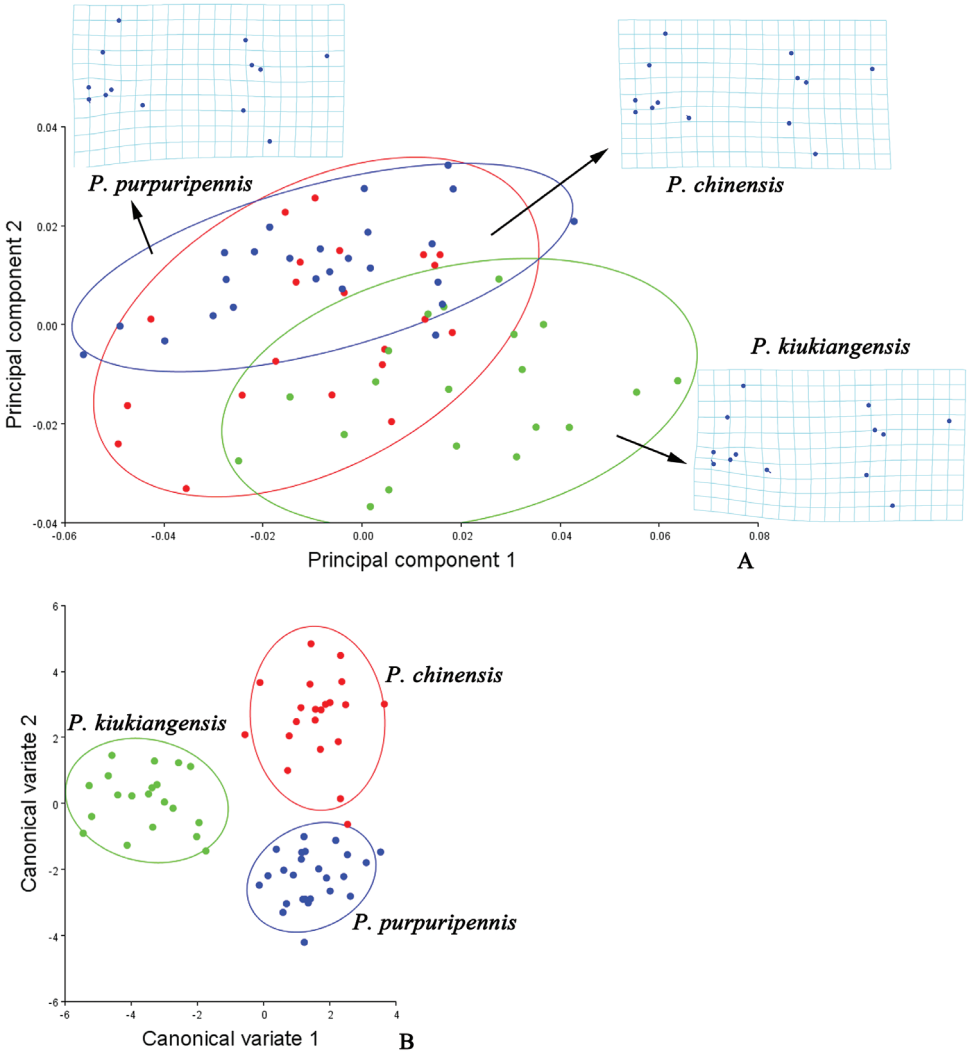

Figure 4. Shape variables of the hind wings in the *Prothemus* species. **A** principal component analysis (PCA) of hind wing configuration. Plot of PC1 (38.40% of total variation) and PC2 (15.88% variation) showing 90% confidence ellipses of population means **B** canonical variate analysis (CVA) of same matrix, also showing 90% confidence ellipses of population means. The averaged shape of each species is depicted as deformations using thin plate splines.

Table 4. Difference in the hind wing shapes among the species of *Lycocerus*. Mahalanobis distances (left) & Procrustes distances (right): *p*-values (above); distances between populations (below).

	L. metallescens	*L. asperipennis*	*L. orientalis*	*L. metallescens*	*L. asperipennis*	*L. orientalis*
L. metallescens	—	<.0001	<.0001	—	<.0001	0.0466
L. asperipennis	5.6866	—	<.0001	0.0413	—	0.0003
L. orientalis	4.2970	4.4457	—	0.0182	0.0321	—

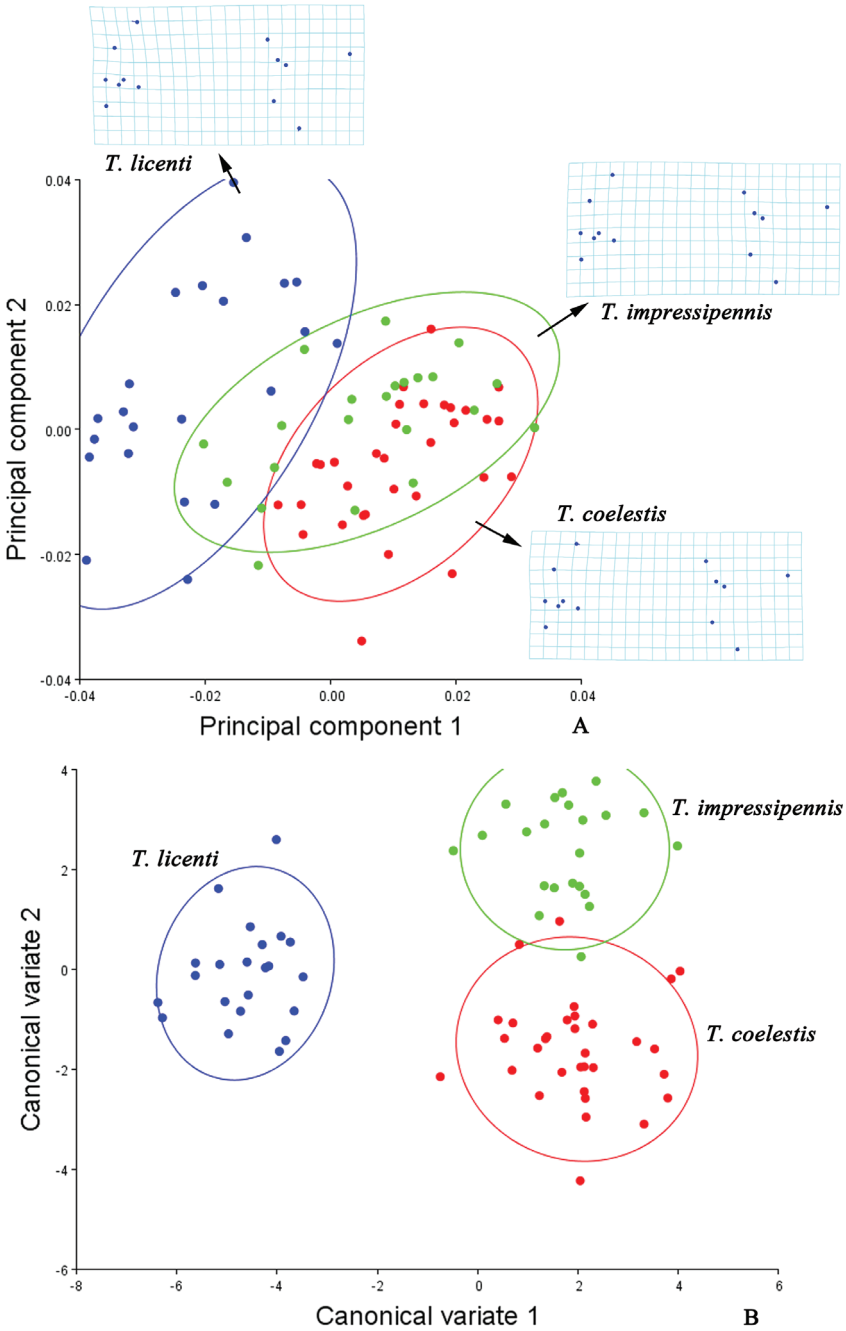

Figure 5. Shape variables of the hind wings in the *Themus* species. **A** principal component analysis (PCA) of hind wing configuration. Plot of PC1 (32.87% of total variation) and PC2 (16.48% variation) showing 90% confidence ellipses of population means **B** canonical variate analysis (CVA) of same matrix, also showing 90% confidence ellipses of population means. The averaged shape of each species is depicted as deformations using thin plate splines.

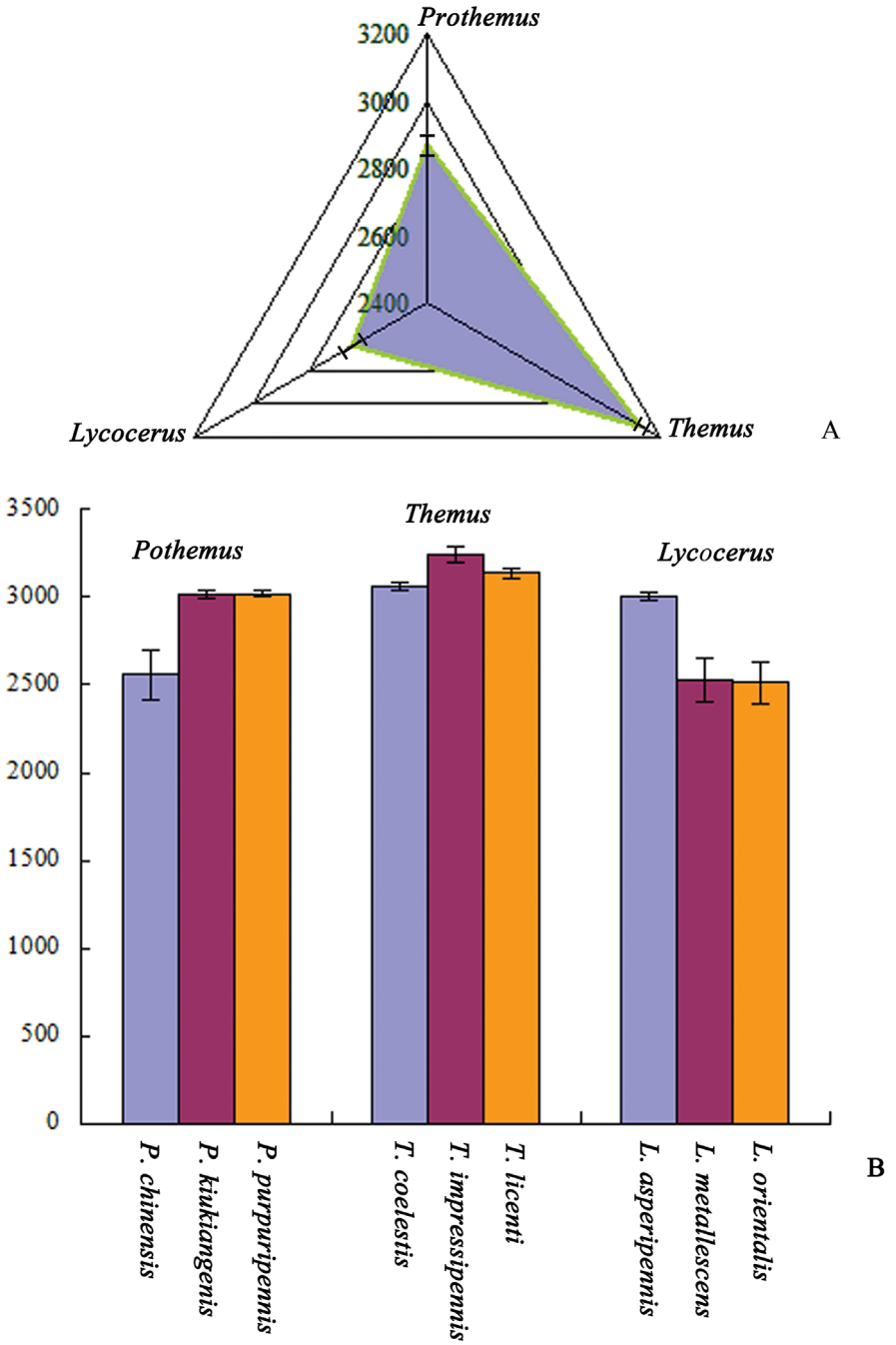

Figure 6. Comparisons of centroid size variables among different groups: **A** *Lycocerus*, *Prothemus* and *Themus* **B** *Lycocerus asperipennis*, *L. metallescens* and *L. orientalis*; *Prothemus chinensis*, *P. kiukiangensis* and *P. purpuripennis*; *Themus licenti*, *T. coelestis* and *T. impressipennis*.

Table 5. Difference in the hind wing shapes among the species of *Prothemus*. Mahalanobis distances (left) & Procrustes distances (right): *p*-values (above); distances between populations (below).

	P. chinensis	***P. kiukiangensis***	***P. purpuripennis***	***P. chinensis***	***P. kiukiangensis***	***P. purpuripennis***
P. chinensis	—	<.0001	<.0001	—	<.0001	0.0002
P. kiukiangensis	5.7352	—	<.0001	0.0376	—	<.0001
P. purpuripennis	4.8174	5.5146	—	0.0247	0.0381	—

Table 6. Difference in the hind wing shapes among the species of *Themus*. Mahalanobis distances (left) & Procrustes distances (right): *p*-values (above); distances between populations (below).

	T. licenti	***T. coelestis***	***T. impressipennis***	***T. licenti***	***T. coelestis***	***T. impressipennis***
T. licenti	—	<.0001	<.0001	—	<.0001	<.0001
T. coelestis	6.7942	—	<.0001	0.0363	—	0.0001
T. impressipennis	6.8548	3.9959	—	0.0311	0.016	—

Table 7. Tukey HSD for the CS among different groups: *p*-values (above); mean differences (below). Asterisk (*) indicates the mean difference is significant at the 0.05 level.

CS among different genera			
	Lycocerus	***Prothemus***	***Themus***
Lycocerus	—	0.006	0
Prothemus	218.52316401(*)	—	0.001
Themus	483.54109456(*)	-265.01793055(*)	—
CS among the species of *Lycocerus*			
	L. asperipennis	***L. metallescens***	***L. orientails***
L. asperipennis	—	0.001	0.001
L. metallescens	474.67493257(*)	—	1
L. orientails	489.29359311(*)	14.61866054	—
CS among the species of *Prothemus*			
	P. chinensis	***P. kiukiangensis***	***P. purpuripennis***
P. chinensis	—	0.005	0.002
P. kiukiangensis	-456.74308033(*)	—	1
P. purpuripennis	-460.37428735(*)	-3.63E+00	—
CS among the species of *Themus*			
	T. coelestis	***T. impressipennis***	***T. licenti***
T. coelestis	—	0.711	0.998
T. impressipennis	-183.8607895	—	0.992
T. licenti	-79.25669086	104.6040987	—

Discussion

The result of PCA shows that the shape differences of the hind wings among the genera *Lycocerus*, *Prothemus* and *Themus* (Fig. 2A) are mostly associated with the junctions of MP_4 and MP_3 (No. 10), ScP and RA (No. 1), r4 and RP (No. 6) and RP and MP_{1+2} (No. 7), and the shape of *Themus* is much more different from that of *Lycocerus* than *Prothemus*. Those variations within each genus (Figs 3A, 4A, 5A) appear in one or two

junctions, which are either same to that of the genera or not, such as MP_{3+4} and CuA_1 (No. 9) in *Lycocerus* and AA and CuA_{3+4} (No. 13) in *Pothemus*. This demonstrates that the shape differences among genera are much more variable than that within genus, and the variations among the species of each genus are different from one another.

The CVA results (Figs 2B, 3B, 4B, 5B) show that the three genera and the species of each genus are all successfully discriminated, since that Mahalanobis and Procrustes distances (Tables 3–6) for each group are significantly different ($p<0.05$). It suggests that the hind wing shape is useful for discrimination of both genus and species in Cantharinae by the geometric morphometrics. Also, the hind wing size is considered to be valuable in delineating the genera, but its role is uncertain for the species because of the inconsistent results in the three genera (Table 7).

Herein it can be concluded that the hind wing shape is useful for the discriminations of genera and species of Cantharinae. The geometric morphometrics represents a reliable tool not only in the taxonomic research but also in further study on the evolution of the hind wing shape of cantharid beetles.

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References

Adam DC, Rohlf FJ, Slice DE (2004) Geometric Morphometrics: Ten Years of Progress following the "Revolution". Italian Journal of Zoology 71: 5–10. doi: 10.1080/11250000409356545

Aytekin MA, Terzo M, Rasmont P, Çağatay N (2007) Landmark based geometric morphometric analysis of wing shape in *Sibiricobombus* Vogt (Hymenoptera: Apidae: *Bombus* Latreille). Annales de la Société Entomologique de France (n.s.) 43(1): 95–102. doi: 10.1080/00379271.2007.10697499

Baracchi D, Dapporto L, Turillazzi S (2011) Relevance of wing morphology in distinguishing and classifying genera and species of Stenogasterinae wasps. Contributions to Zoology 80(3): 191–199.

Baylac M, Villemant C, Simbolotti G (2003) Combing geometric morphometrics with pattern recognition for the investigation of species complex. Biological Journal of Linnean Society 80(1): 89–98. doi: 10.1046/j.1095-8312.2003.00221.x

Bitner-Mathé BC, Klaczko LB (1999) Heritability, phenotypic and genetic correlations of size and shape of *Drosophila mediopuncatata* wings. Heredity 83(6): 688–696. doi: 10.1046/j.1365-2540.1999.00606.x

Bookstein FL (1991) Morphometric tools for landmark data: Geometry and Biology. Cambridge University Press, Cambridge, 435 pp.

Bouchard P, Bousquet Y, Davies AE, Alonso-Zarazaga MA, Lawrence JF, Lyal CH, Newton AF, Reid CA, Schmitt M, Slipiński SA, Smith AB (2011) Family-group names in Coleoptera (Insecta). ZooKeys 88: 1–972. doi: 10.3897/zookeys.88.807

Brancucci M (1980) Morphologie comparee, evolution et systematique des Cantharidae (Insecta: Coleoptera). Entomologica Basiliensia 5: 215–388.

Comstock JH (1893) Evolution and Taxonomy. An essay on the application of the theory of natural selection in the classification of animals and plants, illustrated by a study of the evolution of the wings of insects. The Wilder Quarter-Century Book, Ithaca, New-York. [CD edition available on http://snapper.bio.umass.edu/kunkel/comstock/eassy/]

Debat V, Bégin M, Legout H, David JR (2003) Allometric and nonallometric components of *Drosophila* wing shape respond differently to developmental temperature. Evolution 57: 2773–2784. doi: 10.1111/j.0014-3820.2003.tb01519.x

De la Riva J, Le Pont F, Ali V, Matias A, Mollinedo S, Dujardin JP (2001) Wing geometry as a tool for studying the *Lutzumyia longipalpis* (Diptera: Pychodidae) complex. Memorias do Instituto Oswaldo Cruz 96: 1089–1094. doi: 10.1590/S0074-02762001000800011

Dujardin JP, Le Pont F, Baylac M (2003) Geometric versus interspecific differentiation of sand flies: a landmark data analysis. Bulletin of Entomological Research 93: 87–90. doi: 10.1079/BER2002206

Fairmaire L (1886) Descriptions de coléoptères de l'intérieur de la Chine (2. partie). Annales de la Société Entomologique de France (n.s.) 6(6): 303–356.

Fairmaire L (1891) Coléoptères de l'intérieur de la Chine. (7 partie). Bulletin ou Compte Rendus des Séances de la Société Entomologique de Belgique 35: clxxxvii–ccxxiii.

Fairmaire L (1900) Description de coléoptères nouveaux recueillis en Chine par M. de Latouche. Annales de la Société Entomologique de France (n.s.) 68 [1899]: 616–649.

Francuski Lj, Vujić A, Kovačević A, Ludoški J, Milankov V (2009) Identification of the species of the *Cheilosia variabilis* group (Diptera, Syrphidae) from the Balkan Peninsula using wing geometric morphometrics, with the revision of the status of *C. melanopa redi* Vujić, 1996. Contributions to Zoology 78(3): 129–140.

Gilchrist AS, Azevedo RBR, Partridge L, O'Higgins P (2000) Adaption and constraint in the evolution of *Drosophila melanogaster* wing shape. Evolution & Development 2: 114–124. doi: 10.1046/j.1525-142x.2000.00041.x

Gorham HS (1889) Descriptions of new speicies and a new genus of Coleoptera of the family Telephoridae. Proceedings of the Zoological Society 1889: 96–111.

Gumiel M, Catalá S, Noireau F, de Arias AR, Garcia A, Dujardin JP (2003) Wing geometry in *Triatoma infestans* (Klug) and *T. melanosoma* Martinez, Olmedo & Carcavallo (Hemiptera: Reduviidae). Systematic Entomology 28: 173–179. doi: 10.1046/j.1365-3113.2003.00206.x

Klingenberg CP (2003) Developmental instability as a research tool: using patterns of fluctuating asymmetry to infer the developmental origins of morphological integration. In: Polak M (Ed) Developmental instability, causes of consequences. Oxford University Press, New York, 427–442.

Klingenberg CP (2010) Evolution and development of shape: integrating quantitative approaches. Nature Genetics 11: 623–635. doi: 10.1038/nrg2829

Klingenberg CP (2011) MorphoJ: an integrated software package for geometric morphometrics. Molecular Ecology Resources 11: 353–357. doi: 10.1111/j.1755-0998.2010.02924.x

Klingenberg CP, Monteiro LR (2005) Distances and directions in multidimensional shape spaces: implications for morphometric applications. Systematic Biology 54: 678–688. doi: 10.1080/10635150590947258

Klingenberg CP, Savriama Y (2002) Geometric morphometrics of complex symmetric structures: Shape analysis of symmetry and asymmetry with Procrustes methods. Evolution 56(10): 1909–1920. doi: 10.1111/j.0014-3820.2002.tb00117.x

Klingenberg CP, Mcintyre GS, Zaklan SD (1998) Left-right asymmetry of fly wings and the evolution of body axes. Proceedings of the Society of London B, Biological Sciences 265: 1255–1259.

Kukalová-Peck J, Lawrence JF (1993) Evolution of the hind wings in Coleoptera. Canadian Entomologist 125(2): 181–258. doi: 10.4039/Ent125181-2

Kunkel JG (2004) Wing discrimination projects. http://marlin.bio.umass.edu/biology/kenkel/wing_discrim.html

Marcus LF, Corti M (1996) Overview of the new, or geometric morphometrics. In: Marcus LF, Corti M, Loy A, Naylor GJP, Slice DE (Eds) Advances in Mophometrics. NATO ASI Series A: Life Sciences, vol. 284. Plenum Press, New York, 1–13. doi: 10.1007/978-1-4757-9083-2_1

Matias A, De la Riva J, Torrez M, Dujardin JP (2001) *Rhodnius robustus* in Bolivia identified by its wings. Memorias do Instituto Oswaldo Cruz 96(7): 947–950. doi: 10.1590/S0074-02762001000700010

Moraes EM, Spressola VL, Prado PRR, Costa LF, Sene FM (2004) Divergence in wing morphology among sibling species of the *Drosophila buzzatii* cluster. Journal of Zoology Systematics Evolutionary Research 42: 154–158. doi: 10.1111/j.1439-0469.2004.00256.x

Pic M (1938) Malacodermes exotiques. L'Échange, Revue Linnéenne 54 [hors-texte] (472–474): 149–156, 157–160, 161–164.

Plowright RC, Stephen WP (1973) Evolutionary relationships in northern European *Bombus* and *Psithyrus* species (Apidae: Hymenoptera). Canadian Entomologist 105: 733–743. doi: 10.4039/Ent105733-5

Roggero A, Dentrèves PP (2005) Geometric morphometric analysis of wing variation between two populations of the *Scythris obscurella* species-group: geographic or interspecific differences? (Lepidoptera: Scythrididae). SHILAP Revista de Lepidopterologia 33(130): 101–112.

Rohlf FJ (1993) Relative warp analysis and an example of its application to mosquito wings. In: Marcus LF, Bello E, Garcia-Valdecasas A (Eds) Contributions to Morphometrics. Museo Nacional de Ciencias Naturales, Marid, 264 pp.

Rohlf FJ (2010a) tps-UTIL, File Utility Program, version 1.46. Department of Ecology and Evolution, State University of New York at Stony Brook, New-York.

Rohlf FJ (2010b) tps-DIG, Digitize Landmarks and Outlines, version 2.16. Department of Ecology and Evolution, State University of New York at Stony Brook, New-York.

Rohlf FJ, Marcus LF (1993) A revolution in morphometrics. Trends in Ecology and Evolution, 8: 129–132. doi: 10.1016/0169-5347(93)90024-J

Sadeghi S, Adriaens D, Dumont HJ (2009) Geometric morphometric analysis of wing shape variation in ten European populations of *Calopteryx splendens* (Harris, 1782). Odonatologia 38(4): 343–360.

Švihla V (2004) New taxa of the subfamily Cantharinae (Coleoptera, Cantharidae) from south-eastern Asia with notes on other species. Entomologica Basiliensia 26: 155–238.

Švihla V (2011) New taxa of the subfamily Cantharinae (Coleoptera: Cantharidae) from south-eastern Asia, with notes on other species III. Zootaxa 2895: 1–34.

Tüzün A (2009) Significance of wing morphometry in distinguishing some of the Hymenoptera species. African Journal of Biotechnology 8(14): 3353–3363.

Villegas J, Feliciangeli MD, Dujardin JP (2002) Wing shape divergence between *Rhodnius prolixus* from Cojedes (Venezuela) and *Rhodnius robustus* from Merida (Venezuela). Infection, Genetics and Evolution 2: 121–128. doi: 10.1016/S1567-1348(02)00095-3

Yang YX (2010) Study on the systematics of Cantharinae (Coleoptera, Cantharidae). PhD thesis, Chinese Academy of Sciences, Beijing, China.

Yang YX, Su JY, Yang XK, Bai M (in press) New insight to solve the confusing Taxonomy problem using geometric morphometrics: an Example from a new species of *Falsopodabrus* Pic (Coleoptera, Cantharidae). PLoS ONE.

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RESEARCH ARTICLE

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A new species of the brown lacewing genus *Zachobiella* Banks from China (Neuroptera, Hemerobiidae) with a key to species

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Abstract

The genus *Zachobiella* Banks, 1920 is reviewed and a new species *Zachobiella yunanica* **sp. n.** described from China. All species found in China are redescribed, and *Zachobiella submarginata* Esben-Petersen, 1929 is recorded from China for the first time. A key to the adults of *Zachobiella* is provided.

Keywords

Notiobiellinae, *Zachobiella*, China

Introduction

The genus *Zachobiella* was erected by Banks (1920) based on the type species *Zachobiella punctata*. This genus belongs to the subfamily Notiobiellinae (Nakahara 1960) and is distributed throughout southeast Asia and Australia. It is diagnosed by the following forewing characteristics: anterior radial trace bearing two prestigmal radial sectors, all posthumeral costal veinlets simple and trichosores not evident in the humeral area; the males also typically have highly ornate genitalic armature (Oswald 1993).

Banks (1939) described *Zachobiella hainanensis* from China based on single specimen collected from Hainan province; Nakahara (1966) subsequently described

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the species *Z. striata* from Taiwan. Presently, nine species are described world-wide (New 1988a, 1988b; Oswald 1993, 2014) with four species recorded from China, including the new species described herein from China.

In this paper, all the known species of genus *Zachobiella* in China are redescribed and illustrated, including detailed descriptions and illustrations of the new species *Zachobiella yunanica* sp. n.; *Zachobiella submarginata* Esben-Petersen is recorded from China for the first time. In addition, a key for identification of adults is also presented. All specimens are deposited in the Entomological Museum of China Agricultural University (CAU), Beijing.

Material and methods

Specimens were examined under an Optec SZ760 stereomicroscope. Images of wings were taken with a Nikon EOS D3200 digital camera attached to the stereomicroscope. The terminalia were observed under a Leica DM2500 compound microscope. Descriptions of colouration are based on observations under the stereomicroscope with direct light on specimens preserved in 75% ethyl alcohol. The abdominal apex with genitalia was cut off and heated in 10% sodium hydroxide for about 10–20 min and then transferred to an excavated slide with glycerin. After examination it was transferred to fresh 75% ethyl alcohol and stored in a microvial.

Wing venation terminology follows Oswald (1993) and Makarkin and Wedmann (2009). Terminology of genitalia follows Oswald (1993).

Abbreviations: **7s** 7th sternite; **8s** 8th sternite; **9s** 9th sternite; **7t** 7th tergite; **8t** 8th tergite; **9t** 9th tergite; **ect** ectoproct; **ehgs** extrahemigonarcus; **hgs** hemigonarcus; **ihgs** intrahemigonarcus; **med** mediuncus; **orb#** oblique radial branch of anterior radial trace (= radial sector).

Taxonomy

Key to species of *Zachobiella*

1 Small triangular dark spots present at the forks of longitudinal veins in forewing **2**

– Small triangular dark spots absent at the forks of longitudinal veins in forewing **6**

2 Only one crossvein present in hind wing **3**

– Two crossveins present in hind wing..... **5**

3 3ir1 located before the fork of orb2 in forewing..... ..... ***Z. submarginata*** **Esben-Petersen**

– 3ir1 located after the fork of orb2 in forewing **4**

4 Two gradate series present in forewing; male genitalia with both posterodorsal and posteroventral edges of ectoproct extending upwards into long arms…….....***Z. yunanica* sp. n.**

– Three gradate series present in forewing; male genitalia with only posteroventral edge of ectoproct extending upwards into long arm.....***Z. lobata* New**

5 Rs forked at the base in hind wing.....***Z. punctata* Banks**

– Rs forked in the middle in hind wing .....***Z. marmorata* Navás**

6 3ir1 located before the fork of orb2 in forewing.....**7**

– 3ir1 located after the fork of orb2 in forewing **8**

7 Approximately 12 segments of distal flagellum obviously darker than the others in antennae; obvious brown stripes present in forewing.....
.....***Z. striata* Nakahara**

– Basal half of antennae obviously darker than the others; obvious brown stripes absent in forewing ..... ***Z. jacobsoni* Esben-Petersen**

8 Two crossveins present in hind wing; pronotum brown while paler on sides....
.....***Z. pallida* Banks**

– Only one crossvein present in hind wing; pronotum yellowish-brown while brown longitudinal stripes present along both sides ... ***Z. hainanensis* Banks**

***Zachobiella yunanica* Zhao, Yan & Liu, sp. n.**
http://zoobank.org/7188F319-D5E8-4899-9213-26300007A24A
Figs 1, 5–8

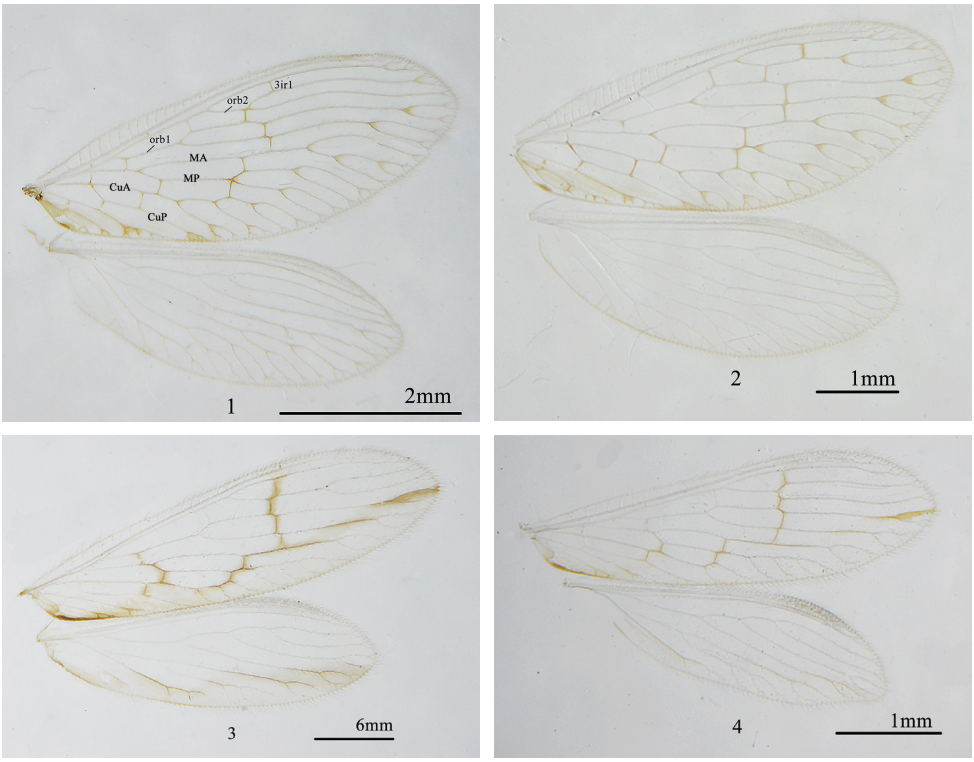
Diagnosis. Triangular dark spots present at the forks of longitudinal veins in forewing and 3ir1 present after the fork of orb2. Male: posterodorsal edge of 7th tergite slightly extending backwards; a pair of rough spiny projections present on the dorsal surface of the 8th tergite; posteroventral edge of the 9th tergite extending upwards with serrated inner margin from one third distally; both posterodorsal and posteroventral edges of ectoproct extending upwards into long arms, especially the posteroventral.

Measurements. Forewing length 5.4–6.0 mm, width 2.1–2.2 mm. Hind wing length 4.4–4.7 mm, width 1.7–1.9 mm. Body length 4.0–5.3 mm.

Description. *Head.* Yellowish-brown. Brown stripe present from the rear of eye to the mandible. Labial and maxillary palpi brown. Antenna light brown, more than fifty segments. Eyes black with a metallic luster.

Thorax. Yellowish-brown, with brown longitudinal stripes along both sides of tergites. Legs yellowish-brown with no spots.

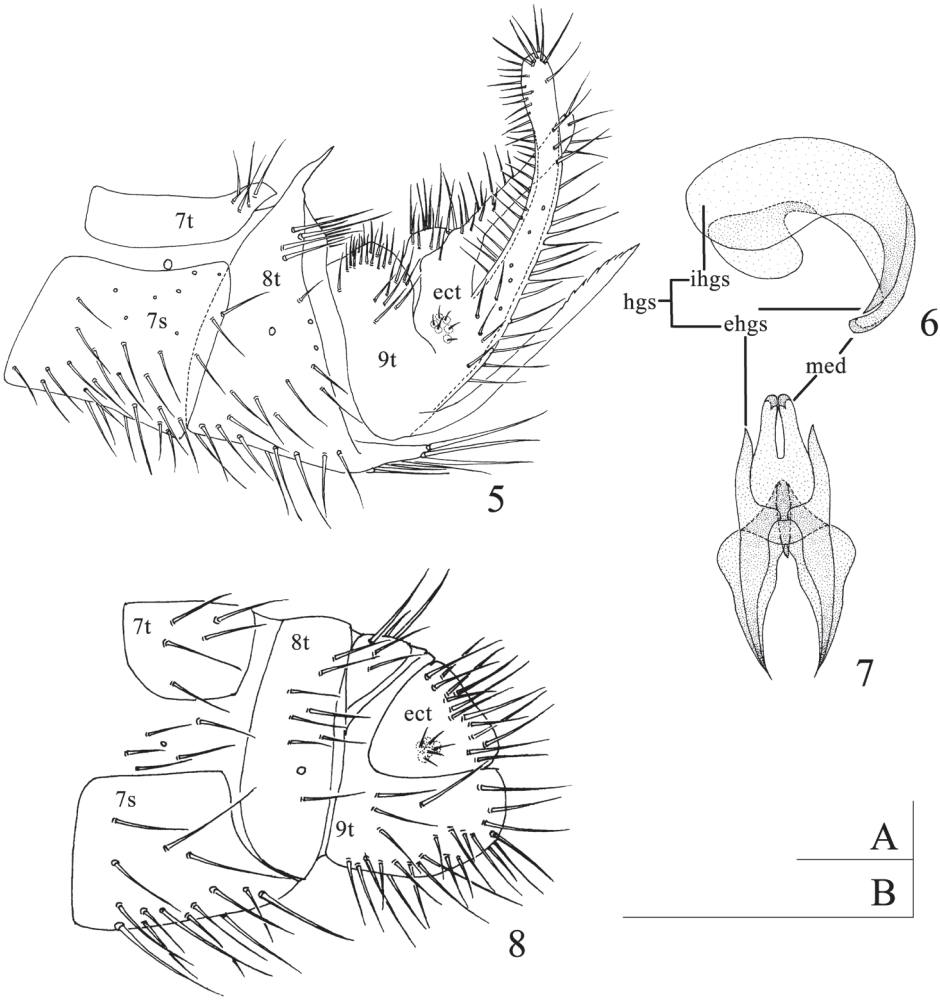
Wings (Fig. 1). Forewing shape oval. Yellowish-brown and hyaline; triangular dark spots present at the forks of longitudinal veins; veins yellowish-brown with crossveins brown. Anterior radial trace bearing two ORB's, with two secondary branches respectively; 3ir1 present after the fork of orb2; 3ir2 present after the fork of orb1 and before the fork of orb2. M with two branches, MA forked into 2–3 branches after the gradate series and MP



Figures 1–4. Wings. **1** *Zachobiella yunanica* Zhao, Yan & Liu, sp. n. **2** *Zachobiella submarginata* Esben-Petersen, 1929 **3** *Zachobiella striata* Nakahara, 1966 **4** *Zachobiella hainanensis* Banks, 1939.

into four branches. CuA with four branches. CuP simple. Two gradate series, inner gradate series with three crossveins and the outer with six. Hind wing oval. Pale yellow, hyaline; immaculate; veins pale yellowish-brown. Rs forked at base with four branches. M forked into two branches, with two secondary branches respectively after the gradate series. CuA with 3–4 branches. CuP simple. One gradate series, with only one crossvein r-m.

Abdomen. Yellowish-brown. Pilose. *Male terminalia* (Fig. 5). Posterodorsal edge of 7th tergite slightly extending backwards, with a group of setae on the surface. 8th tergite fused with the 8th sternite, with a pair of distinct rough spiny projections dorsally, stout bristle tufts present below in lateral view; posteroventral edge extending backwards as a stout spine, densely covered with long setae. 9th tergite covered with short setae on the dorsal and posteroventral edge extending upwards, blade-shaped, with serrated inner margin from one third distally. The dorsal surface of ectoproct protruding slightly and densely covered with short setae; both posterodorsal and posteroventral edges extending upwards into long arms, densely covered with setae. Mediuncus of gonarcus (Figs 6–7) consisting of a pair of long curved hooks, smooth surface without any spines; extrahemigonarcus long and tapering distally as a stout spine; hemigonarcus connected into a bridge internally. *Female terminalia* (Fig. 8). 9th tergite split into two parts, the hind margin in the ventral part exceeding the posterior of ectoproct slightly. Ectoproct subtriangular in lateral view. Subgenitale absent.



Figures 5–8. *Zachobiella yunanica* Zhao, Yan & Liu, sp. n. **5** Male terminalia, lateral view (B) **6** Gonarcus, lateral view (A) **7** Gonarcus, dorsal view (A) **8** Female terminalia, lateral view (B). Scale bars: 0.1 mm (A); 0.5 mm (B).

Distribution. China (Yunnan).

Material examined. CHINA: Holotype, 1♂, Yunnan province, Ruili city, Mengxiu county, Gaoerxing. 4.v.1981, Chikun Yang (CAU). Paratypes, 1♂, Yunnan province, Ruili city, Mengxiu county, Gaoerxing. 5.v.1981, Chikun Yang (CAU); 1♀, Yunnan province, Ruili city, Mengxiu county, Gaoerxing. 2.v.1981, Chikun Yang (CAU).

Etymology. The specific name refers to the type locality where this species is found.

Remarks. This new species is closely related to *Z. lobata* New, 1988, *Z. punctata* Banks, 1920, and *Z. submarginata* Esben-Petersen, 1929 based on the small triangular dark spots present at the forks of longitudinal veins in forewing. It can be distin-

guished from *Z. submarginata* by 3ir1 present after the fork of orb2 in forewing while in *Z. submarginata* it present before the fork of orb2. It also can be easily distinguished from *Z. punctata* by having only one crossvein of gradate series in hind wing while in *Z. punctata* there are two crossveins. In this new species two gradate series are present in the forewing and both the posterodorsal edge and the posteroventral edge of the ectoproct extend upwards into long arms. In *Z. lobata* three gradate series are present in the forewing and only the posteroventral edge of the ectoproct extends upwards.

Zachobiella submarginata **Esben-Petersen**

Figs 2, 9

Zachobiella submarginata Esben-Petersen, 1929: 33.

Diagnosis. Triangular dark spots present at the forks of longitudinal veins in forewing and 3ir1 present before the fork of orb2; Rs forked at the base in hind wing. Female: hind margin of 9th tergite depressed forwards from lateral view and the hind margin of ventral part exceeding the posterior of ectoproct.

Measurements. Forewing length 5.5–5.9 mm, width 1.9–2.2 mm. Hind wing length 4.0–4.8 mm, width 1.5–1.8 mm. Body length 4.2–5.0 mm.

Description. *Head.* Yellowish-brown. Brown stripe present from the rear of eye to the mandible. Labial and maxillary palpi brown. Antenna light brown, more than fifty-five segments. Eyes black with a metallic luster.

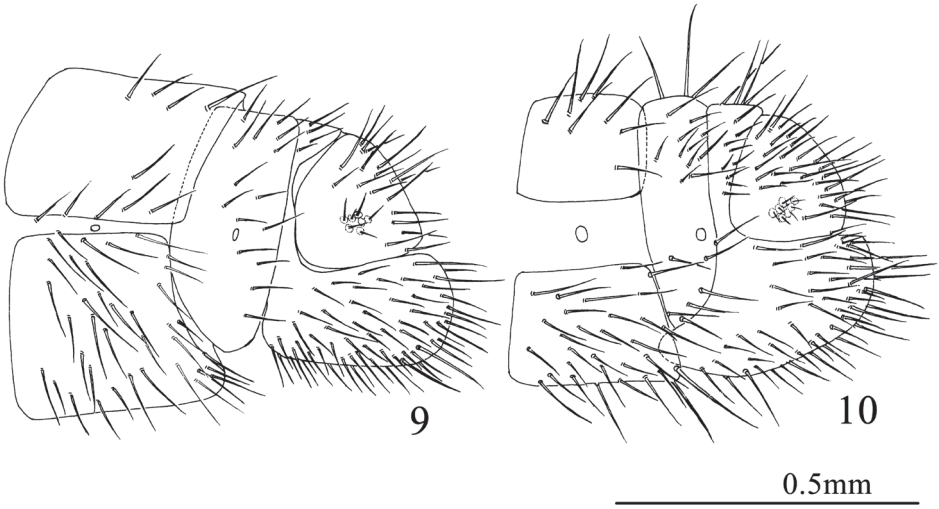
Thorax. Yellowish-brown, with brown longitudinal stripes along both sides of tergite. Legs yellowish-brown without spots.

Wings (Fig. 2). Forewing oval. Yellowish-brown and hyaline, a pale brown stripe present from the base, along the hind margin and small triangular dark spots present at the forks of longitudinal veins; veins yellowish-brown with crossveins brown. Anterior radial trace bearing two ORB's, with two secondary branches respectively; 3ir1 present before the fork of orb2; 3ir2 present after the fork of orb1 and before the fork of orb2. M with two branches and with two secondary branches respectively. CuA with four branches. CuP simple. Two gradate series, inner gradate series with two crossveins and the outer with six. Hind wing oval, pale yellow, hyaline; immaculate; veins pale yellow. Rs forked at base with four branches. M forked into two branches, with two secondary branches respectively after the gradate series. CuA with 3–4 branches. CuP simple. One gradate series, with the only one crossvein r-m.

Abdomen. Yellowish-brown. Hairy. *Female terminalia* (Fig. 9). Hind margin of 9th tergite depressed forwards, hind margin in the ventral part exceeding the posterior of ectoproct. Ectoproct subtriangular from lateral view. Subgenitale absent.

Distribution. China (Yunnan, Guangxi)

Material examined. CHINA: 3♀, Yunnan province, Ruili city, Mengxiu county. 2.v.1981, Chikun Yang (CAU); 4♀, Yunnan province, Ruili city, Mengxiu county, Gaoerxing. 4.v.1981, Chikun Yang (CAU); 1♀, Yunnan province, Ruili city, Mengx-



Figures 9–10. 9 *Zachobiella submarginata* Esben-Petersen, 1929. Female terminalia, lateral view **10** *Zachobiella striata* Nakahara, 1966. Female terminalia, lateral view. Scale bar: 0.5 mm.

iu county, Gaoerxing. 4.v.1981, Fasheng Li (CAU); 1♀, Yunnan province, Puer city, Lancang county. 20.iv.1981, Chikun Yang (CAU); 1♀, Guangxi province, Yulin city, Bobai county, Langping. 28.v.1982, Chikun Yang (CAU).

Remarks. This species was described by Esben-Petersen (1929) from Australia without the description of genitalia; New (1988a) figured the male and female terminalia in his revision of the Australian brown lacewings. In this paper we figure the female genitalia and provide new distribution records for this species in China. This species is related to *Z. yunanica* and *Z. punctata* based on the triangular dark spots present at the forks of longitudinal veins in forewing. It can be distinguished from *Z. punctata* by having only one crossvein of gradate series in the hind wing, while in *Z. punctata* there are two crossveins.

Zachobiella striata **Nakahara**

Figs 3, 10

Zachobiella striata Nakahara, 1966: 198.

Diagnosis. Forewing pale yellow and hyaline, thin brown stripe present along the gradate series and from the middle of MA to the lateral margin, an oval brown spot present at the margin, triangular dark spots absent at the forks of longitudinal veins and 3ir1 present before the fork of orb2. Female: 9th tergite approximate 'L' -shaped from lateral view, anteroventral edge protruding forwards slightly.

Measurements. Forewing length 4.5–5.7 mm, width 1.5–1.8 mm. Hind wing length 3.6–4.6 mm, width 1.2–1.5 mm. Body length 3.2–5.7 mm.

Description. *Head.* Yellowish-brown, without any dark areas. Antenna more than sixty segments, most segments amber but over a dozen of segments of distal flagellum obviously darker than the others. Eyes black with a metallic luster. Mandibles brown.

Thorax. Yellowish-brown, with a light-coloured longitudinal stripe throughout. Legs yellowish-brown without spots; distal tarsomere darker than proximal four.

Wings (Fig. 3). Forewing narrow, apex slightly tapered. Pale yellow and hyaline, thin brown strips present along the gradate series and from the middle of MA to the lateral margin, an oval brown spot present at the margin; veins pale yellow and transparent with crossveins of gradate series brown. Anterior radial trace bearing two ORB's, with two secondary branches respectively; 3ir1 present before the fork of orb2; 3ir2 present after the fork of orb1 and before the fork of orb2. M with two branches, MA forked into two branches after the gradate series and MP into 3–5 branches. Cu with two branches. Three gradate series, inner gradate series with 2–3 crossveins; middle with 2–3 and the outer with four. Hind wing narrow, apex slightly tapered. Pale yellow and hyaline, brown strip present from the base to the apex; veins yellow and transparent, crossvein of gradate series yellowish-brown. Rs forked in the middle with four branches. M forked into two branches, with 2–3 secondary branches respectively after the gradate series. Cu simple. One gradate series with the only one crossvein r-m.

Abdomen. Yellowish-brown, tergites and sternites brown, darker than the arthropleuron. Hairy. *Female terminalia* (Fig. 10). 9th tergite approximate 'L'-shaped from lateral view, anteroventral edge protruding forwards slightly, hind margin exceeding the hind margin of ectoproct. Ectoproct quadrant shaped from lateral view. Subgenitale absent.

Distribution. China (Taiwan, Hainan, Yunnan)

Material examined. CHINA: 2♀, Yunnan province, Dehong Autonomous Prefecture, Longchuan county. 5.v.1981, Chikun Yang (CAU); 1♀, Yunnan province, Hani-Yi Autonomous Prefecture of Honghe, Hekou town. 12.v.2011, Luxi Liu (CAU); 1♀, Hainan province, Wuzhishan city, Wuzhi hills. 16.v.2007, Yongjie Wang (CAU); 1♀, Taiwan province, Nantou city, Nantou County Council. 6.vii.2013, Xinyu Luo (CAU).

Remarks. This species was described by Nakahara (1966) with only female specimens from Taiwan province and Iriomote Island without the description of genitalia. In this paper we describe the female, including the genitalia, and update the distribution records for this species in China. This species is similar to *Z. pallida* Banks, 1939 and *Z. jacobsoni* Esben-Petersen, 1926; however, it can be distinguished from *Z. pallida* by 3ir1 present before the fork of orb2 in forewing while in *Z. pallida* it is present after the fork of orb2. It also can be distinguished by the Rs forked in the middle in hind wing, while in *Z. jacobsoni* the Rs is forked basally.

***Zachobiella hainanensis* Banks**
Figs 4, 11–14

Zachobiella hainanensis Banks, 1939: 467.

Diagnosis. Forewing pale yellow and hyaline, brown stripes present along the gradate series and from the middle of MA to the lateral margin, triangular dark spots absent at the forks of longitudinal veins and 3ir1 present after the fork of orb2. Male: dorsal surface of 8th tergite protruding upwards as a short rod; dorsal of 9th tergite slightly depressed and posteroventral edge extending upwards as a strong spine; dorsal of ectoproct obviously protruding upwards, posteroventral edge extending upwards into a thickened process. Female: 9th tergite very small, triangular from lateral view; ectoproct large, slightly depressed in the middle of the hind margin.

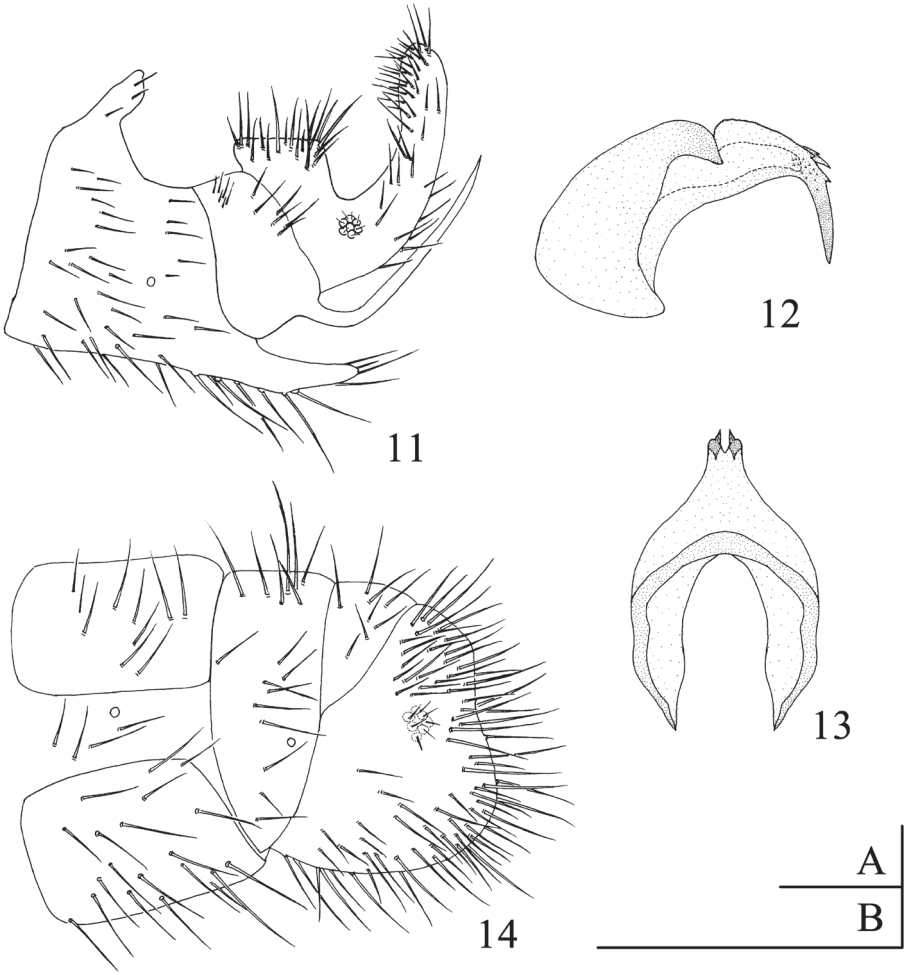
Measurements. Forewing length 3.2–4.9 mm, width 1.2–1.4 mm. Hind wing length 3.5–4.2 mm, width 1.1–1.3 mm. Body length 2.8–4.3 mm.

Description. *Head.* Yellowish-brown, without any dark areas. Antenna amber, more than fifty-five segments, more than a dozen of segments of distal flagellum obviously paler than the others. Eyes black with a metallic luster.

Thorax. Yellowish-brown. Brown longitudinal stripes present along both sides of the pronotum; scutum of mesonotum and metanotum obviously brown. Legs yellowish-brown with no spots.

Wings (Fig. 4). Forewing narrow, apex slightly tapered. Pale yellow and hyaline, thin brown strips present along the gradate series and from the middle of MA to the lateral margin; veins pale yellow and transparent with crossveins of gradate series brown. Anterior radial trace bearing two ORB's, with two secondary branches respectively; 3ir1 present after the fork of orb2; 3ir2 present after the forks of orb1 and orb2. M forked into two branches, MA simple, MP forked into 4–5 branches. Cu with two branches. Three gradate series, inner gradate series with 2–3 crossveins; middle with two and the outer with four. Hind wing narrow, apex slightly tapered. Pale yellow, hyaline and immaculate; veins pale yellow and transparent. Rs forked in the middle with four branches. M forked into two branches, with 2–3 secondary branches respectively after the gradate series. Cu simple. One gradate series, with the only one crossvein r-m.

Abdomen. Yellowish-brown, tergites and sternites brown, darker than the arthropleuron, pilose. *Male terminalia* (Fig. 11). 8th tergite fused with the 8th sternite, dorsal of both 8th tergite protruding upwards as a short rod; posteroventral edge extending backwards as a stout spine, densely covered with long setae. Dorsal of 9th tergite slightly depressed and posteroventral edge extending upwards as a strong spine. Dorsal surface of ectoproct obviously protruding upwards and densely covered with long setae; posteroventral edge extending upwards into a thickened process, densely covered with setae on the inner surface. Mediuncus of gonarcus (Fig. 12–13) consisting of a pair of long curved hooks, three to four stout spines present on the surface with small spines around; extrahemigonarcus small and slightly tapered. *Female terminalia* (Fig. 14). 9th



Figures 11–14. *Zachobiella hainanensis* Banks, 1939. **11** Male terminalia, lateral view (B) **12** Gonarcus, lateral view (A) **13** Gonarcus, dorsal view (A) **14** Female terminalia, lateral view (B). Scale bars: 0.1 mm (A); 0.5 mm (B).

tergite very small, triangular from lateral view. Ectoproct large, slightly depressed in the middle of the hind margin. Subgenitale absent.

Distribution. China (Hainan, Yunnan)

Material examined. CHINA: 2♂2♀, Yunnan province, Dehong Autonomous Prefecture, Longchuan county. 28.iv.1981, Chikun Yang (CAU); 1♂, Yunnan province, Dehong Autonomous Prefecture, Ruili county. 1.v.1981, Fasheng Li (CAU); 1♂1♀, Hainan province, Wuzhishan city, Wuzhi hills. 16.v.2007, Yongjie Wang (CAU); 1♂, Hainan province, Baisha county, Yuanmen country, Hongxing village. 10.ix.2008, Xiushuai Yang (CAU).

Remarks. This species was described by Banks (1939) based on one specimen from Hainan province. In this paper both male and female are described, including the genitalia, and the distribution records for this species in China are updated. This species is similar to *Z. striata* but it can be easily distinguished by the different positions of 3ir1 in forewing.

Acknowledgements

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References

Banks N (1920) New neuropteroid insects. Bulletin of the Museum of Comparative Zoology 64: 297–362. doi: 10.5962/bhl.title.28705

Banks N (1939) New genera and species of neuropteroid insects. Bulletin of the Museum of Comparative Zoology 85: 439–504.

Esben-Petersen P (1926) Fauna sumatrensis. Neuroptera II. Entomologische Mitteilungen 15: 404–407.

Esben-Petersen P (1929) Australian Neuroptera. Part VI. Queensland Naturalist 7: 31–35.

Makarkin VN, Wedmann S (2009) First record of the genus *Sympherobius* (Neuroptera: Hemerobiidae) from Baltic amber. Zootaxa 2078: 55–62.

Nakahara W (1960) Systematic studies on the Hemerobiidae (Neuroptera). Mushi 34: 1–69.

Nakahara W (1966) Hemerobiidae, Sisyridae and Osmylidae of Formosa and Ryukyu Islands (Neuroptera). Kontyû 34: 193–207.

New TR (1988a) A revision of the Australian Hemerobiidae (Insecta: Neuroptera). Invertebrate Taxonomy 2: 339–411. doi: 10.1071/IT9880339

New TR (1988b) Hemerobiidae (Insecta: Neuroptera) from New Guinea. Invertebrate Taxonomy 2: 605–632. doi: 10.1071/IT9880605

Oswald JD (1993) Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). Journal of the New York Entomological Society 101: 143–299.

Oswald JD (2014) Neuropterida Species of the World. Version 3.0. http://lacewing.tamu.edu/Species-Catalogue/ [accessed on 31 December 2014]

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REVIEW ARTICLE

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Revision of the genus *Trypogeus* Lacordaire, 1869 (Cerambycidae, Dorcasominae)

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Abstract

The ten species of the genus *Trypogeus* Lacordaire are revised. *T. apicalis* Fisher, 1936, is proposed as a new synonym of *T. javanicus* Aurivillius, 1925. A neotype for *T. sericeus* (Gressitt, 1951) and lectotypes for *Toxotus fuscus* Nonfried, 1894 and *T. javanicus* are designated. *Trypogeus fuscus* auct. nec Nonfried is a misidentification of *Philus ophthalmicus* Pascoe. All the species are described and keys are given for distinguishing the species. Photographs of the types of all the *Trypogeus* species are published for the first time.

Keywords

Taxonomy, revision genus *Trypogeus*, Dorcasominae, southeast Asia

Introduction

Lacordaire (1868) described the Group IX *Dorcasomides*, amongst the representatives of the subfamily Cerambycinae, in "*légion II des Cérambycides vrais, Cohorte I, Cérambycides silvains, section-B, avec les yeux finement granulés*" and in this group he included the genera *Dorcasomus* Serville, 1834 and *Megacoleus* Lacordaire, 1869.

This division was elevated to Tribe Dorcasomini by Aurivillius (1912), who included six genera (*Dorcasomus* Lacordaire, 1869, *Neoclosterus* Heller, 1899; *Plectogaster* Waterhouse, 1881; *Aphelogaster* Kolbe, 1897; *Gahania* Distand, 1907; and *Lycosomus* Aurivillius, 1903). Quentin and Villiers (1970) separated the latter five genera into other tribes, leaving the genus *Dorcasomus* as the sole representative of the tribe.

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Danilevsky (1979) proposed the status of subfamily Apatophyseinae for Lacordaire's (1869) Apatophysides, originally comprising the genera *Apatophysis* Chevrolat, 1860; *Pachyticon* Thomson, 1857 and *Trypogeus* Lacordaire, 1869. Later, however, Özdikmen (2008), in agreement with the comments of P. Svacha and M. Danilevsky (1987, 1989), established the synonymy of the subfamilies Dorcasominae and Apatophyseinae.

Material and methods

Terminology and descriptions

Terminology for body parts and terminalia used in the text is explained in the general description below. General terminology follows Yamasako and Ohbayashi (2011) and Svacha and Lawrence (2014). The description of species and the key for identification focus mainly on the colour and the patterns of antennae, pronotum, elytra and legs.

Acronyms of the collections studied and mentioned in this work:

BPBM Bernice P. Bishop Museum, Honolulu, USA
DEIM Deutsche Entomologische Institute, Müncheberge, Germany
EVC Eduard Vives Collection, Terrassa, Spain
IRSNB Institute Royal des Sciences Naturelles de Bélgique
IZAS Institute of Zoology, Chinese Academy of Sciences, Beijing, China
KMC Kiyoshi Matsuda Collection, Takarazuka City, Japan
MNHN Muséum National d'Histoire Naturelle, Paris, France
NHML Natural History Museum, London, Great Britain
NRSC Naturhistoriska Riksmuseet, Stockholm, Sweden
NOC Nobuo Ohbayashi Collection, Miura City, Japan.
SMC Sergey Murzin Collection, Moscow, Russia.
USNM United States National Museum, Smithsonian Institution, Washington, DC, USA.

Taxonomy

Subfamily Dorcasominae Lacordaire, 1869

Dorcasomides Lacordaire, 1868: 456.
Apatophysides Lacordaire, 1869: 234.
Apatophysinae Danilevsky, 1979: (misspelling).
Apatophyseinae: Lobanov et al. 1981; Löbl and Smetana 2010.
Dorcasominae: Özdikmen 2008; Villiers et al. 2011; Vives and Heffern 2012; Svacha and Lawrence 2014: 34.

Note. The subfamily Dorcasominae currently has 321 species in Africa, Europe, and southeastern Asia. Among these, 257 are endemic to Madagascar and the Comoros islands, 24 species are Oriental (Vives and Heffern 2006), 22 species are South Palearctic and 12 are Afro-tropical. Dorcasominae are not present in the western hemisphere, Australia or Polynesia (Villiers et al. 2011).

Genus *Trypogeus* Lacordaire

Trypogeus Lacordaire, 1869: 236.
Toxotus (auct. nec Dejean, 1821).
Trypogeus Aurivillius, 1912; Boppe 1921; Hayashi and Villiers 1985; Chiang and Chen 2001; Vives 2007; Miroshnikov 2014.
Paranthophylax Gressitt, 1951: 50.
Paranthophylax Gressitt & Rondon, 1971.

Type species. *T. albicornis* Lacordaire (by monotypy)

Description. Anterior part of head with short rostrum. Long protruding mandibles, curved at the apex, the inner margin of the left mandible is sinuate and has no tooth whereas the margin of the right mandible is straight and has a sharp tooth in the middle. The neck is not narrowed or convex behind the eyes. Very long maxillary palpi, extending past the apex of the mandibles. Eyes moderately coarsely faceted; small and not very prominent. Antennae reaching or surpassing the apex of elytra in males, shorter in the females, the insertion is in front of the eyes as in other tribes of the Dorcasominae. The pronotum is subcylindrical, slightly wider than long at the level of the lateral protuberances, transverse in females, the anterior border is thin and simple and the posterior border is sinuate and margined. Discal area finely punctuate and presenting four or five gibbosities. Very short broad prosternum, the intercoxal process very narrow and dilated posteriorly. Procoxal cavities round and well extended towards the sides, almost reaching the lateral protuberance of the pronotum. Front coxae conical and protruding. Sides of the pronotum with a slight border in front of the protuberances. Mesocoxae closer together in males (Fig. 9), and more broadly separated by the mesosternal process in the females (Fig. 10). Triangular scutellum with rounded apex. Elytra not very long, flattened and strongly narrowed in the middle, slightly dehiscent at apex. In the females the elytra do not usually cover the abdomen and leave some terminal abdominal segments uncovered, particularly when it is swollen with eggs. The epipleura are well delimited and flattened. Wings (Fig. 1) are present and well developed in both males and females; they are translucent and somewhat darkened, the radial cell closed and the anal cell open, with simplified venation. Short slender legs, the femurs dilated in the middle and tibiae straight and widened at the apex. Female metatarsi are strongly dilated (Fig. 2), particularly the first two tarsomeres which are wider than the apex of the tibiae. The male aedeagus (Fig. 3) is long and slightly arched, acuminated at the apex,

Figures 1–8. 1 *Trypogeus barclayi* Vives, left wing **2** *T. sericeus* female, tarsi from posterior leg **3** *T. gressitti* Miroshnikov, dorsal view of aedeagus **4** tegmen **5** pygidium and *spiculum gastrale* **6** *Philus ophthalmicus* Pascoe, (=Lectotype of *Toxotus fuscus* Nonfried) **7–8** *T. fuscus* labels of lectotype (DEI).

the lower lamina is distinctly longer than the upper. Very simple endophalus lacking interior sclerites (Fig. 14). Short narrow tegmen (Fig. 4) with long slender acuminated parameres, bearing about six long golden apical setae. In general the morphology of the male copulatory organ differs little between species. There are only small differences in the shape of the apex of the aedeagus and in the apical setae on the parameres of the

tegmen (Figs 11–13). The integument is generally testaceous yellow with a dark elytral border in some species. The males are darker and generally part of the prothorax and legs is black, whereas the legs of the females are always yellow. Brown and yellowish antennae with the last segments usually almost white.

Remarks. The genus *Trypogeus* was described by Lacordaire (1869) in order to include his new species *T. albicornis*, from Malaysia. He assigned the new genus to his division "*Cohorte II. Cérambycides vrais souterrains*", basically due to the morphology of the intercoxal protuberance on the metasternum, narrow and triangular in the males, wide and rounded in the females. The genus *Trypogeus* was included in the tribe *Apatophysides* because of its robust maxillary palpi, much longer than the labial palpi and also the weakly narrowed neck. Subsequently, with the exception of Lacordaire, the genus *Trypogeus* was considered as belonging in the subfamily Lepturinae; Boppe (1921) and Aurivillius (1912) included it in the tribe Toxotini. Nonfried (1894) described *Toxotus fuscus* from Sumatra (this was a misidentification of *Philus ophthalmicus* Pascoe), and Aurivillius (1912) later transferred it unduly to the genus *Trypogeus.* Gressitt (1951) described the genus *Paranthophylax* in order to include his new species *P. sericeus* Gressitt from southern China and *Artelida asiatica* Matsushita, 1933 and placed that genus in the tribe Xylosteini (Lepturinae). Gressitt and Rondon (1970) also transferred *Toxotus superbus* Pic, 1922 to *Paranthophylax*. Hayashi and Villiers (1985) retained the genus *Trypogeus* in the tribe Xylosteini (Lepturinae) together with *Formosotoxotus* Hayashi, synonymized *Paranthophylax* with *Trypogeus* and placed in this genus *Toxotus aureopubens* Pic, 1903 and *Toxotus superbus* Pic, 1922 in addition to *Trypogeus javanicus* Aurivillius, 1925, and *Trypogeus apicalis* Fisher, 1936. They moved *Artelida asiatica* to the genus *Formosotoxotus*. Vives (2005 and 2007) described *Trypogeus cabigasi* from the Philippines and *Trypogeus barclayi* from Borneo, Holzschuh (2006) described *Trypogeus coarctatus* from Java, Indonesia, and Miroshnikov (2014) described two additional species, *Trypogeus murzini* and *Trypogeus gressitti*, so that currently the genus contains twelve known species. Of these, I hereby synonymize *T. apicalis* Fisher, 1936 with *T. javanicus* Aurivillius, 1925. *T. fuscus* sensu Hayashi and Villiers (1985) and Vives (2007) (nec Nonfried, 1894) should be assigned to *T. coarctatus* Holzschuh, 2006, because *Toxotus fuscus* Nonfried is a misidentification of *Philus ophthalmicus*; therefore, the genus would be reduced to ten species.

Trypogeus albicornis Lacordaire, 1869	W Malaysia, Java
Trypogeus aureopubens Pic, 1913	China (Yunnan), Thailand
Trypogeus barclayi Vives, 2007	Borneo
Trypogeus cabigasi Vives, 2005	Philippines (Mindanao)
Trypogeus coarctatus Holzschuh, 2006	Sumatra
Trypogeus gressitti Miroshnikov, 2014	Laos
Trypogeus javanicus Aurivillius, 1925	Java
Trypogeus murzini Miroshnikov, 2014	Cambodia
Trypogeus sericeus (Gressit, 1951)	China (Fujian, Sichuan)
Trypogeus superbus (Pic, 1922)	Laos, Vietnam

Figures 9–10. 9 *Trypogeus cabigasi* Vives, male underside **10** *Trypogeus barclayi* Vives, female underside.

Keys for the identification of species

1 Disc of pronotum with five gibbosities **2**

– Disc of pronotum with four gibbosities **3**

2 Colour reddish, matte, clothed in brown and gold pubescence. Pronotum with a very sharp lateral spine. Female with completely yellow pronotum. Yunnan ..... ***T. aureopubens*** (Pic)

– Colour testaceous, with golden pubescence and slightly sharp spine. Female with completely yellowish pronotum and antennae, 16.5 mm. China .... ***T. sericeus*** (Gressitt)

3 Golden-yellow scutellum, sometimes blackish at the base. Head and pronotum partially black and partially yellow **4**

– Head, pronotum and scutellum of the male completely black. Female not known. Cambodia ..... ***T. murzini*** Miroshnikov

4 Blackish-brown antennae with the exception of segments (9) 10 and 11 that are almost completely white **5**

– Antennae almost black or a testaceous brown throughout their whole length. Teguments almost black. Black scapus, labrum, clypeus, frons, elytra except for margins. Female with black pronotum and elytra black at both sides. Java ..... ***T. javanicus*** **Aurivillius**

5 Elytral teguments mostly yellowish. Antennae with segments 1–6 reddish .. **6**

– Teguments almost black, clothed in golden tomentum. Antennae with all segments reddish brown except 11, which is white, 17 mm. Female not known. Sumatra ..... ***T. coarctatus*** Holzschuh

6 Black antennae, base of segments 3–8 reddish, apical part of 9–11 white. Brown-yellow elytra, clothed in silver tomentum, sides blackish and dark

spots on the disc, 15 mm. Female with entirely brownish yellow teguments, silky, 16 mm. Vietnam, Laos ..... ***T. superbus*** (Pic)

– Brown antennae with segments 1–2 testaceous, segments 3–8 black and 9–11 white **7**

7 Teguments yellow, clothed in silky golden tomentum. Pronotum with 4 discal gibbosities..... **8**

– Yellowish-brown teguments, clothed in silky golden tomentum. Pronotum with yellow disc, black at both sides, 11 mm. Female with yellow legs and antennae segments 3–8 black. Malaysia ..... ***T. albicornis*** **Lacordaire**

8 Elytra entirely yellow with blackish apical apex..... **9**

– Elytra completely brown with blackish sides, basal area yellowish, 12.5 mm. Female not known. Laos..... ***T. gressitti*** **Miroshnikov**

9 Pronotum with discal area yellowish and black sides, 11.5 mm. Female with yellowish pronotum. Philippines..... ***T. cabigasi*** **Vives**

– Pronotum with discal area yellowish, anterior and posterior parts dark, 11 mm. Females completely yellowish, except for the dark elytral apex. Brunei, Borneo, Kalimantan, Sabah ..... ***T. barclayi*** **Vives**

Trypogeus albicornis **Lacordaire, 1860**

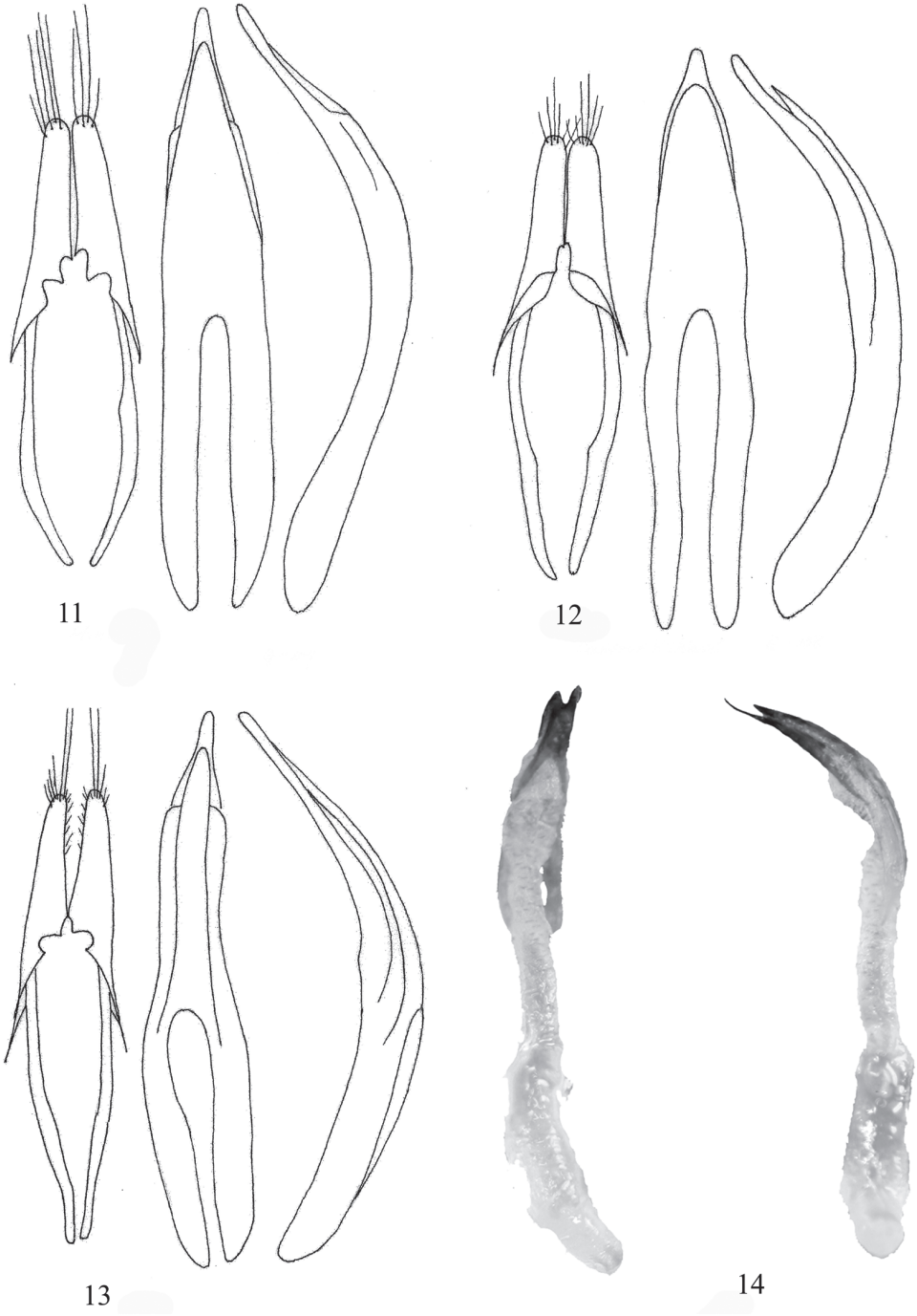
Figs 12, 15

Trypogeus albicornis Lacordaire, 1860: 236

Trypogeus albicornis: Aurivillius 1912: 159; Boppe 1921: 44; Hayashi and Villiers 1985: 27; Vives 2007: 54; Miroshnikov 2014: 53

Material studied. 1 female holotype, Malaysia, Ex-Musaeo Mniszech, "TYPE" "Museum Paris coll. J.Thomson, 1952" (MNHN). 2 males, 6 females from Indonesia, Java occ., Sukabumi, 2000 m, 1893, H. Fruhstofer leg. (MNHN), 1 female from Java, Mt. Kawis, J.B. Lebdru, 1898 (ex coll. Oberthure, 1952), (MNHN). 1 male from Malaysia, Cameron Highlands, March 1987, local collector (NOC), 4 males and 1 female from the Malaysian Peninsula, Pasoh Forest reserve, Negeri Sembilan, 2–8.IV.1993, 26.III.1993, 3–9.IV.1993; 2–8.IV.1993; and 8–15.IV.1993, coarse malaise trap, K. Kimishi & K. Maeto leg. (NOC); 1 male from Malaysia, Pahang, Tanah Rata C.E., Mt. Gu. Jabar, 14–26.I.2011, T.S. Wong leg. (KMC).

Redescription. Size of the male: length 9–11 mm; width 3.3 mm. Size of the female: length 14–16 mm; width 4.6 mm. General colour testaceous-yellow. Antennae with segments 1–3 yellowish, segments 4–8 brown and 9–11 white. Testaceous legs. Elytra with darkened, almost black, sutural and apical areas as well as sides including epipleura. All the body is clothed in short golden tomentum. The first sternites are testaceous-yellow, the last two are black in the males and yellow in the females. Head subquadrate, with prominent eyes. Long reddish mandibles, slightly darker in the inner margin, the external border arched and covered in long golden setae, extending



Figures 11–14. Tegmen, dorsal and lateral view of aedeagus **11** *Trypogeus cabigasi* Vives **12** *Trypogeus albicornis* Lacordaire **13** *Trypogeus barclayi* Vives **14** *Trypogeus coarctatus* Holzschuh, dorsal and lateral view of aedeagus and endophallus (drawings by Dr. N. Ohbayashi).

from the base and almost reaching the apical part. Long slender maxillary palpi, the last segment cup shaped and truncate at apex. Labial palpi longer than the mandibles, the second segment reaching the apex. Frons with a longitudinal groove. Antennae not long, only just reaching the apical fifth of elytra in males, scapus strongly punctate and enlarged distally. Antennomere 3 long and narrow, flattened, after antennomere 4 they are slightly dilated in the external apical part. Pronotum subcylindrical, slightly wider than long (70/80) at the level of the strongly rounded lateral protuberances. Triangular scutellum with slightly rounded apex, punctate and with short golden tomentum. Long narrow elytra, rounded and very prominent humeri, narrowed at the middle and dehiscent at apex, which is rounded in each elytron. Bordered suture. Discal area with a depression from elytral base to the centre. The elytra leave the last two abdominal segments uncovered. Mesosternum and metasternum short and broad, with a very broad, subquadrate mesoepisterna, the mesocoxal cavities well separated by an angular process. Wide abdomen in females, slightly more so than the elytra, the tegument of the five visible sternitesis translucid, through which around fifty eggs can be seen in the holotype specimen, which Lacordaire (1869) probably mistook for "scattered white spots". The sternites are finely punctate and clothed in short golden tomentum. Short robust legs, femora widened at middle, straight tibiae dilated at apex.

Distribution. Peninsular Malaysia, Indonesia (Java).

Trypogeus aureopubens **(Pic, 1913)**

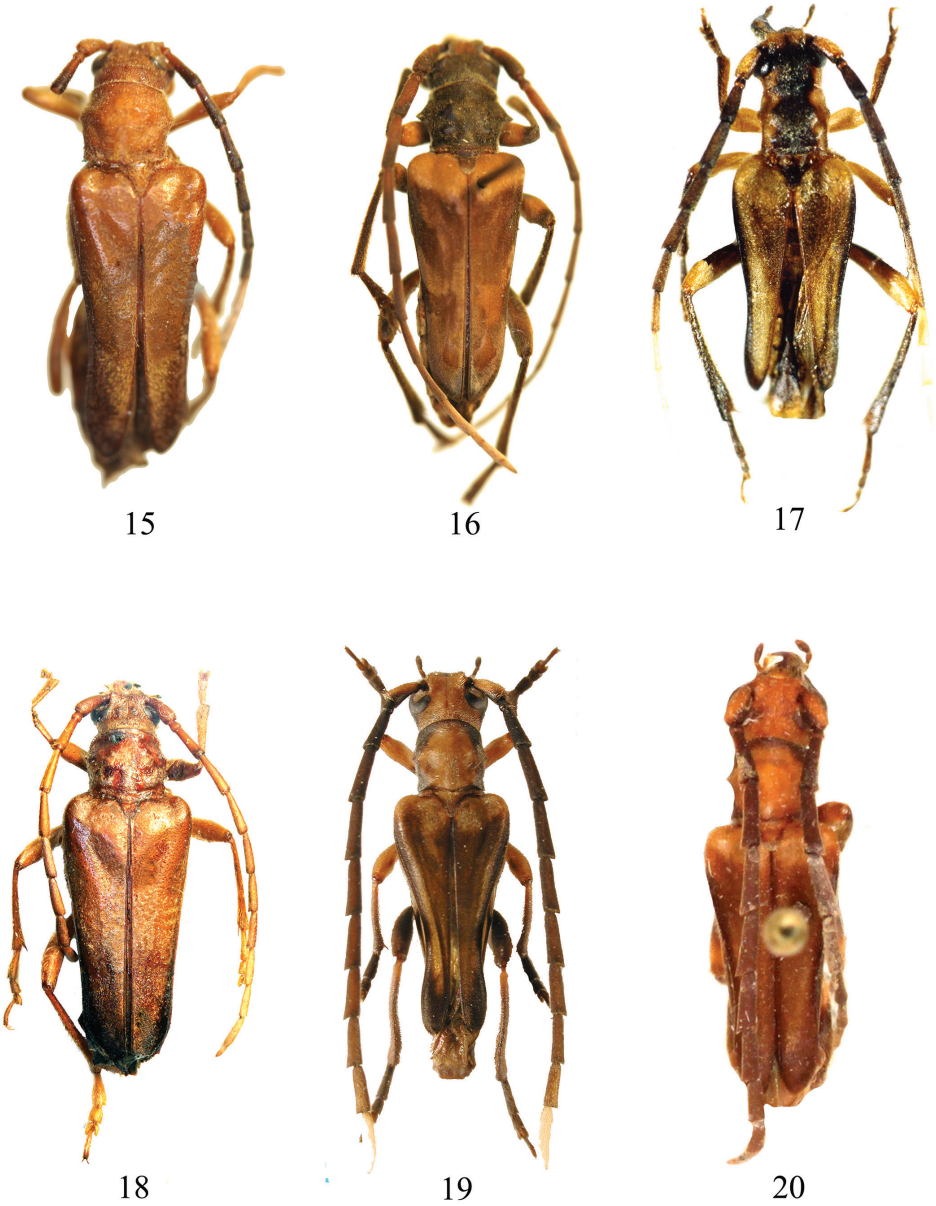
Fig. 16

Toxotus aureopubens Pic, 1913.

Trypogeus aureopubens: Hayashi and Villiers 1985: 27; Vives 2007: 54; Weigel et al. 2013: 68; Miroshnikov 2014: 54.

Material studied. 1 male holotype, "*Toxotus aureopubens* Pic, n. sp. Yunnan",[China],P. Guerin,1924, (MNHN). 1 male from Thailand, Khao Chong, Trang, 16.IV.1969, A. Samraadkit leg. (NOC). 4 males and 1 female from Thailand, Loa Phu Ruea N.P., 13–19.IX.2006, 26.IX.2006, N. Jaroeuchai leg. (EVC); 1 male from Thailand, Thung Shlaeng mang N.P., 13–19.VIII.2006, P. Praenea leg. (EVC).

Redescription. Size of the male: length 10–14 mm, width 4.3 mm. Size of the female: length 14–16 mm, width 4.5 mm. The general body colour of the male is dark brown, the base of the elytra is testaceous, antennal segments 1–3 reddish, segments 10–11 white. Legs with femora yellow-ringed at apical third and base. Elytra completely covered in a golden brown tomentum that changes direction giving it a marbled appearance. The male has a short broad head, maxillary palpi as long as mandibles, the third segment two times as long as wide and truncate at the apex with a slight depression at each side. Antennae reaching past apex of elytra after the ninth segment. Vertex of head slightly furrowed between antennal bases. Almost smooth gular area with transverse grooves. Subquadrate pronotum, the maximum width is in



Figures 15–20. 15 *Trypogeus albicornis* Lacordaire, holotype female, Malaysia; **16** *Trypogeus aureopubens* Pic, holotype male, Yunnan **17** *Trypogeus barclayi* Vives, holotype male, Brunei **18** *Trypogeus cabigasi* Vives, holotype female, Philippines **19** *Trypogeus coarctatus* Holzschuh, holotype male, Sumatra, (Photo: L. Dembický) **20** *Trypogeus javanicus* Aurivillius, syntype male, Java.

the front third at the height of the lateral calli that are protruding and sharp, with a slightly convex area at the front. Disc of pronotum with five rounded and well defined gibbosities. Posterior border of pronotum weakly sinuate. Prosternum finely punctate

with large prominent procoxae, prosternal process very fine and narrow. Triangular scutellum widely rounded at apex, finely punctate and with long golden tomentum. Long elytra, weakly narrowed at the middle with prominent rounded humeri. Base with a depression at either side and somewhat raised around the scutellum. Fine and dark sutural border. Elytral apex weakly rounded and weakly dehiscent sutural angle. Finely punctuate mesosternum with separated mesocoxae and weakly projecting coxae. Metasternum with large subquadrate episternae, the coxae almost joined in the male. The abdomen has five visible sternites, these are dark but have a yellowish posterior margin. The entire underside of the body bears long silver setae. Short robust legs with femora dilated at the middle and presenting a smooth, shiny oval area at the distal part. Tibiae straight and widened at apex. Short narrow tarsi, the first segment of the metatarsi slightly longer than the remaining tarsi together.

Distribution. China (Yunnan), Thailand.

Trypogeus barclayi **Vives, 2007**

Fig. 17

Trypogeus barclayi Vives, 2007: 54.
Trypogeus barclayi: Miroshnikov 2014: 59.

Material studied. 1 male holotype from Brunei, II-III.1992, (E 115, 7° - N 4, 34°) Kuala Belalong FSC, N. Mawdsley leg. (BMNH); 1 male paratype, *idem*, (EVC); 1 female from Malaysia SW, Sabah, Long Pa Sia, Payakalaba, 1010 m, 13–13.IV.1987, C.V. Achterberg leg. (EVC); 1 male from Malaysia SW, Sabah, Borneo, Headquarters, 5.V.1980, A. Sakai leg. (NOC); 3 males from Indonesia, Kalimantan, Timur, Bikit Bangkiria, 14–20. IX.1999, 8–14.XI.2000, 11–17.X.2000, H. Makihara leg. (NOC); 1 male from Indonesia, east Kalimantan, Bukit Soeharto, 11–18.X.1996, H. Makihara & H. Kinumura leg. (NOC); 1 male from Malaysia SW, Sabah, Trus Madi, V.2000 (NOC).

Redescription. Size of the male 9–11 mm long and 3.9–3.2 mm wide. Body completely testaceous except for the external margin of mandibles, the lateral margin and apex of elytra, the first seven antennal segments and the tibiae, which are almost black. The occiput and thoracic disc have a large brown-black spot. The underside of the body is brown except for the abdominal sternites which are almost black. Broad short head, prominent eyes with medium facets. The lower lobe is almost double the length of the upper lobe. The mandibles are broad, arched and protruding; the inner margin is smooth, lacking a medial tooth. The antennae are long and robust, extending past elytral apex from the third antennomere, the last four antennomeres are yellowish. Pronotum subquadrate, slightly longer than wide with four discal protuberances, one at each side of the pronotal middle. A large brown spot extends longitudinally from the front to the rear border, narrowing at apical third. The entire pronotal surface is coarsely punctate, almost rugged. The hind margin is doubly sinuate. Yellowish prosternum with the front and rear parts brown. Prosternal process long and narrow, the coxal

cavities opened behind and procoxae extended at an angle to the sides. Dark brown triangular scutellum with a central depression. The central plate of the mesonotum lacking a stridulatory area. Subconical elytra, wider than pronotum with humeri very obtuse, rounded and projecting upwards. Bordered protruding suture. Apex of elytra rounded and dehiscent. The elytra are narrowed after the middle, widening slightly at apical fifth. Elytral punctation is coarse and granulose, decreasing after apical third. The entire elytral surface is clothed in golden tomentum that becomes brown at sides and brown-black at apex. Legs short and robust, tibiae widened at apex. Clothed in golden tomentum except for tibiae that are covered in dense blackish pubescence. Tarsi not widened and with the first segment of mesotarsi and metatarsi longer than the second and third together. The lower part of the body is finely punctate and clothed in golden tomentum. Copulatory organ of male elongate (Fig. 13) slightly arched with a strongly acuminate apex and the upper lamina narrower and thinner than the lower, not reaching the apex. Lateral parameres long and slender, bearing long setae at apex and some short setae on the inner side.

This species is the smallest in the genus, it can be distinguished from the others by the almost black spots on head and pronotum and the tibiae with black pubescence. The most similar species is *T. javanicus* Aurivillius, from which it can be separated by the characters mentioned, by the different colouration of elytra and the morphology of the pronotum.

Distribution. Borneo, including Sabah, Brunei, and Kalimantan.

Trypogeus cabigasi **Vives, 2005**

Fig. 18

Trypogeus cabigasi Vives, 2005: 303.
Trypogeus cabigasi: Miroshnikov 2014: 59.

Material studied. 1 female holotype from Philippines, Mindanao, Bukidnon, Impasung-ong,10.V.2002, E. Cabigasi leg. (EVC); 2 males from Philippines, Mindanao, Mt. Apo, 5.VII.1978 and 5.VIII.1978, O Yata leg. (NOC); 1 female from Philippines, Mindanao, Mt. Apo, 26.30.III.1980, T. Hirowatari & Y. Funatsa leg. (NOC); 1 female from Philippines, Mindanao Is., N Agusan, V-VI.1977, R.M. Lumawig leg. (KMC).

Redescription. Size of the male: 13–15 mm; width 3.2–4.5 mm. Size of the female: 16.5 mm. Entirely testaceous except for the internal margin of mandibles, the apex of labial palpi, the anterior margin of pronotum, half of the elytral margin and the elytral apex, which are dark brown. Antennae reddish except for the last three segments, that are yellowish white. Underside of body testaceous, lacking the yellow markings on the abdomen present in the other species of the genus. Broad short head with large broad long mandibles, presenting a longitudinal furrow on their external margin and almost completely covered with golden pubescence. Small and slightly convex eyes, small-faceted. Dorsal surface of head furrowed by a longitudinal impres-

sion between the antennal bases. Broad neck, not narrowing behind the eyes. Antennae slightly longer than elytra; third segment clearly longer than fourth. All antennomeres elongated and cylindrical, except for segments 9 to 11, fairly flattened and yellowish. Eleventh antennomere appendiculate. Rather square pronotum, almost as long as wide, with a small protuberance on each side, slightly in front of the middle. Pronotal disc with four inconspicuous protuberances, the two anterior closer together than the two behind. Entire surface of pronotum and head strongly punctate, almost rugged, both covered by a short golden tomentum that becomes longer at the sides. Triangular scutellum covered by dark pubescence. Elytra relatively short, wider at the base and tapering apically, not narrowing behind the apical quarter. Round protruding humeri; suture narrowly bordered and raised. Basal third of the elytra with an oblique depression running from the humerus to the suture, delimiting a convex area. Elytral punctation coarse and scattered, formed by black disseminated punctures not reaching the posterior half of the elytra. Round dehiscent elytral apex. Elytra covered by short golden and silky tomentum which becomes reddish or black at the apex and margin of the apical third. Legs short and robust, covered by long silky golden pubescence. Tibiae slightly dilated apically. Tarsi of males not enlarged; the first metatarsal segment longer than the second and third together. Long narrow onychium. Underside of the body yellowish-testaceous and covered with long golden silky tomentum. Aedeagus of male (Fig. 11) slightly arched with a strongly acuminate apex. Lateral parameres long and slender bearing long setae at apex and some short setae on interior side.

Distribution. Philippines (Mindanao).

Trypogeus coarctatus **Holzschuh, 2006**
Fig. 19

Trypogeus fuscus: auct. nec *Toxotus fuscus* Nonfried, 1894: 209.
Trypogeus coarctatus Holzschuh, 2006: 207.

Material studied. 1 male from Indonesia, Bandar Baru, Sumatra Utara, 3-V-1999, S. Tsuyuki leg. (NOC,); 1 male from Indonesia, N Sumatra, Brastagi, 27.IV-4.V-1988, A. Saito leg. (*in* NOC); 1 female from Indonesia, SW Sumatra, Marang, W. Doherty leg, 1890 (ex coll. Oberthur) (MNHN); 1 female from Indonesia, W Sumatra, Merapi, IV.1991, S. Ymada leg. (KMC).

Redescription. Size of the male: length 10–12 mm; width 3.6 mm. Size of the female: length 14–17 mm; width 4.2 mm. The general colour of the integument is testaceous yellow, males are darker and browner. Head brown except for the upper part which is yellowish. The antennae of males are completely brown, except for the last antennomere which is yellow; in females the scapus is testaceous, the antennomeres 3–8 are brown and the remaining 9–11 are yellow. The legs of the males are brown except for the femora which are mostly yellow. The legs of the females are completely yellowish. Pronotum brown in males with the discal area yellowish, in females it is almost completely testaceous. Entirely

brown elytra, except for the basal area which is yellower, slightly lighter in the females. Elytra wider than pronotum with very obtuse humeri, rounded and projecting upwards. The suture is bordered and protruding. Apex of elytra rounded and dehiscent. The elytra are narrowed after the middle, widening slightly at apical fifth. Underside of the body and head brown except gular area which is yellow. Brown epimerae and abdominal sternites yellowish in both sexes. Large head with very short broad neck. The mandibles are long and almost entirely covered in golden tomentum. Translucid epistome, rectangular labrum bearing long golden setae on the free margin. Maxillary palpi longer than mandibles, with the last segment fusiform. Labial palpi shorter with the last segment cup-shaped. Base of the antennae with a granulous crest that extends to base of mandibles. Large prominent eyes, medium granulation. Posterior part of the head with dense golden tomentum. Antennae of males slightly longer than elytra, in females only reaching apical third. Long slender antennomeres, slightly flattened and angulose at the external distal part from antennomeres 4–10, the last is fusiform. Cylindrical pronotum, almost as wide as long in males, transverse in females, weakly arched sides with a barely protruding gibbosity before the middle. Discal area with four rather indistinct protuberances, the two anterior ones are very close to each other, the posterior pair slightly transverse in the males. Anterior border of pronotum finely margined, the posterior border is sinuate with double margination. Narrow prosternum, prosternal process in the shape of a fine lamina, hardly dilated behind. Widely opened procoxal cavities. Conical prominent coxae contiguous. Mesocoxae slightly separated in males and much more so in females, the metacoxae, contiguous in males, are separated in the females. Triangular scutellum rounded at apex. Elytral apex round and dehiscent. Elytra covered by golden tomentum which becomes reddish or black at the apex and margin of the apical third. Legs short and robust, covered by long silky golden pubescence. Tibiae slightly dilated apically. The male aedeagus (Fig. 14) is long and slightly arched, acuminated at the apex, the lower lamina is distinctlylonger than the upper. Very simple endophalus lacking interior sclerites.

Remarks. Two syntype specimens described as *Toxotus fuscus* Nonfried, 1894, were examined that correspond in reality to *Philus ophthalmicus* Pascoe, 1886 (Fig. 6). It is hereafter established that the species assigned as *Trypogeus fuscus auct.* belong to *T. coarctatus* Holzschuh. A lectotype is designated between the two syntypes studied by Nonfried, in order to establish the exact taxonomic status of the species. Lectotype, 1 male from NW Sumatra, Tebing Tinggi, Dr. Schultheiss; 12.V.1884, (DEI) (Figs 7–8).

Distribution. Indonesia (Sumatra).

Trypogeus gressitti **Miroshnikov, 2014**

Fig. 26

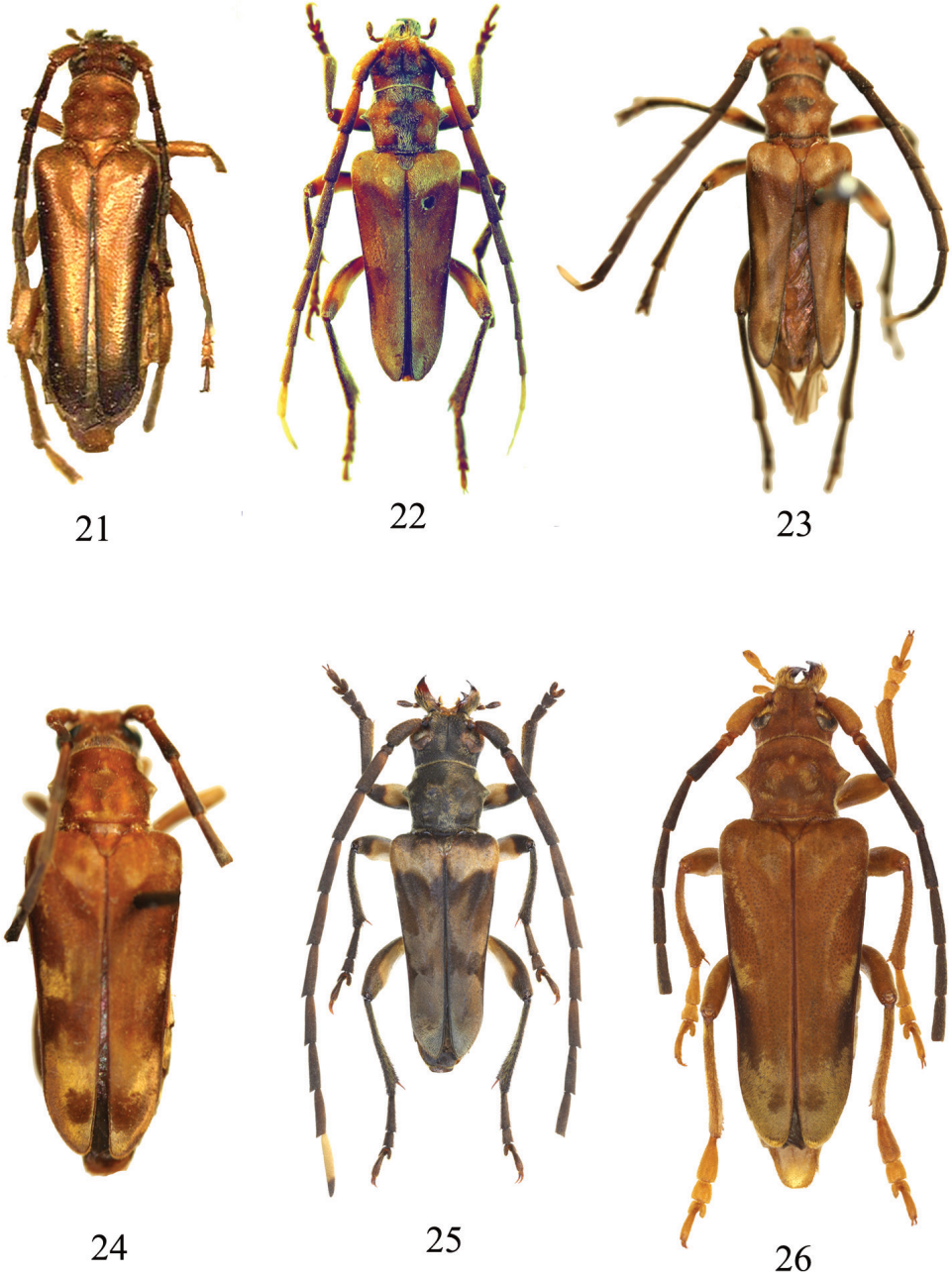
Trypogeus gressitti Miroshnikov, 2014: 55.
*Paranthophylax superbus*Gressitt & Rondon, 1970: 31 (partim).
Trypogeus superbus: Hayashi and Villiers 1985: 4, 29 (partim); Vives 2007: 54 (partim).

Material studied. 1 male holotype, Laos, Phou Kou Khouei, 1.X.1963, Vientiane, ex. coll. J.A. Rondon (BPBM); 1 female paratype, Laos, Tampheng, 15.X.1965, ex coll. J.A. Rondon (BPBM).

Redescription. Size of the male: length 10–12 mm; width 3.6 mm. Size of the female: 15.3 mm. Dorsal part of head entirely or only partially red-yellow, particularly behind eyes and in area of clypeus, black-brown between eyes and on vertex, sides and underside mostly black and dark brown with a lighter gula; black eyes and mandibles; red-yellow scutellum; elytra almost completely covered by a contrasting red-yellow fascia at base with a complicated pattern, lateral margin partly black-brown, remaining surface red-yellow. Prosternum entirely dark brown with a reddish hue, as well as mesosternum completely or mostly;part of the metasternum always including episternae and adjoining lateral surface; sternites either completely or excluding both the apical part of penultimate sternite and the last sternite, as well as last tergite; remaining surface yellow. Head narrower than pronotum at level of lateral tubercles; dorsally mostly with a granulate-rugose sculpture, with coarse confluent punctation covering most of the vertex and a sharp longitudinal median groove. Moderately developed antennal tubercles. Ventral side between eyes with abundant coarse bumps; conspicuous transverse wrinkles on gula; sharp, irregular, partly condensed punctationon either side. Antennae much longer than body, reaching beyond apex of elytra. Pronotum at level of lateral tubercles as wide as at base and as long , lateral tubercles clearly more strongly developed in females than in the males; structure of tubercles on disc and impression before tubercles at base the same as in males, sharp at apex, slightly sinuatelateral margin narrowed at apex. Disc with four tubercles, two at the base and a further two in the middle, with a very sharp, transverse, oblique impression before tubercles at base; fine granular sculpture. Triangular scutellum, subequal in length and width at base. Elytra strongly narrowed towards apex; sides straighter in apical third; conspicuously diverging along suture at apex. Prosternal process very narrow between coxae; moderately wide mesosternal process; metasternum with fine, dense, coarse punctation; wide metepisterna, moderately narrowed towards apex; sternites with fine, dense, coarse punctation. Legs robust, moderately long; femora thickened, but not claviform; metatibiae clearly emarginate at apex. Well-developed decumbent pubescence that lies in different directions giving elytra an iridescent appearance, common to other species in the genus.

Female. Head red-yellow, except for the strongly darkened apical part of mandibles and the margin of genae; entire pronotum, venter, legs, antennomeres 1–2; elytra except for the darkened apex and partially black margin. Antennomeres 3–8 black, except for a red-yellow base, most noticeably antennomeres 3 and 4 (both dorsally and ventrally); the two or three last antennomeres (see below) usually entirely pale. Head considerably narrower than pronotum at level of lateral tubercles; antennal tubercles more strongly developed and sharper than in the male; sculpture about the same as in the male; antennae usually slightly longer than body, reaching beyond apex of elytra.

Distribution. Laos.



Figures 21–26. 21 *Trypogeus apicalis* Fisher, holotype female, Java (=*T. javanicus*) **22** *Trypogeussericeus* (Gressitt), neotype, China **23** *Trypogeus superbus* (Pic)**,** holotype, Tonkin **24** *Trypogeus superbus* v. *innotatus* Pic, holotype, Vietnam (=*T. superbus* S. str.) **25** *Trypogeus murzini* Miroshnikov, holotype male, Cambodia **26** *Trypogeus gressitti*Miroshnikov, holotype male.

***Trypogeus javanicus* Aurivillius, 1925**
Fig. 20

Trypogeus javanicus Aurivillius, 1925: 2
Trypogeus apicalis Fisher, 1936: 171. **syn. n.**
Trypogeus javanicus: Hayashi and Villiers 1985: 27; Makihara et al. 2002: 190; Vives 2007: 54.
Trypogeus apicalis: Hayashi and Villiers 1985: 27; Vives 2007: 54.

Material studied. Syntype 1 male (N°23248); Syntypes, 1 female (n° 2350) Java, Tengger Berg, 4.000 f.h., Fruhstorfer leg. (NRSC); 1 male (N° 2349), 1 female (N°.2351). Holotype of *Trypogeus apicalis* Fisher, 1936, from Indonesia; 1 female, Java, G. Tangkoeban 4000–5000 Voet Prahoe Preanger, 16.II-8.III.1933, Drescher, F.C., (USNM); 1 male from Indonesia, Java, Mt. Djampang, local collector (EVC); 1 male from Java, Pengalenhan, 4000, 1893, H. Fruhstorfer leg. (EVC); 1 female from W Java., Toegoe, local collector (EVC); 1 female from Java, Preangar, P.F. Sijthaff (EVC); 1 male from Java, ex coll.Moffarts (IRSNB); 1 female from Malang, Java (IRSNB).

Redescription. Size of the male: length 9–11 mm; width 3.6 mm. Size of the female: length 14–16 mm; width 3.8 mm. The male is dark and clothed in pale tomentum. Yellowish labrum, clypeus, scapus, elytra, fore-and mid-femora. Yellow pronotum and abdomen. Frons naked, wrinkled and punctate. Antennae as long as the body with segments 3–5 subequal, segments 4–10 with slightly serrated external margin. Eyes with fine granulation, weakly emarginated. Pronotum clothed in dense white tomentum, shape subcylindrical, the widest part is before the middle, the sides have two small lateral tubercles, discal area with four gibbosities. Triangular scutellum with rounded apex and dense white silky tomentum. Elytra with broad base, almost twice as wide as the base of the pronotum, acuminate at apex with emarginate sides, each elytron is individually rounded and weakly dehiscent. Discal area with a depression from elytral base to the middle. Bordered suture. Basal tomentum white and silky, darkened suture. Anterior coxae subcontiguous, midcoxae rather separate, mesosternal process with wide, strongly bordered apex. Anterior femora thickened after apical half, longer than fourth abdominal segment. Female testaceous yellow, with golden-yellow tomentum on the head, very abundant on the external side of mandibles. Antennomeres 3–8, lateral margin and apex of elytra dark, almost black. Antennomeres 1–3 testaceous, 9–11 white. Pronotal disc with four inconspicuous gibbosities.

Remarks. I have studied the holotype of *Trypogeus apicalis* Fisher, 1933 (Lingafelter et al. 2014: 18) and can hereby confirm that it corresponds perfectly to the female of *T. javanicus*, which is why its synonymy with *Trypogeus javanicus* Aurivillius, 1925 is preoposed.

Distribution. Indonesia (Java).

Trypogeus murzini **Miroshnikov, 2014**
Fig. 25

Trypogeus murzini Miroshnikov, 2014: 57.

Material studied. 1 male holotype from Cambodia, Phuom Bokor Nat. Reserv., 600 m, 24–28.XI.2007, S. Murzin leg. (SMC).

Redescription. Size of the male: length 11.3 mm; width 3.3 mm. Head almost completely black, with only small, unequally developed, yellow specks behind antennal tubercles; eyes and mouthparts partly lighter. Antennae on dorsal side almost entirely black, bases of antennomeres 1 and 3–8 reddish, last antennomere beige, except for its black apex; ventral side of antennae mostly beige, apices of antennomeres 1, 3–8 and last black, antennomeres 9 and 10 entirely black, antennomere 2 almost-completely black. Entirely black pronotum and scutellum. Black elytra, partly black-brown at the very base before a wide yellow fascia with zigzag margins, and then it is black-brown until the apex. Venter with almost entirely black pro- and mesosterna, as well as sternites, a partly black metasternum. Legs black except for the yellow coxae. Head clearly narrower than pronotum at level of lateral tubercles; dorsally mostly with a clearly coarsely granulated sculpture, vertex predominantly with a coarse confluent punctuation. Long mandibles, strongly curved right mandible, ventral side between eyes coarsely and abundantly tuberculate; with an inconspicuous sculpture; at either side there is a clear, sparse, but in places condensed punctuation. Antennae much longer than body, reaching beyond apex of elytra by antennomere 8. Pronotum with lateral tubercles very well-developed, sharp at apex, lateral margin moderately narrowed towards its base; disc with four moderately conspicuous gibbosities, two at base and a further two in the middle; finely granulose sculpture and fine punctation. Barely elongate, triangular scutellum. Elytra strongly narrowed towards apex; straighter in apical third; each elytron narrowly rounded at apex. Very narrow prosternal process between coxae; moderately wide mesosternal process; metasternum with dense, coarse punctation; wide metepisterna, moderately narrowed towards apex. Sternites with fine, dense, rugulose punctation; last sternite slightly impressed, broad but slightly emarginate at apex. Legs robust, moderately long; femora thickened, but not claviform; metatibiae clearly emarginate at apex.

Distribution. Cambodia.

Trypogeus sericeus **(Gressitt, 1951)**
Fig. 22

Paranthophylax sericeus Gressitt, 1951: 50.
Trypogeus sericeus: Hayashi and Villiers 1985: 27; Makihara 1999: 48; Chiang and Chen 2001: 37; Hua 2002: 235; Vives 2007: 54; Hua et al. 2008: 284; Miroshnikov 2014: 53.

Material studied. 1 male neotype (designated here) 12.2 mm long and 4.3 mm wide, originating from China, Fujian Prov., Chong'an, Xingcun, Sangang, alt. 720–850m: 1960.VIII.10, leg. Shengqiao Jiang (IZAS coll., 1858382) with red label of neotype; 1 male from China, Sichuan, Huili, Yimen, alt. 2000–2200 m, 30.VII.1974, leg. Yinheng Han, IZAS coll., 1858383;1 female from China, Fujian, Sangang, 20.IX.1979, leg. Jinxing Gong, IZAS coll.1858381. A neotype is designated here because the original type described by Gressitt (1951) has not been found in the collection of Fujian Agriculture and Forestry University.

Redescription. Size of the male, length 10.6–14.1 mm; width 3.5–4.6 mm. Size of the female16.4 mm. Overall colour of the male testaceous-yellow, clothed with golden pubescence. Head subquadrate, longitudinally furrowed, eyes not very prominent. Mandibles reddish on the inner margin and blackish on external side and apex. Generally with a blackish spot between the eyes, in some specimens it can be completely black. Antennae long, extending past apex of elytra at antennomere 9, slightly serrated after antennomere 4, usually testaceousbrown from the scapus to the fourth antennomere, the last two segments are usually yellowish. Pronotum subquadrate (23/30) with four protuberances in the centre of the disc and a fifth in the middle of the posterior border. Prominent lateral gibbosities barely sharp. Disc testaceous red with a blackish cross-shaped spot. Prosternum short with very narrow prosternal process slightly enlarged towards the rear. Procoxal cavities opened, narrow mesosternum with coxal cavities separated by a bilobed and strongly punctate mesosternal process. Scutellum black and rounded at apex. Elytra long and slightly narrowed after basal third, rounded humeri very prominent. Finely bordered elytral suture slightly darker than the rest of the elytra. Elytra hunched at base, behind scutellum, with strong sparse punctures; the rest of the elytra are reddish-brown with a darker epipleural margin and much finer and sparser punctation. Apex of each elytron rounded, dehiscent sutural angle. Abdominal segments brown and punctate, clothed in golden pubescence. Short robust legs with femora dilated at middle, testaceous except for the apex which is brown. Straight tibiae vey dilated at apex, usually brown. Tarsi short and narrow, except for the first metatarsus which is almost as long as the others together. Aedeagus long and slender, very narrow median lobe, upper apical lamina shorter and narrower than the lower. Smooth endophalus lacking chitinous sclerites. Short narrow lateral parameres with rounded apex and bearing some long golden setae (Fig. 11).

Distribution. China.

Trypogeus superbus **(Pic, 1922)**

Fig. 23

Toxotus superbus Pic, 1922: 22.
Toxotus superbus var. *innotatus* Pic: 16. **syn. n.**
Paranthophylax superbus: Gressitt and Rondon 1970: 31 (partim).
Trypogeus superbus, Hayashi and Villiers 1985: 27 (partim); Vives 2007: 54 (partim); Miroshnikov 2014: 54.

Material studied. 1 male holotype, Hao Djing, Tonkin, "Type", "Toxotus superbus"; "Museum Paris, coll. M.Pic" (MNHN). 1 female from W Tonkin, region of Hoa Binh, R.P.A. de Cooman, 1918, (ex coll. Oberthur, 1952), (MNHN). 1 female holotype of *Toxotus superbus v. innotatus* Pic, from Vietnam, Hoa Bihn (MNHN); 1 female from Vietnam, Lukbiho, Tonkin, (MNHN); 1 male from Laos, Kinsey Kuany, (MNHN); 1 female from South Vietnam, Bao Loc, 1800 m, 25.IV.1993, Sinaiev & Simonov leg. (EVC).

Redescription. Size of the male: length 9–13 mm; width 4 mm. Size of the female: length 15.8 mm. Males generally have testaceous-yellow teguments; the mandibles, antennomeres 3–9, tibiae and tarsi are brown, almost black. The front and rear margins of the pronotum are brown, as well as a rounded spot in the centre of the disc. Reddish palpi. Underside of head, prosternum, sides of mesosternum and metasternum and abdominal tergites brown. Base of antennomeres 1–4 yellowish, antennomere 10 half yellow and the other half testaceous, antennomere 11 yellow. Abdominal segments brown in males and yellow in females. Head large, almost transverse, the neck strongly sunk into the pronotum, eyes small and not very prominent. Mandibles strongly curved at apex, the right mandible crosses over the left. Long palpi, the last segment is oval and truncate with a depression on each side. Long antennae, extending past apex of elytra after antennomere 9, somewhat dentate externally. Head grooved longitudinally and strongly punctate. Pronotum subcylindrical, the maximum width is at the height of the lateral protuberances which are small, conical and sharp. The discal area has four gibbosities and is more strongly punctate in the centre where it has a dark spot. Long golden tomentum. Short broad prosternum. Very slender intercoxal process, barely widened behind. Procoxal cavities opened and very extended to the sides, reaching sides of pronotum. Triangular scutellum with rounded apex. Elytra narrow with rounded prominent humeri, slightly narrowed at the middle and slightly rounded at apex. Suture blackish and finely bordered, sides and epipleurae also blackish. Discal area slightly raised and convex. Mesosternum with short broad mesoepisternae, finely punctate and pubescent. Mesocoxal cavities open laterally. Broad mesosternal process and coxae very separate. Metasternum with coxae almost in contact. Abdomen with short wide sternites, finely punctate and with golden tomentum. Legs short and robust with femora widened at middle. Tibiae straight and dilated at apex. Tarsi dark and punctate, the first segment of metatarsi is longer than the other segments together.

Distribution. Laos and Vietnam.

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References

Aurivillius C (1912) Cerambycidae: Cerambycinae. In: Junk W, Schenkling S (Eds) Berlin. Coleopterorum Catalogus 39: 1–574.

Aurivillius C (1925) Neue oder wenig bekannte Coleoptera Longicornia. 20. Arkiv för Zoologi. Bd. 17. Ser. A. No. 12. S: 481–501.

Boppe PL (1921) Coleoptera, Longicornia Fam. Cerambycidae, Subfam. Disteninae-Lepturinae. In: Wytsman P (Ed.) Genera Insectorum 178: 1–121.

Chiang Y, Chen L (2001) Coleoptera, Cerambycidae, Lepturinae. Fauna Sinica. Insecta, vol. 12. Science Press, Beijing, 296 pp.

Danilevsky ML (1979) Description of the female, pupa and larva of *Apatophysis pavlovskii* Plav., and discussion of systematic position of the genus *Apatophysis* Chevr. (Coleoptera, Cerambycidae). Entomologicheskoe. Obozrenie 58: 821–828. [In Russian]

Fisher WS (1936) Fauna Javanica. New Cerambycidae from Java. – Tijdschrift voor Entomologie. Deel 79.Afl. 3–4, 169–198.

Gressitt JL (1951) Longicorn beetles of China. In: Lepesme P (Ed.) Longicornia 2. Paul Lechevalier, Paris, 1–667.

Gressitt JL, Rondon JA (1970) Cerambycids of Laos (Disteniidae, Prioninae, Philinae, Aseminae, Lepturinae, Cerambycinae). Pacific Insects Monograph 24: 1–314.

Hayashi M, Villiers A (1985) Revision of the Asian Lepturinae (Coleoptera: Cerambycidae) with special reference to the type specimens' inspection, PartI. Bulletin of Osaka Jonan Women's Junior College 19–20: 1–75, 15pl.

Holzschuh C (2006) Beschreibung von 51 neuen Bockkäfern aus der palaearktischen und orientalischen Region, vorwiegend aus Borneo und China (Coleoptera, Cerambycidae). Entomologica Basiliensia et Collectionis Frey. Bd. 28.S: 205–276.

Hua LZ (2002) Listof Chinese Insects, vol. II. Zhogshan (Sun Yat-sen) University Press, Guangzhou, 189–237.

Hua LZ, Nara H, Samuelson GA, Lingafelter SW (2009) Iconography of Chinese Longicorn Beetles (1406 Species) in Color. Sun Yat-sen University Press, Guangzhou, 474 pp.

Lacordaire T (1868) Histoire Naturelle des Insectes. Genera des Coléoptères ou exposé méthodique et critique de touts les genres proposés jusqu'ici dans cet ordre d'insectes 8. Roret, Paris, 552 pp.

Lacordaire T (1869) Histoire Naturelle des Insectes. Genera des Coléoptères ou exposé méthodique et critique de touts les genres proposés jusqu'ici dans cet ordre d'insectes 9. Roret, Paris, 409 pp.

Lingafelter SW, Nearns EH, Tavakilian GL, Monné MA, Biondi M (2014) Lonhorned Woodboring Beetles (Coleoptera: Cerambycidaae and Distenidae). Primary Types of the Smithsonian Institution. Smithsonian Institution Scholary Press, Washington, DC, 390 pp.

Löbl I, Smetana A (Eds) (2010): Catalogue of Palearctic Coleoptera, vol. 6. Stenstrup, Apollo Books, 924 pp.

Lobanov A, Danilevsky ML, Murzin SV (1981) Systematic list of Longicorn beetles (Coleoptera, Cerambycidae) of the USSR. I. Entomologisceskoe Obozrenie 60(4): 784–803.

Makihara H (1999) Atlas of Longicorn Beetles in BukitSoehartoEducationForest, MulawarmanUniversity, East-Kalimantan, Indonesia. Pusrehut, Special Publication 7: 1–140.

Makihara H, Simbolon H (2002) Longicorn Beetles from Gunung Halimun N.P. West Java, Indonesia, from 1997–2002 (Col. Distenidae and Cerambycidae). Bulletin FFPRI 1(3): 189–223.

Miroshnikov A (2014) In: Konstantinov AS, Ślipiński SA, Solodovnikov Ayu (Eds) Advances in studies on Asian cerambycids (Coleoptera: Cerambycidae). KMK Scientific Press Ltd., Krasnodar, Moscow, 51–71.

Nonfried AF (1894) Beiträge zur Coleopteren-Fauna von Tebing-Tinggi (Süd-Sumatra). Cerambycidae. Deustche entomologische Zeitschrift, 193–215.

Özdikmen H (2008) A nomenclatural act: some nomenclatural changes on Palearctic lonhorned beetles (Coleoptera: Cerambycidae). Munis Entomology and Zoology 3(2): 707–715.

Pic M (1903a) Diagnoses préliminaires de Longicornes du Yun Nam. L'Échange, Revue Linnéenne. Année 39.No. 221.P: 121.

Pic M (1903b) Contribution à la faune de la Chine. In: Matériaux pour servir à l'étude des Longicornes. 4me cahier. 2me partie. Imprimerie Bussière, Saint-Amand (Cher), 18–25.

Pic M (1927) Coléoptères du Globe. Mélanges Exotico-Entomologiques. Fasc. 50, 1–36.

Svacha P, Danilevsky ML (1987) Cerambycoid larvae of Europe and Soviet Union (Coleoptera, Cerambycoidea) Part I. Acta Universitatis Carolinae-Biologica 30: 1–176.

Svacha P, Danilevsky ML (1989) Cerambycoid larvae of Europe and Soviet Union (Coleoptera, Cerambycoidea) Part III. Handbook of Zoology. Acta Universitatis Carolinae- Biologica 32: 1–205.

Svacha P, Lawrence JF (2014) Coleoptera, Beetles. Morphology and Systematics (Phytophaga). In: Handbook of Zoology. Arthropoda. Insecta. De Gruyter Ed. Vol 3, 77–177.

Villiers A, Quentin A, Vives E (2011) Cerambycidae, Dorcasominae de Madagascar. Ex Natura 3: 1–385.

Vives E (2005) Notes on Lepturinae (XI). Four new species of Lepturinae from South East Asia (Coleoptera, Cerambycidae). Lambillionea 105(2): 302–306.

Vives E (2007) El género *Trypogeus* Lacordarie, 1869 (Coleoptera, Cerambycidae) y su posición sistemática. Nouvelle Revue d'Entomologie (N.S.) 24(1): 53–59.

Vives E, Heffern D (2006) Description of a New Genus from Borneo and New Status of Southeast Asian Apatophysinae (Coleoptera: Cerambycidae). Les Cahiers Magellanes, Paris, 60: 1–7.

Vives E, Heffern D (2012) Description and notes on Oriental longhorned beetles, mostly from Borneo. (Coleoptera, Cerambycidae). Les Cahiers Magellanes, Paris, NS 10: 1–17.

Yamasako J, Ohbayashi N (2011) Review of the genus *Paragolsinda* Breuning, 1956 (Coleoptera, Cerambycidae). Zootaxa 2882: 35–50.

Wang ZC, Hua LZ (2009) Collect and revision of list on longicorn beetles in China. Journal of Beihua University (Natural Science). Vol. 10. No. 2, 159–192.

Weigel A, Meng LZ, Lin MY (2013)Contribution to the Fauna of Longhorn Beetles in the Naban River Watershed National Nature Reserve. Formosa Ecological Company, Taiwan, 1–219.

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A taxonomic review of Korean species of the *Atheta* Thomson subgenus *Microdota* Mulsant & Rey, with descriptions of two new species (Coleoptera, Staphylinidae, Aleocharinae)

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Abstract

A taxonomic review of the *Atheta* Thomson subgenus *Microdota* Mulsant & Rey in Korea is presented. The subgenus is represented in Korea by 15 species including two new species, *Atheta* (*Microdota*) *jangtaesanensis* Lee & Ahn, **sp. n.** and *A.* (*M.*) *pasniki* Lee & Ahn, **sp. n.** Four species [*A.* (*M.*) *kawachiensis* Cameron, *A.* (*M.*) *muris* Sawada, *A.* (*M.*) *spiniventris* Bernhauer, and *A.* (*M.*) *spinula* (Sawada)] are new to the Korean Peninsula and two [*A.* (*M.*) *formicetorum* Bernhauer and *A.* (*M.*) *subcrenulata* Bernhauer] to South Korea. Two other species [*A.* (*M.*) *kobensis* Cameron and *A.* (*M.*) *scrobicollis* (Kraatz)] previously recorded in North Korea had been identified incorrectly. A key, descriptions, habitus photographs and illustrations of the diagnostic features are provided. Species distributions and diversity in East Asia are discussed.

Keywords

Coleoptera, Staphylinidae, Aleocharinae, *Atheta*, *Microdota*, new species, Korea

Introduction

Mulsant and Rey (1873) proposed the genus name *Microdota* and described seven species. Since Ganglbauer (1895) first treated it as a subgenus of *Atheta*, Fenyes (1920), Yosii and Sawada (1976), Smetana (2004), and others followed his concept. Later,

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many additional species were described or transferred to the subgenus *Microdota* from other subgenera (for example, see Lynch Arribálzaga 1884; Peyerimhoff 1938; Scheerpeltz 1976). Although they are common in diverse microhabitats, nothing is known of their biology and immature stages.

The *Atheta* subgenus *Microdota* contains 215 species in the Palaearctic region. In East Asia, 40 species and 20 species were recorded in China and in Japan respectively (Smetana 2004). Paśnik (2001) reported 13 species including three new species from North Korea. We found that two species, *A.* (*M.*) *kobensis* Cameron and *A.* (*M.*) *scrobicollis* (Kraatz), were incorrect identifications of other *Atheta* (*Microdota*) species. Smetana (2004) transferred two other species, *Atheta mortuorum* (Thomson) and *A. nana*, treated in the subgenus *Microdota* by Paśnik (2001), to the subgenera *Pachyatheta* Munster and *Badura* Mulsant & Rey, respectively. None was recorded in South Korea.

In this study we recognize 15 *Atheta* (*Microdota*) species in Korea including two new species, *Atheta* (*Microdota*) *jangtaesanensis* Lee & Ahn, sp. n. and *A.* (*M.*) *pasniki* Lee & Ahn, sp. n. Four species, *A.* (*M.*) *kawachiensis* Cameron, *A.* (*M.*) *muris* Sawada, *A.* (*M.*) *spiniventris* Bernhauer, and *A.* (*M.*) *spinula* (Sawada) are newly added to the Korean fauna and two other species, *A.* (*M.*) *formicetorum* Bernhauer and *A.* (*M.*) *subcrenulata* Bernhauer, are identified for the first time in South Korea. A key to Korean *Atheta* (*Microdota*) species, descriptions, habitus photographs, and line drawings of diagnostic characters are provided.

The first author studied North Korean species in the Institute of Systematics and Evolution of Animals (ISEA), Kraków, Poland. All the other examined specimens are deposited in the Chungnam National University Insect Collection (CNUIC), Daejeon, Korea. Type specimens of *Atheta* (*Microdota*) species were also borrowed from the Field Museum of Natural History (FMNH), Chicago, USA, Museum für Naturkunde (MNHB), Berlin, Germany and the Natural History Museum (NHM), London, UK to have more reliable identifications. The explanation of labels is placed in square brackets in order to provide clearer collecting data in the material examined section.

Results

Genus *Atheta* Thomson, 1858

Subgenus *Microdota* Mulsant & Rey, 1873

See Smetana (2004) for detailed synonymy.

Diagnosis. Members of *Microdota* can be distinguished from other subgenera of *Atheta* by combination of the following characters: body small, parallel-sided; antennomere 2 distinctly longer than 3, 5–10 transverse; median region of prementum very narrow, without pseudopore; pronotum transverse, more than 1.2 times as wide as long, with

midline of pubescence directed anteriorly in most; hypomera fully visible in lateral aspect; tarsal formula 4-5-5; flabellum reduced; abdominal tergites II–III without anterior macroseta in most, III–VI impressed in basal region, VI about as long as VII; internal sac of median lobe of aedeagus well developed (Fenyes 1920, Benick and Lohse 1974, Yosii and Sawada 1976, Seevers 1978).

Key to Korean species of the subgenus Microdota Mulsant & Rey

1 Eyes small, shorter than tempora **2**
– Eyes medium or large, at least as long as or longer than tempora..... **5**
2 Infraorbital carina complete; male abdominal sternite VIII with 8 macrosetae on each side of midline ..... ***Atheta* (*Microdota*) *silvatica***
– Infraorbital carina incomplete; male abdominal sternite VIII with 7 macrosetae on each side of midline..... **3**
3 Abdominal tergites with transversely striate microsculpture .... ***A.* (*M.*) *hamgyongsani***
– Abdominal tergites with imbricate microsculpture **4**
4 Body smaller, less than 1.6 mm; antennomeres more transverse (Fig. 29); posterior margin of male abdominal tergite VIII slightly modified as in Fig. 38; male abdominal sternites V–VII with many small pores..... ..... ***A.* (*M.*) *jangtaesanensis* sp. n.**
– Body larger, more than 1.6 mm; antennomeres less transverse (Fig. 33); posterior margin of male abdominal tergite VIII different as in Fig. 42; male abdominal sternites V–VII without many small pores..... ***A.* (*M.*) *pasniki* sp. n.**
5 Infraorbital carina incomplete..... **6**
– Infraorbital carina complete..... **8**
6 Eyes about as long as tempora; antennomeres more transverse, 11 slightly longer than preceding two combined (Fig. 28)..... ***A.* (*M.*) *palleola***
– Eyes slightly longer than tempora; antennomeres less transverse, 11 as long as preceding two combined (Fig. 35) **7**
7 Body reddish brown; abdominal tergites with transversely striate microsculpture..... ***A.* (*M.*) *sogamensis***
– Body yellowish brown; abdominal tergites with imbricate microsculpture .... ***A.* (*M.*) *spinula***
8 Antennomere 11 slightly longer than preceding two combined (Figs 28, 34); posterior margin of male abdominal tergite VIII with process (Figs 37, 43) **9**
– Antennomere 11 as long as or shorter than preceding two combined (Figs 29–33, 35–36); posterior margin of male abdominal tergite VIII without processes (Figs 38–42, 44–45) **10**
9 Labrum with about 11–12 macrosetae on each side of midline; mandibles with denticles in molar region; posterior margin of male abdominal tergite VIII with two processes (Fig. 37); male abdominal sternite VIII with 8 macrosetae on each side of midline..... ***A.* (*M.*) *formicetorum***

– Labrum with about 8 macrosetae on each side of midline; mandibles without denticles in molar region; posterior margin of male abdominal tergite VIII with more than two processes (Fig. 43); male abdominal sternite VIII with 7 macrosetae on each side of midline ..... ***A.* (*M.*) *spiniventris***

10 Abdominal tergites with imbricate microsculpture **11**

– Abdominal tergites with reticulate microsculpture (Sawada 1974: figs 10F, 11F, 18F)..... **3**

11 Antennomere black; abdominal tergite VIII with 5 macrosetae on each side of midline (Paśnik 2001: fig. 27) ..... ***A.* (*M.*) *kangsonica***

– Antennomere yellowish brown to dark brown; abdominal tergite VIII with 4 macrosetae on each side of midline (Figs 37–45)..... **12**

12 Body surface less glossy; pronotum, elytra and abdominal tergites II–IV reddish brown and darker; male sternite VIII with 7 macrosetae on each side of midline ..... ***A.* (*M.*) *kawachiensis***

– Body surface more glossy; pronotum, elytra and abdominal tergites II–IV yellowish brown and brighter; male sternite VIII with 8 macrosetae on each side of midline ..... ***A.* (*M.*) *muris***

13 α-sensillum of epipharynx shorter (Sawada 1974: fig. 18B); abdominal tergites with slightly reticulate microsculpture; male abdominal sternites V–VII without many small pores ..... ***A.* (*M.*) *koreana***

– α-sensillum of epipharynx longer (Sawada 1974: figs 10B; 11B); abdominal tergites with distinctly reticulate microsculpture; male abdominal sternites V–VII with many small pores **14**

14 Paramedian apophyses of internal sac longer, laterally produced basal plate narrower, copulatory piece less obtuse (Sawada 1974: fig. 10J); spermathecal duct less elongate (Sawada 1974: fig. 10N) ..... ***A.* (*M.*) *amicula***

– Paramedian apophyses of internal sac shorter, laterally produced basal plate broader, copulatory piece more obtuse (Sawada 1974: fig. 11J–K); spermathecal duct more elongate (Sawada 1974: fig. 11N) ..... ***A.* (*M.*) *subcrenulata***

***Atheta* (*Microdota*) *amicula* (Stephens, 1832)**

Fig. 1

Aleochara amicula Stephens, 1832: 132.

Aleochara picipennis Stephens, 1832: 132 (as valid species); Fenyes 1920: 186; Smetana 2004: 384 (as synonym of *Atheta amicula*).

Homalota sericea Mulsant & Rey, 1852: 41 (as valid species); Fenyes 1920: 186; Brundin 1948: 32; Smetana 2004: 384 (as synonym of *Atheta amicula*).

Homalota subsericea Wollaston, 1864: 540 (as valid species); Fenyes 1920: 186; Smetana 2004: 384 (as synonym of *Atheta amicula*).

Homalota jezabel Saulcy, 1865: 438 (as valid species); Fenyes 1920: 186; Smetana 2004: 384 (as synonym of *Atheta amicula*).

Microdota terricola Mulsant & Rey, 1873b: 351 (as valid species); Fenyes 1920: 186; Smetana 2004: 384 (as synonym of *Atheta amicula*).

Homalota meludyi Quedenfeldt, 1884: 366 (as valid species); Fenyes 1920: 186; Smetana 2004: 384 (as synonym of *Atheta amicula*).

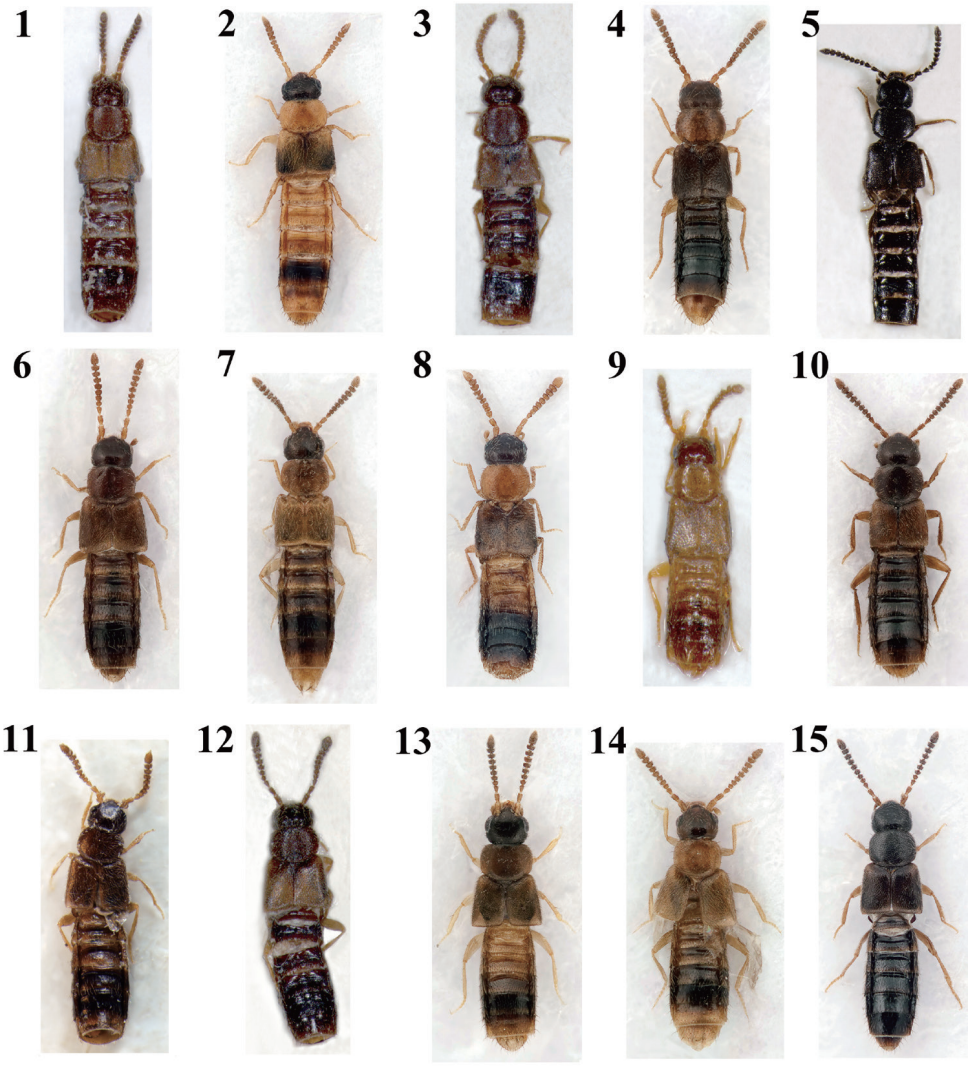
Atheta (*Microdota*) *amicula attarum* Bernhauer, 1929: 201 (as valid species); Smetana 2004: 384 (as synonym of *Atheta amicula*).

Atheta (*Microdota*) *nuda* G. Benick, 1975: 4 (as valid species); Smetana 2004: 384 (as synonym of *Atheta amicula*).

Atheta (*Microdota*) *amicula*: Brundin 1948: 32; Palm 1970: 190; G. Benick and Lohse 1974: 163; Sawada 1974: 164; Pace 1990: 906; Paśnik 2001: 207; Smetana 2004: 384 (as valid species).

Material examined. Syntype, 3 exx., labeled as in Figs 82–83. NORTH KOREA: 3 exx., Corea sept 1987 Hyjćhon & vicin. Exped. ISEZ Cr. [North Korea, Jagang Prov., Huicheon-si, 1987, ISEA]; 3 exx., Corea sept. Kangvon–do 9–14 X 1991 [North Korea, Gangwon Prov., 9–14.x.1991]; 3 exx., Corea sept. 1987 Tanćhon & vic. Exped. ISEZ Cr.; 6 exx., Korea 5-8.6.1974 prov. Kesong-si Exp. Inst.Zool.Cr. [North Korea, Gyeonggi Prov. Gaeseong-si, 5–8.vi.l974, ISEA]; 4 exx., Korea 16-18.6.74. Kymgangsan Mts. Exp. Inst.Zool.Cr. [North Korea, Gangwon Prov., Mt. Geumgangsan, 16–18.vi.1974, ISEA].

Description. Length 1.6–2.0 mm. Body (Fig. 1) slender and parallel-sided, more or less flattened; surface fairly glossy and densely pubescent, with fine microsculpture. Body usually reddish brown to dark brown; head and abdomen slightly darker than other parts; elytra slightly paler than pronotum; legs yellowish brown. *Head.* Quadrate, about as wide as long, widest across eyes, slightly narrower than pronotum; eyes moderate in size and slightly prominent, about 1.0–1.2 times longer than tempora; infraorbital carina complete; gular sutures moderately separated, diverged basally. Antennae dilated apically, slightly longer than head and pronotum combined; antennomeres 1–3 elongate, 1 longest, 4–10 distinctly transverse, 11 longer than wide, about as long as preceding two combined. *Thorax.* Pronotum transverse, approximately 1.3 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Elytra slightly transverse, slightly wider than pronotum, elytron approximately 1.7 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; meso- and metatarsomeres 1–4 subequal in length. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely pubescent; male tergite VIII with 4 macrosetae on each side of midline, posterior margin slightly emarginate, with slight crenation; male sternite VIII with 7 macrosetae on each side of midline, posterior margin rounded; posterior margin of female tergite VIII subtruncate; posterior margin of female sternite VIII broadly rounded, with long and short marginal setae. *Genitalia.* Median lobe elongated oval; apical process convergent at apex in ventral aspect. Spermatheca with relatively large bursa; duct recurved apically.



Figures 1–15. Habitus: **1** *Atheta* (*Microdota*) *amicula*, 1.8 mm **2** *A.* (*M.*) *formicetorum*, 2.4 mm **3** *A.* (*M.*) *hamgyongsani*, 1.7 mm **4** *A.* (*M.*) *jangtaesanensis* sp. n., 1.4 mm **5** *A.* (*M.*) *kangsonica*, 2.6 mm **6** *A.* (*M.*) *kawachiensis*, 1.8 mm **7** *A.* (*M.*) *koreana*, 1.6 mm **8** *A.* (*M.*) *muris*, 1.7 mm **9** *A.* (*M.*) *palleola*, 1.6 mm **10** *A.* (*M.*) *pasniki* sp. n., 2.1 mm **11** *A.* (*M.*) *silvatica*, 1.9 mm **12** *A.* (*M.*) *sogamensis*, 2.0 mm **13** *A.* (*M.*) *spiniventris*, 1.8 mm **14** *A.* (*M.*) *spinula* **15** *A.* (*M.*) *subcrenulata*, 2.0 mm.

Distribution. Korea (North), China (Beijing), Cyprus, Israel, Europe (Austria, Azores, Croatia, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Iceland, Ireland, Italy, Lithuania, Luxembourg, Malta, Macedonia, The Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and Ukraine), Russia (North European Territory and West Siberia), Neotropical region and North Africa (Algeria, Canary Islands, Egypt, Morocco, Madeira Archipelago).

Remarks. This species was recorded by Paśnik (2001) in North Korea and a dissected specimen was unavailable. Accordingly, we could not describe the mouthparts and aedeagus in detail. This species has been known to be often found on mushrooms (Palm 1970).

***Atheta* (*Microdota*) *formicetorum* Bernhauer, 1907**
Figs 2, 28, 37, 46, 55, 64, 73

Atheta (*Microdota*) *formicetorum* Bernhauer, 1907: 400; Paśnik 2001: 206; Smetana 2004: 385 (as valid species).
Atheta (*Amidobia*) *formicetorum*: Sawada 1974: 162 (as valid species).

Material examined. Syntype, 1♀, labeled as in Fig. 84. NORTH KOREA: 1 ex., Corea sept. Kangvon–do 9–14 X 1991 [North Korea, Gangwon Prov., 9–14.x.1991]. SOUTH KOREA: Chungbuk Prov.: 3 exx., Danyang-gun, Yeongchun-myeon, Mt. Taehwasan, 14.vii–14.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT;; Chungnam Prov.: 5 exx., Daejeon-si, Dong-gu, Daeseong-dong, Mt. Sikjangsan, Secheon park, 30.vii.2000, MH Kim, mushroom; 10 exx., Gongju-si, Banpo-myeon, Sangsin-ri, Mt. Gyeryongsan, 26.viii.2001, MH Kim, mushroom; Gangwon Prov.: 46 exx., Yangyang-gun, Seomyeon, Mt. Seoraksan, Osaekyaksu, 16.viii.2000, MH Kim, mushroom; Gyeongbuk Prov.: 51 exx., Sangju-si, Hwanam-myeon, imgok-ri, Mt. Cheongtaesan, 10.ix.2000, MH Kim, mushroom; 11 exx., same data as the former except '27.vii.2001'; 3 exx., Uljin-gun, Onjeong-myeon, Mt. Baekamsan, Sinseon valley, 12.viii.1999, HJ Kim, mushroom; Gyeonggi Prov.: 3 exx., Yangju-gun, Jangheung-myeon, Songchu-ri, Mt. Bukhansan, 26.vii–31.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT.

Description. Length 1.8–2.5 mm. Body (Fig. 2) subparallel-sided, surface glossy, densely pubescent. Body usually reddish yellow to yellowish brown; head almost black; abdominal segment VI darker than other segments. *Head.* Slightly transverse, approximately 1.1–1.2 times wider than long, widest across eyes, slightly narrower than pronotum; eyes distinctly large and prominent, about 1.8–2.0 times longer than tempora; infraorbital carina complete; gular sutures moderately separated; cervical carina complete. Antennae (Fig. 28) long and slender, dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 distinctly transverse, 11 longer than wide, about as long as preceding two combined. *Mouthparts.* Labrum transverse, anterior margin emarginate; two lateral sensilla and about 11–12 macrosetae present on each side of midline; α-sensillum setaceous, about twice as long as ε-sensillum, β- and γ-sensilla reduced. Mandibles asymmetrical, pointed apically, about 1.6–1.7 times as long as basal width; many denticles present in molar region; right one with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb region, two isolated spines present, distal comb region and isolated spines narrowly separated; maxillary palpus elongate, with pubescence and long setae; palpomere 1 about 1.6–1.8 times longer than wide, 2 about 2.5–2.6 times longer than wide, 3 slightly longer than 2, about 2.6–2.8 times as long as wide, 4 digiti-

form, filamentous sensilla reaching to apical half. Labium with ligula narrowly long, divided into two lobes in basal half; two medial setae narrowly separated; two basal pores closed together; lateral pseudopores, one setal pore and two real pore present on each side of prementum; palpus elongate, with many setulae; palpomere 1 largest and dilated basally, about 1.5–1.7 times longer than wide, with γ-setula close b-setula, 2 shortest, about 1.4–1.6 times longer than wide, 3 slightly dilated apically, about as long as 1, about 3.0–3.5 times longer than wide. *Thorax.* Pronotum distinctly transverse, approximately 1.3–1.4 times wider than long, widest in apical third; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and about 3–4 short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process pointed at apex, as long as or slightly longer than isthmus and metaventral process combined; length ratio of mesoventral process, isthmus and metaventral process 16:5:10. Elytra slightly wider than pronotum; elytron approximately 1.5–1.6 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited about four setose lobes. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; length ratio of tarsomeres 22:24:25:65 (protarsus); 26:29:29:32:64 (mesotarsus); 35:33:31:30:69 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle, surface fairly glossy and densely pubescent, with imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02 (or 12)-12-12-13; ; male tergite VII with small and round tubercle in postero-median region; male tergite VIII (Fig. 37) with 4 macrosetae on each side of midline, posterior margin with two outer processes and two inner processes, outer process narrower and longer than inner process; male sternites VI–VII with many pores in anterior margin, VIII with 8 macrosetae on each side of midline, posterior margin convex, crenate in median region; posterior margin of female tergite VIII emarginate; posterior margin of female sternite VIII slightly emarginate at middle, with conspicuous and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 46, 55) elongated oval; apical process convergent at apex in ventral aspect. Apical lobe of paramerites (Fig. 64) small and globular, with four setae, a- and b-setae longer than c- and d-setae, b-seta longest, c- and d-setae short, subequal in length. Spermatheca (Fig. 73) with bursa large and fusiform; umbilicus absent; duct short, round apically.

Distribution. Korea (South, North) and Japan.

Remarks. This species is identified for the first time in South Korea. Most specimens were found on mushrooms in forest.

***Atheta* (*Microdota*) *hamgyongsani* Paśnik, 2001**

Fig. 3

Atheta (*Microdota*) *hamgyongsani* Paśnik, 2001: 211; Smetana 2004: 385 (as valid species).

Material examined. Holotype, ♂, labeled as follows: 'Corea septentr. Hamgjong-pukdo 2-6 X 1991 ISEZ, HOLOTYPE Atheta (Microdota) hamgyongsani sp. n. det. G. Paśnik 2000' [North Korea, Hamgyeongbuk Prov., 2–6.x.1991, ISEA].

Description. Length 1.6–1.8 mm. Body (Fig. 3) slender and parallel-sided, more or less flattened; surface distinctly glossy and densely pubescent, with fine microsculpture. Body usually reddish brown; head and abdomen slightly darker than other parts; antennae and legs paler. *Head.* Subquadrate, about as wide as long, widest across eyes, slightly narrower than pronotum; eyes small and slightly prominent, about 0.6–0.7 times longer than tempora; infraorbital carina incomplete; gular sutures moderately separated, dilated apically. Antennae dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 distinctly transverse, 11 longer than wide, about as long as preceding two combined. *Thorax.* Pronotum transverse, approximately 1.3 times wider than long, widest at apical third; pubescence directed posteriorly in midline. Elytra slightly transverse, slightly wider than pronotum, elytron approximately 1.5 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin slightly sinuate; hind wings fully developed. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; meso- and metatarsomeres 1–4 subequal in length. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely pubescent; male tergite VIII with 4 macrosetae on each side of midline, posterior margin subtruncate; male sternite VIII with 7 macrosetae on each side of midline, posterior margin rounded. *Genitalia.* Median lobe (Paśnik 2001: Figs 30–31) oval; apical process abruptly convergent at apex in ventral aspect.

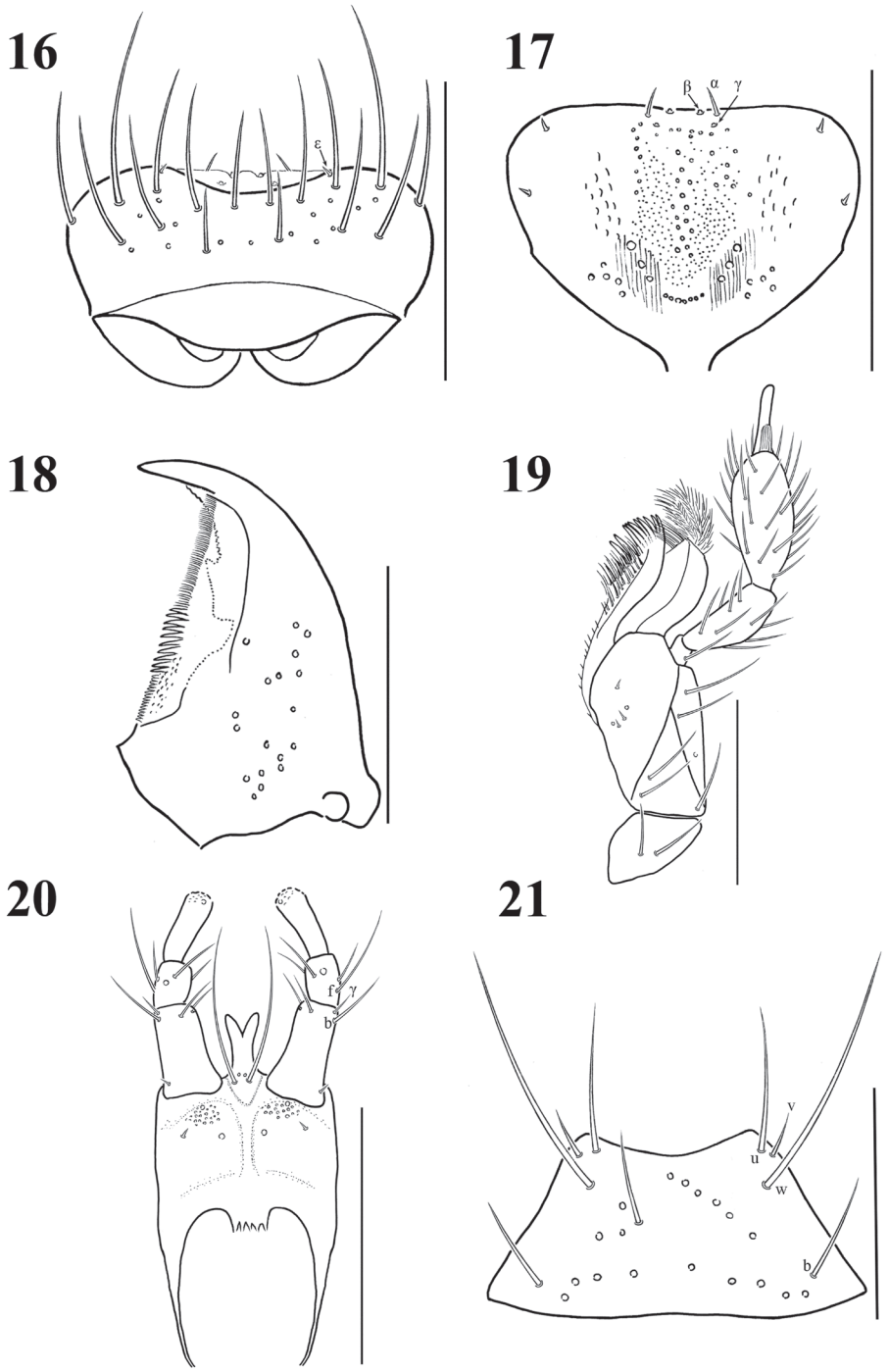
Distribution. Korea (North).

Remarks. This species was recorded by Paśnik (2001) in North Korea and a dissected specimen was unavailable. Accordingly, we could not describe the mouthparts and aedeagus in detail.

***Atheta* (*Microdota*) *jangtaesanensis* Lee & Ahn, sp. n.**
http://zoobank.org/68BC54E8-FC59-4131-BFD0-282F07B5E50B
Figs 4, 16–21, 29, 38, 47, 56, 65, 74

Material examined. Holotype, labeled as follows: 'KOREA: Chungnam prov., Daejeon-si, Seo-gu, Jangan-dong, Mt. Jangtaesan, N36°13'03.3", E127°20'36.2", 258 m, 28 III 2012, DH Lee, TK Kim, SG Lee, leaf litter; HOLOTYPE, *Atheta* (*Microdota*) *jangtaesanensis* Lee and Ahn, Desig. S.-G. Lee and K.-J. Ahn 2015.' Deposited in CNUIC, Daejeon. Paratypes, 11 exx. (total); 4 exx., same data as holotype; 6 exx., same data as holotype except '5 IV 2013, SG Lee'.

Description. Length 1.3–1.6 mm. Body (Fig. 4) slender and parallel-sided, more or less flattened dorso-ventrally; surface significantly glossy, densely pubescent, with fine microsculpture. Body usually reddish brown to reddish black; pronotum slightly paler than other parts; legs yellowish brown. *Head.* Subquadrate, approximately 1.0–1.1 times wider than long, widest behind eyes, slightly narrower than pronotum; eyes relatively small and prominent, about 0.7–0.8 times longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina incomplete; cervical carina almost complete. Antennae (Fig. 29) dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 transverse, 11 about as long as preceding two combined. *Mouthparts.* Labrum (Fig. 16) transverse, anterior margin emarginate; two lateral sensilla and about 8–9 macrosetae present on



Figures 16–21. Mouthparts of *Atheta* (*Microdota*) *jangtaesanensis* sp. n.: **16** labrum, dorsal aspect **17** epipharynx, ventral aspect **18** right mandible, ventral aspect. **19** right maxilla, ventral aspect **20** labium, ventral aspect **21** mentum, ventral aspect. Scale bars: 0.1 mm.

each side of midline; α-sensillum relatively long and setaceous, more than twice as long as ε-sensillum, β- and γ-sensilla reduced; epipharynx as in Fig. 17. Mandibles asymmetrical, pointed apically, approximately 1.7 times as long as basal width; right one (Fig. 18) with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb region, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about twice as long as wide, 2 about 2.2–2.4 times longer than wide, 3 slightly longer than 2, about 2.6–2.8 times as long as wide, 4 digitiform, filamentous sensilla reaching to basal half (Fig. 19). Labium (Fig. 20) with ligula narrowly long, divided into two lobes in basal half; two medial setae narrowly separated; two basal pores closed together; lateral pseudopores, one setal pore and two real pores present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest, about twice longer than wide, with γ-setula close b-setula, 2 shortest, about as long as wide, 3 dilated apically, about 2.4–2.5 times longer than wide. Mentum (Fig. 21) trapezoidal, anterior margin emarginate, v-seta relatively long. *Thorax.* Pronotum transverse, approximately 1.2–1.3 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and about 1–2 short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process distinctly pointed at apex, about as long as isthmus and metaventral process combined; length ratio of mesoventral process, isthmus and metaventral process 13:9:4. Elytra slightly wider than pronotum; elytron approximately 1.7 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited about one setose lobe. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 17:20:20:42 (protarsus); 20:25:24:23:44 (mesotarsus); 29:30:30:28:57 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface fairly glossy and densely pubescent, with fine and imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII with 4 macrosetae on each side of midline, posterior margin truncate, slightly emarginate in median region; male sternites V–VII with many pores in anterior margin, VIII with 7 macrosetae on each side of midline, posterior margin round; posterior margin of female tergite VIII (Fig. 38) subtruncate; posterior margin of female sternite VIII broadly rounded, slightly emarginate at middle, with long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 47, 56) entirely oval, apical process narrow apically, blunt at apex in ventral aspect. Apical lobe of paramerites (Fig. 65) elongate and subparallel-sided with four setae, b-seta longest, other setae subequal in length. Spermatheca (Fig. 74) with conical shaped umbilicus, duct sinuate and coiled apically.

Distribution. Korea (South).

Remarks. This species is similar to *A.* (*M.*) *muris*, but can be distinguished by the small body; posterior margin of male tergite VIII with broad process; apical process of median lobe of aedeagus broad; annellus of internal sac relatively large; different shape of spermatheca. All specimens were collected by sifting leaf litter piled up in a ditch.

Etymology. Named after the type locality Mt. Jangtaesan, where all of specimens were collected.

Atheta (*Microdota*) *kangsonica* Paśnik, 2001
Fig. 5

Atheta (*Microdota*) *kangsonica* Paśnik, 2001: 209; Smetana 2004: 386 (as valid species).

Material examined. Holotype, ♂, labeled as follows: 'Korea Thesôsong, distr. Kangsô 8. 1971 1eg. Szeptycki, HOLOTYPE Atheta (Microdota) kangsonica sp. n. det. G. Paśnik 2000' [North Korea, Pyeongannam Prov., Nampo-si, Gangseo-gun, Taeseong-ho, viii.1971, A. Szeptycki].

Description. Length about 2.6 mm. Body (Fig. 5) parallel-sided, more or less flattened dorso-ventrally; surface glossy and densely pubescent, with fine microsculpture. Body usually dark brown; legs paler than other parts. *Head.* Slightly transverse, approximately 1.1 times wider than long, widest at middle, narrower than pronotum; eyes slightly large and prominent, about 1.1 times longer than tempora; infraorbital carina complete; gular sutures moderately separated, diverged basally. Antennae dilated apically; antennomeres 1–3 elongate, 1 longest, 4–7 slightly transverse, 8–10 distinctly transverse, 11 longer than wide, about as long as preceding two combined. *Thorax.* Pronotum slightly transverse, approximately 1.2–1.3 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Elytra slightly transverse, slightly wider than pronotum, elytron approximately 1.7 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; meso- and metatarsomeres 1–4 subequal in length; one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface glossy and densely pubescent; male tergite VIII (Paśnik 2001: fig. 27) with 5 macrosetae on each side of midline, posterior margin emarginate; posterior margin of male sternite VIII convex and round. *Genitalia.* Median lobe (Paśnik 2001: figs 25–26) oval, apical process triangular, convergent at apex in ventral aspect.

Distribution. Korea (North).

Remarks. This species was recorded by Paśnik (2001) in North Korea and a dissected specimen was unavailable. Accordingly, we could not describe the mouthparts and aedeagus in detail.

Atheta (*Microdota*) *kawachiensis* Sawada, 1974
Figs 6, 30, 39, 48, 57, 66, 75

Atheta (*Amidobia*) *kawachiensis* Sawada, 1974: 158.
Atheta (*Microdota*) *kawachiensis*: Smetana 2004: 386 (as valid species).

Material examined. SOUTH KOREA: Gangwon Prov.: 32 exx., Sokcho-si, Mt. Seoraksan, Hwaamsa, 21.vi.2002, JS Park, sifting.

Description. Length 1.6–2.0 mm. Body (Fig. 6) slender and parallel-sided, more or less flattened dorso-ventrally; surface glossy, densely pubescent, with fine microsculpture. Body usually reddish brown to dark brown; head and abdomen dark brown to black; pronotum slightly darker than elytra; legs yellowish brown. *Head.* Subquadrate, approximately 1.0–1.1 times wider than long, widest across eyes, slightly narrower than pronotum; eyes moderate in size and prominent, about 1.0–1.2 times longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina complete; cervical carina complete. Antennae (Fig. 30) dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 slightly transverse to transverse, 11 longer than wide, about as long as preceding two combined. *Mouthparts.* Labrum transverse, anterior margin emarginate; two lateral sensilla and about 8 macrosetae present on each side of midline, α-sensillum setaceous, slightly longer than ε-sensillum, β- and γ-sensilla reduced. Mandibles asymmetrical, pointed apically, about 1.6–1.7 times as long as basal width; anterior margin serrulate; right one with small internal tooth; prostheca developed. Lacinia of maxilla with seven spines in distal comb, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about 1.6–1.8 times as long as wide, 2 about 2.5–2.7 times longer than wide, 3 longer than 2, about 2.4–2.5 times as long as wide, 4 digitiform, filamentous sensilla reaching to basal half. Labium with ligula divided into two lobes in basal half; two medial setae narrowly separated; two basal pores contiguous; lateral pseudopores, one setal pore and two real pores present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest and dilated basally, about 1.3–1.5 times longer than wide, with γ-setula close b-setula, 2 shortest, about 1.2–1.4 times longer than wide, 3 long and slender, about as long as 1, about 3.5–4.0 times longer than wide. *Thorax.* Pronotum transverse, approximately 1.2 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and about 1–2 short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process pointed at apex, about twice longer than metaventral process. Elytra slightly wider than pronotum; elytron approximately 1.7–1.8 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited one long setose lobe. Legs. Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 16:17:19:49 (protarsus); 20:22:23:23:48 (mesotarsus); 28:28:28:27:60 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely pubescent, with fine and imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 39) with 4 macrosetae on each side of midline, posterior margin slightly emarginate; male sternites V–VII with many pores in anterior margin, VIII with 7 macrosetae on each side of midline, posterior margin convex, slightly rounded, with long marginal setae; posterior margin of female tergite VIII similar to male; posterior margin of female sternite VIII slightly emarginate at middle, with long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 48, 57) oval; apical process triangular, convergent at apex in ventral aspect. Apical lobe

of paramerites (Fig. 66) subparallel-sided and elongate with four short setae; a-seta longest, slightly longer than other setae. Spermatheca (Fig. 75) with small umbilicus, duct one coiled apically.

Distribution. Korea (South) and Japan.

Remarks. All specimens were collected by sifting leaf litter in Gangwon province.

Atheta (*Microdota*) *koreana* Bernhauer, 1923

Figs 7, 31, 40, 49, 58, 67, 76

Atheta (*Microdota*) *koreana* Bernhauer, 1923: 128; Cho and Ahn 2001: 32; Paśnik 2001: 208; Smetana 2004: 386 (as valid species).

Atheta (*Amidobia*) *bulbosa* Sawada, 1974: 179 (as valid species); Smetana 2004: 386 (as synonym of *Atheta koreana*).

Ischnopoda (*Atheta*) *koreana*: Yuh et al. 1985: 251 (as valid species).

Atheta koreana: Kim et al. 1994: 144 (as valid species).

Material examined. Syntype, 1♀, labeled as in Fig. 85. NORTH KOREA: 1 ex., Korea 25.5.1974 Jonghen ad Dżuyr Exp. Inst.Zool.Cr. [North Korea, Hamgyeong-buk Prov., Gyeongseong-gun, Yonghyeon-ri, 25 v 1974, ISEA]. SOUTH KOREA: Chungbuk Prov.: 3 exx., Boeun-gun, Maro-myeon, Imgok-ri, Mt. Cheontaesan, 6.viii.2000, MH Kim, mushroom; Chungnam Prov.: 7 exx., Gongju-si, Mt. Gyeryongsan, N36°21'17.4", E127°14'55.7",, 1–18.vi.2004, KJ Ahn, SM Choi, JS Park, FIT; 1 ex., Gongju-si, Sangsin-ri, Mt. Gyeryongsan, N36°22'03.2", E127°12'50",, 31.v–18.vi.2004, SM Choi, JS Park, FIT; Gongju-si, Mt. Gyeryongsan, Eunseon-waterfall, N36°20'58.7", E127°12'41.3",, 1–18.vi.2004, SM Choi, JS Park, FIT; 6 exx., Gongju-si, Mt. Gyeryongsan, Donghaksa, N36°21'17.4", E127°14'55.7",, 1–18.vi.2004, SM Choi, JS Park, FIT; 9 exx., Gongju-si, Mt. Gyeryongsan, Dongwol, N36°19'39", E127°15'46.7",, KJ Ahn, SM Choi, JS Park, FIT; 5 exx., Gongju-si, Mt. Gyeryongsan, Gapsa, N36°22'03.2", E127°12'50",, 31.v–18.vi.2004, KJ Ahn, SM Choi, JS Park, FIT; Gongju-si, Mt. Gyeryongsan, Nam-maetap, N36°21'11.8", E127°13'20.8",, SM Choi, JS Park, FIT; Gangwon Prov.: 3 exx., Hoengseong-gun, Gangrim-myeon, Bugok-ri, Mt. Chiaksan, 15.viii.2000, MH Kim, rotten mushroom (Boletaceae); 6 exx., Hongcheon-gun, Nae-myeon, Gyebangsan, Unduryeong, 18.viii.2000, MH Kim, rotten mushroom (Boletaceae); 4 exx., Hongcheon-gun, Naecheon-myeon, Garyeong fall, 25.v–20.vi.2002, KJ Ahn, SJ Park, JS Park, FIT; 9 exx., Pyeongchang-gun, Bangrim-myeon, Ungyo 2-ri, Mt. Baedeoksan, 12.vii.–16.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT; 4 exx., Pyeongchang-gun, Jinbu-myeon, Mt. Odaesan, Sangwonsa, 18.v–23.vi.2002, SJ Park, FIT; 2 exx., Sokcho-si, Mt. Seoraksan, Biseondae, 30.vii–15.ix.2002, SJ Park, JS Park, FIT; 6 exx., Yeongwol-gun Yeongwol-eup, Taehawasan 14.viii.2001, MH Kim, rotten mushroom (Boletaceae); Gyeonggi Prov.: 3 exx., Gapyeong-gun, Buk-myeon, Mt. Myeongjisan, 25.vii.–30.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT;

3 exx., Yangju-gun, Jangheung-myeon, Songchu-ri, Mt. Bukhansan, 24.iii.1998, YS Kim.

Description. Length 1.5–1.8 mm. Body (Fig. 7) parallel-sided; surface glossy, densely pubescent, with fine microsculpture. Body usually yellowish brown to reddish brown; head and abdomen darker than other parts. *Head.* Slightly transverse, approximately 1.1–1.2 times wider than long, widest across eyes, slightly narrower than pronotum; eyes prominent, about 1.2–1.3 times longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina complete, cervical carina complete. Antennae (Fig. 31) dilated apically; antennomeres 1–3 elongate, 1 about as long as 11, 4–10 distinctly transverse, 11 longest, about as long as preceding two combined. *Mouthparts.* Labrum transverse, anterior margin emarginate, two lateral sensilla and about 8 macrosetae present on each side of midline; α-sensillum setaceous, more than twice as long as ε-sensillum, β- and γ-sensilla reduced. Mandibles asymmetrical, pointed apically, about 1.5–1.6 times as long as basal width; right one with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about 1.5–1.7 times as long as wide, 2 about 2.6–2.7 times longer than wide, 3 longer than 2, about 2.3–2.5 times as long as wide, 4 digitiform, filamentous sensilla reaching to basal half. Labium with ligula divided into two lobes in basal half; two medial setae narrowly separated; two basal pores close; lateral pseudopores, one setal pore and two real pores present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest and dilated basally, about as long as wide, with γ-setula close b-setula, 2 shortest, about 1.4–1.6 times longer than wide, 3 slightly dilated apically, slightly shorter than 1, about 2.5 times longer than wide. *Thorax.* Pronotum transverse, approximately 1.2–1.3 times wider than long, widest at middle; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and about 2–3 short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process pointed at apex, longer than isthmus and metaventral process combined; length ratio of mesoventral process, isthmus and metaventral process 14:7:5. Elytra subquadrate and slightly dilated apically, slightly wider than pronotum; elytron approximately 1.6–1.7 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited about one setose lobe. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 14:15:16:32 (protarsus); 17:19:20:20:40 (mesotarsus); 24:24:24:24:49 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface fairly glossy and densely pubescent, with slightly reticulate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 40) with 4 macrosetae on each side of midline, posterior margin truncate, with minute crenation; male sternite VIII with 7 macrosetae on each side of midline, posterior margin rounded; posterior margin of female tergite VIII subtruncate; posterior margin of female sternite VIII broadly rounded, slightly emarginate at middle, with long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe

(Figs 49, 58) oval, apical process constricted in median region, convergent at apex in ventral aspect; internal sac complicated. Apical lobe of paramerites (Fig. 67) subparallel-sided and elongate, with four setae subequal in length. Spermatheca (Fig. 76) with very large bursa, duct one coiled apically.

Distribution. Korea (South, North), China (Liaoning) and Japan.

Remarks. This species is distinguished from similar species by the characters provided in Sawada (1974). Some specimens were found on mushrooms in forest areas.

Atheta (*Microdota*) *muris* Sawada, 1974

Figs 8, 32, 41, 50, 59, 68, 77

Atheta (*Amidobia*) *muris* Sawada, 1974: 176.
Atheta (*Microdota*) *muris*: Smetana 2004: 387 (as valid species).

Material examined. SOUTH KOREA: Chungnam Prov.: 1 ex., Buyeo-gun, Oesan-myeon, Gaedeok-ri, Mt. Wolmyeongsan, 1.vi.2000, US Hwang, HJ Kim, sifting; 26 exx., Daejeon-si, Chungnam National Univ., 13.v.2002, JS Park, sifting; 7 exx., Daejeon-si, Yuseong-gu, Chungnam National Univ., 26.ix.2002, SM Choi, JH Choi, sifting; 1 ex., Daejeon-si, Mt. Sikjangsan, Secheon park, 17.vii.2000, HJ Kim, mushroom; 1 ex., Gongju-si, Mt. Gyeryongsan, 23.vi.2000, HJ Kim, near stream; 1 ex., Hongseong-gun, Gwangcheon-eup, Oseosan, 20.vi.1999, HJ Kim, near stream; Gangwon Prov.: 6 exx., Pyeongchang-gun, Odaesan, Jeokmyeolbogung, 8.vii.1998, KJ Ahn, mushroom; Gyeonggi prov.: 6 exx., Namyangju-si, Sudong-myeon, Oebang-ri, Mt. Chukryeongsan, 13.ix.1999, US Hwang, HJ Kim, sifting.

Description. Length 1.4–1.9 mm. Body (Fig. 8) slender and parallel-sided, more or less flattened dorso-ventrally; surface distinctly glossy, densely pubescent, with fine microsculpture. Body usually yellowish brown; head and abdominal segments V–VII dark brown to black; pronotum slightly paler than elytra. *Head.* Subquadrate, approximately 1.0–1.1 times wider than long, widest across eyes, slightly narrower than pronotum; eyes moderate in size and prominent, about 1.0–1.2 times longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina complete; cervical carina complete. Antennae (Fig. 32) dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 transverse, 11 longer than wide, slightly shorter than preceding two combined. *Mouthparts.* Labrum transverse, anterior margin emarginate; two lateral sensilla and about 8 macrosetae present on each side of midline; α-sensillum setaceous, slightly longer than ε-sensillum, β- and γ-sensilla reduced. Mandibles asymmetrical, pointed apically, about 1.5–1.6 times as long as basal width; right one with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about 1.8–2.0 times as long as wide, 2 about 2.5–2.7 times longer than wide, 3 slightly longer than 2, about 2.2–2.5 times as long as wide, 4 digitiform, filamentous sensilla reaching to

basal half. Labium with ligula divided into two lobes in basal half; two medial setae narrowly separated; two basal pores close; lateral pseudopores and two real pores present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest and dilated basally, about 1.5–1.7 times longer than wide, with γ-setula close b-setula, 2 shortest, about 1.4–1.6 times longer than wide, 3 about as long as 1, about 3.0 times longer than wide. *Thorax.* Pronotum transverse, approximately 1.3 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and about two short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process pointed at apex, longer metaventral process; length ratio of mesoventral process, isthmus and metaventral process 15:8:6. Elytra slightly wider than pronotum; elytron approximately 1.5–1.6 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited one setose lobe. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 18:20:20:44 (protarsus); 20:23:24:24:45 (mesotarsus); 31:31:31:30:53 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely pubescent, with fine and imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 41) with 4 macrosetae on each side of midline, posterior margin truncate; male sternites V–VII with many pores in anterior margin, VIII with 8 macrosetae on each side of midline, posterior margin broadly rounded, with long marginal setae; posterior margin of female tergite VIII subtruncate; posterior margin of female sternite VIII slightly emarginate at middle, long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 50, 59) oval, apical process abruptly convergent at apex in ventral aspect. Apical lobe of paramerites (Fig. 68) elongate and subparallel-sided with four setae; a- and b-setae longer than c- and d- setae. Spermatheca (Fig. 77) with duct relatively long, coiled apically.

Distribution. Korea (South) and Japan.

Remarks. Some specimens were found on mushrooms in forests.

Atheta (*Microdota*) *palleola* (Erichson, 1837)

Fig. 9

Homalota palleola Erichson, 1837: 333.

Atheta (*Microdota*) *palleola*: Palm 1970: 186; Paśnik 2001: 209; Smetana 2004: 387 (as valid species).

Material examined. Syntype, 4 exx., labeled as follows: '5451, pallola Er. Berol. Weis.'. NORTH KOREA: 2 exx., Korea, Jongak-san Pnjongjang-si, lg. Pawlowski, 8.1971 [North Korea, Pyeongannam Prov. Pyeongyang-si, Mt. Yongaksan, viii.1971, J. Pawlowski]; 4 exx., Korea 1-3.6.1974 Sujang-san Mt. Exp. Inst.Zool.Cr. [North Korea, Hwanghae Prov. Mt. Suyangsan, 1–3.vi.1974, ISEA].

Description. Length 1.4–1.8 mm. Body (Fig. 9) slender and parallel-sided; surface glossy and densely pubescent, with fine microsculpture. Body usually yellowish brown; head and abdominal tergites VI–VII darker than other parts. *Head.* Slightly transverse, approximately 1.1–1.2 times wider than long, widest across eyes, slightly narrower than pronotum; eyes moderate in size and prominent, about 1.0–1.1 times longer than tempora; infraorbital carina incomplete; gular sutures moderately separated, diverged basally. Antennae dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 distinctly transverse, 11 longer than wide, slightly longer than preceding two combined. *Thorax.* Pronotum slightly transverse, approximately 1.2–1.3 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Elytra slightly transverse, slightly wider than pronotum, elytron approximately 1.7 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; meso- and metatarsomeres 1–4 subequal in length. *Abdomen.* Parallel-sided, widest at middle; surface glossy and densely pubescent; male tergite VIII with 4 macrosetae on each side of midline, posterior margin broadly truncate, slightly emarginate; posterior margin of male sternite VIII rounded. *Genitalia.* Median lobe oval, apical process convergent at apex in ventral aspect. Apical lobe of paramerites elongate. Spermatheca with large bursa, duct long and slender, coiled apically.

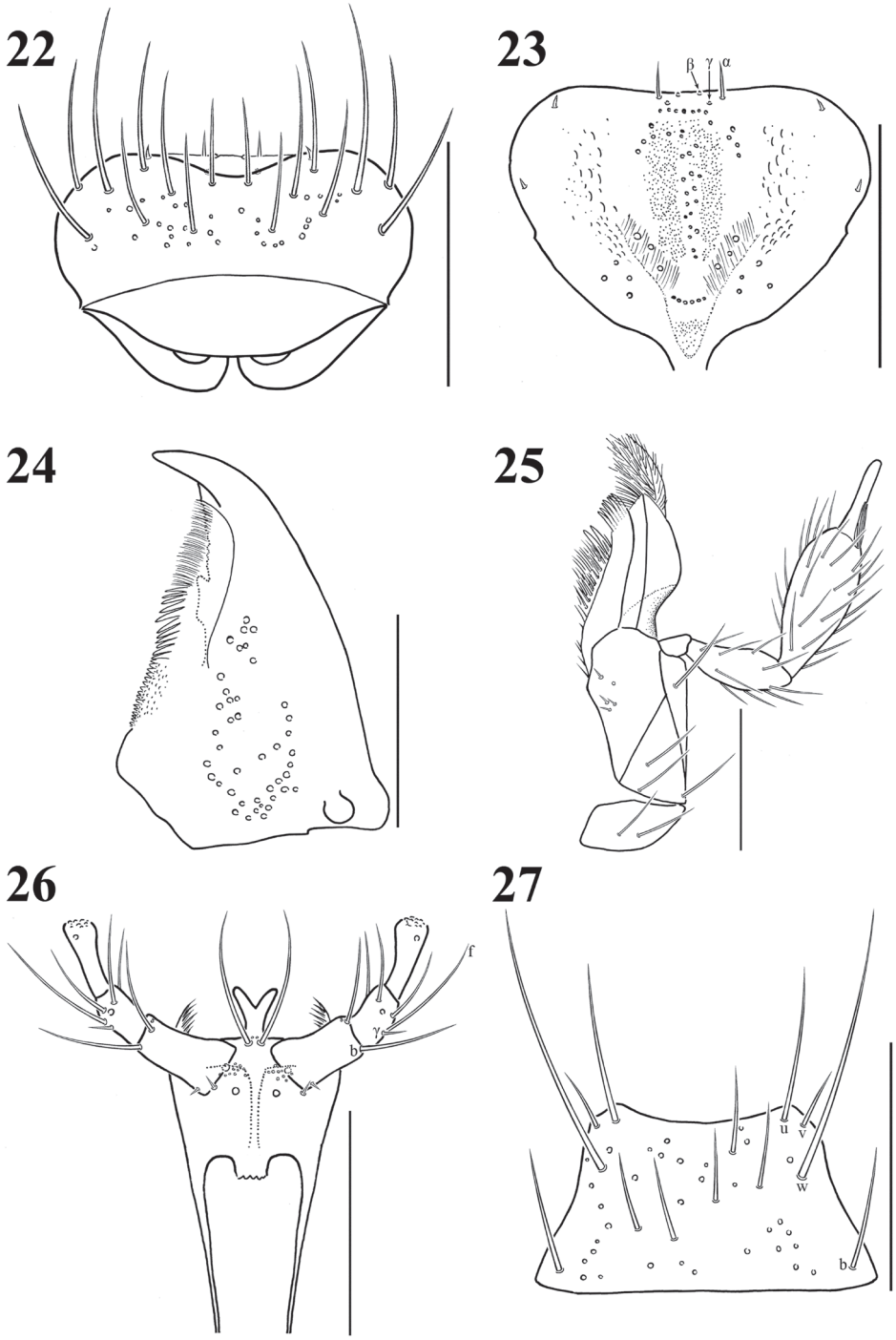
Distribution. Korea (North), Europe (Austria, Belgium, Bulgaria, Croatia, Czech Republic, Finland, France, Great Britain, Germany, Hungary, Italy, The Netherlands, Norway, Poland, Romania, Slovakia, Sweden and Switzerland) and Russia (Caucasus and East Siberia).

Remarks. This species was recorded by Paśnik (2001) in North Korea and a dissected specimen was unavailable. Accordingly, we could not describe the mouthparts and aedeagus in detail. This species has been known to occur on disc fungi (Palm 1970).

Atheta (*Microdota*) *pasniki* Lee & Ahn, sp. n.

http://zoobank.org/C6A4FB75-A11F-4732-805E-E47039541DF3
Figs 10, 22–27, 33, 42, 51, 60, 69, 78

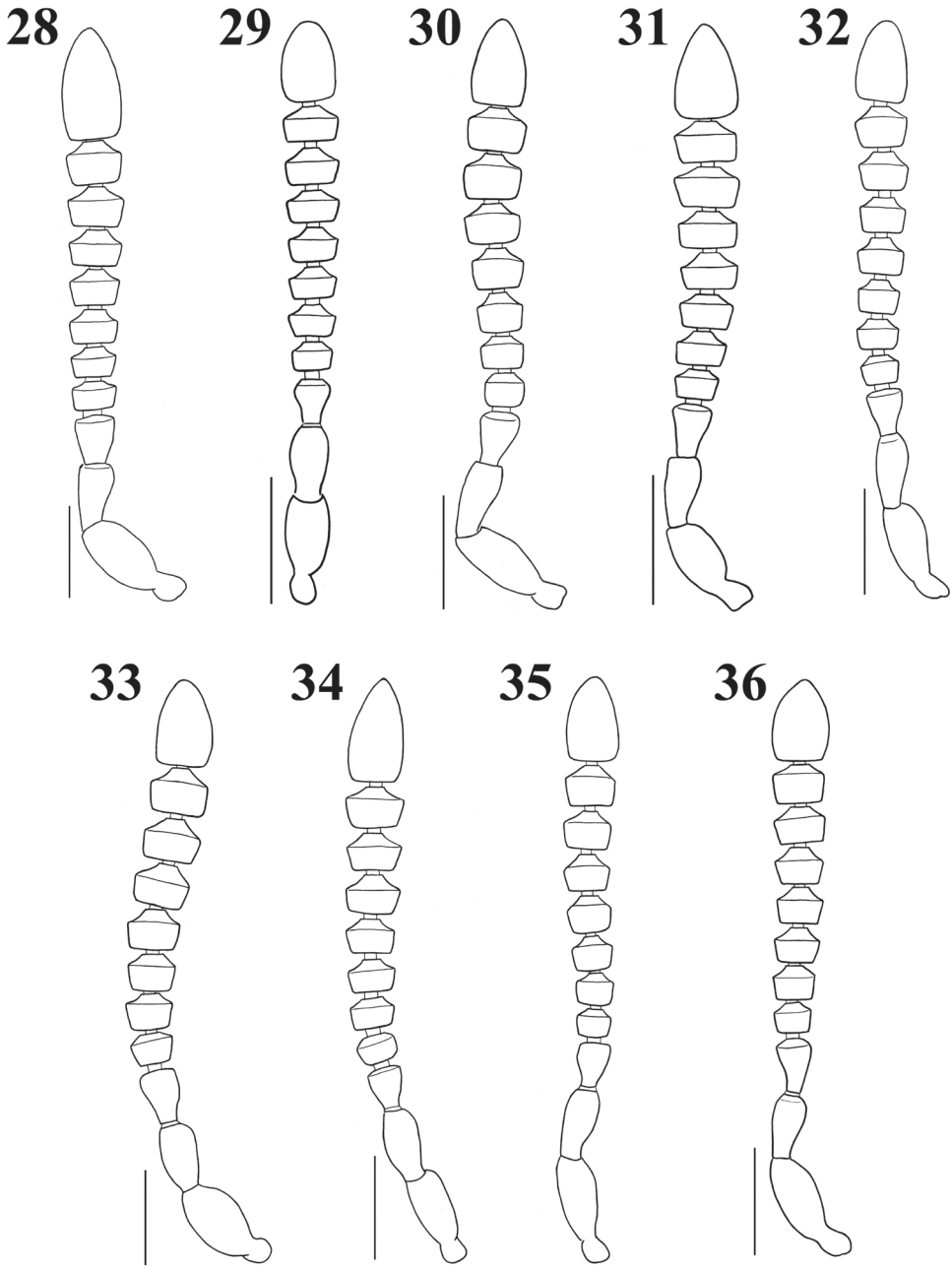
Material examined. Holotype, labeled as follows: 'KOREA: Gangwon Prov., Pyeongchang-gun, Jinbu-myeon, Dongsan-ri, Mt. Odaesan, Sangwonsa, 4 VI 2001, S.-J. Park, *ex* sifting, HOLOTYPE *Atheta* (*Microdota*) *pasniki* Lee and Ahn, Desig. S.-G. Lee and K.-J. Ahn 2015' Deposited in CNUIC, Daejeon. Paratypes, 40 exx. (total); 5 exx., same data as holotype; 8 exx., same data as holotype except 'N37°47.074' E128°33.735', 15 V 2006, S.-J. Park, Y.-H. Kim, *ex* near stream'; 4 exx., same data as holotype except 'N37°47.104' E128°33.57.2', 10 V 2007, TK Kim, sifting'; 2 exx., same data as holotype except '8 V 2004,S.J.Park, D.H. Lee, S. M. Choi *ex* sifting; 1 ex., same data as holotype except '25 - 26 IV 2001, K.-J. Ahn, *ex* sifting'; 2 exx., Gangwon Prov., Pyeongchang-gun, Mt. Odaesan, Sangwonsa, 26 IV 2001, M.-J. Jeon'; 1 ex.,



Figures 22–27. Mouthparts of *Atheta* (*Microdota*) *pasniki* sp. n.: **22** labrum, dorsal aspect **23** epipharynx, ventral aspect **24** right mandible, ventral aspect. **25** right maxilla, ventral aspect **26** labium, ventral aspect **27** mentum, ventral aspect. Scale bars: 0.1 mm.

same data as former except 'S.-J. Park, *ex* near stream; 8 exx., same data as the former except '25 V 2004, S J Park, J S Park, *ex* sifting; 1 ex., Gangwon Prov., Hongcheon-gun, Nae-myeon, Mt. Gyebangsan, Unduryeong, N37°42.49.9' E128°26.40.5', 1100m, 11 V 2007, TK Kim, *ex* leaf litter near stream; 5 exx., Kangwon Prov., Inje-gun, Yongdaeri, 13 IX 1998, K.-J. Ahn, K.-L. You, H.-J. Lim, *ex* leaf litter.

Description. Length 1.7–2.3 mm. Body (Fig. 10) parallel-sided, more or less flattened dorso-ventrally; surface glossy, densely pubescent, with fine microsculpture. Body usually reddish brown; elytra paler than other parts; legs yellowish brown. *Head.* Subcircular, approximately 1.0–1.1 times wider than long, widest behind eyes, slightly narrower than pronotum; eyes small, about 0.8 times longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina incomplete; cervical carina complete. Antennae (Fig. 33) dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 transverse, 11 longer than wide, about as long as preceding two combined. *Mouthparts.* Labrum (Fig. 22) transverse, anterior margin emarginate; two lateral sensilla and about 8 macrosetae present on each side of midline; α-sensillum long and setaceous, more than twice longer than ε-sensillum, β- and γ-sensilla reduced; epipharynx as in Fig. 23. Mandibles asymmetrical, pointed apically, about 1.6–1.7 times as long as basal width; right one (Fig. 24) with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about 1.7–1.8 times as long as wide, 2 about 2.3–2.5 times longer than wide, 3 longer than 2, about 2.2–2.4 times as long as wide, 4 digitiform, filamentous sensilla not reaching to basal half (Fig. 25). Labium (Fig. 26) with ligula divided into two lobes in basal half; two medial setae contiguous; two basal pores closed together; lateral pseudopores, one setal pore and two real pores present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest and dilated basally, about 1.4–1.6 times longer than wide, with γ-setula close f-setula, 2 shortest, about 1.5–1.7 times longer than wide, 3 about as long as 1, about 2.2–2.4 times longer than wide. Mentum (Fig. 27) trapezoidal, anterior margin emarginate, v-seta relatively long. *Thorax.* Pronotum transverse, approximately 1.3 times wider than long, widest at apical third; pubescence directed anteriorly. Metanotal scutum with one long seta and about two short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process pointed at apex, about as long as isthmus and metaventral process combined. Elytra relatively short, transverse, slightly wider than pronotum; elytron approximately 1.6–1.7 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited one setose lobe. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 19:20:22:57 (protarsus); 22:25:26:26:53 (mesotarsus); 31:33:33:33:68 (metatarsus); one empodial seta present, very short. *Abdomen.* Subparallel-sided, widest at middle; surface glossy and densely pubescent, with fine and imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 42) with 4 macrosetae on each side of midline, posterior margin subtruncate; male sternite VIII with 7 macrosetae on each



Figures 28–36. Antenna: **28** *Atheta* (*Microdota*) *formicetorum* **29** *A.* (*M.*) *jangtaesanensis* sp. n. **30** *A.* (*M.*) *kawachiensis* **31** *A.* (*M.*) *koreana* **32** *A.* (*M.*) *muris* **33** *A.* (*M.*) *pasniki* sp. n. **34** *A.* (*M.*) *spiniventris* **35** *A.* (*M.*) *spinula* **36** *A.* (*M.*) *subcrenulata*. Scale bars: 0.1 mm.

side of midline, posterior margin convex, subtriangular, with marginal setae; posterior margin of female tergite VIII truncate; posterior margin of female sternite VIII slightly emarginate at middle, with long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 51, 60) oval; apical process parallel-sided, convergent at apex in ventral aspect. Apical lobe of paramerites (Fig. 69) elongate and parallel-sided with four setae, subequal in length. Spermatheca (Fig. 78) with large bursa and small umbilicus; duct relatively short, one coiled apically.

Distribution. Korea (South).

Remarks. This species is similar to *A.* (*M.*) *nakanei*, but can be distinguished by shape and structure of internal sac of aedeagus. They were usually collected near streams or in moist regions of forest of Gangwon province by sifting litter.

Etymology. Named after Grzegorz Paśnik in honor of his research on Korean Athetini.

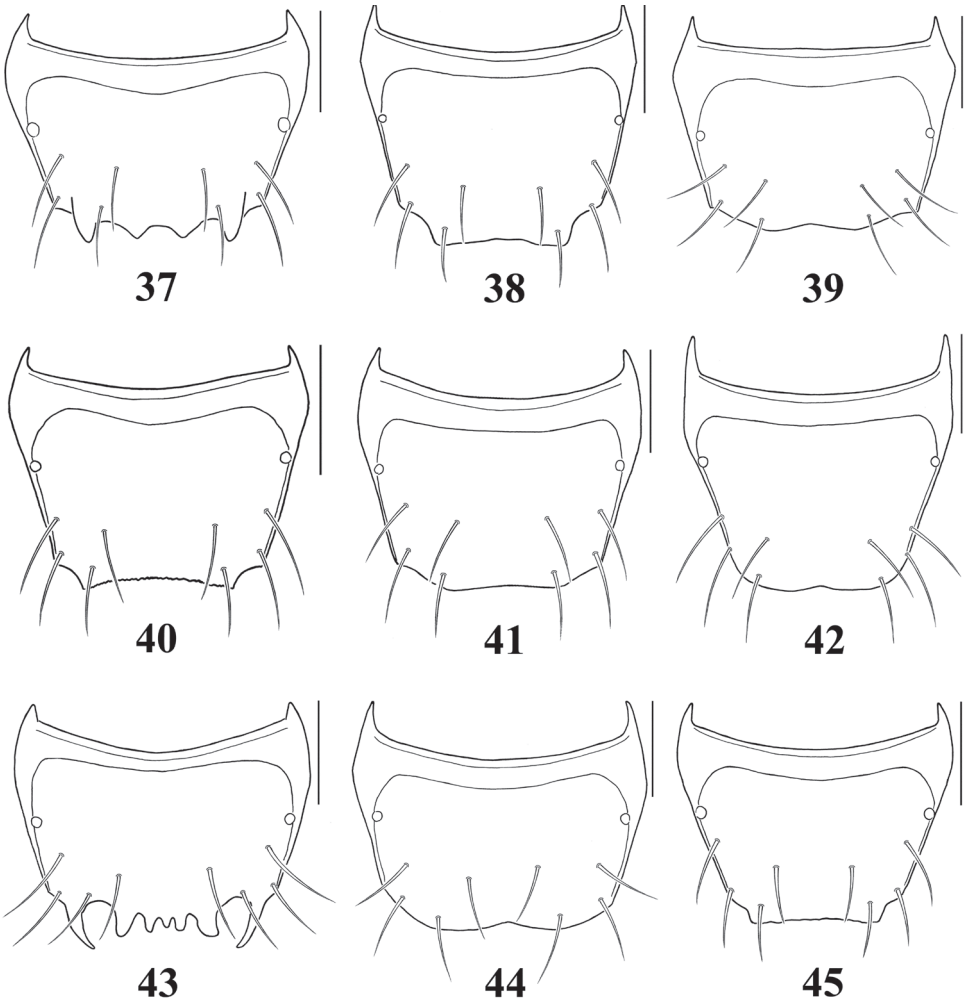
Atheta (*Microdota*) *silvatica* Bernhauer, 1907

Fig. 11

Atheta (*Microdota*) *silvatica* Bernhauer, 1907: 405.
Atheta (*Amidobia*?) *silvatica*: Sawada 1974: 184 (as valid species).
Atheta (*Microdota*) *silvatica*: Paśnik 2001: 209; Smetana 2004: 388 (as valid species).

Material examined. Syntype, 1♂, labeled as follows: 'Japan. Sauter Negishi, 25. 2. 05, silvatica bernh typ. det Bernhauer, silvatica Bernh. Typus, Chicago NHMus M.Bernhauer Collection'. NORTH KOREA: 1 ex., Korea 12.6.1974 Vaudo ad Nampo Exp. Inst.Zool.Cr. [North Korea, Pyeongannam Prov., Nampo-si, Waudo, 12.vi.1974, ISEA].

Description. Length about 1.5–2.0 mm. Body (Fig. 11) slender and parallel-sided, more or less flattened; surface distinctly glossy and densely pubescent, with fine microsculpture. Body usually reddish brown; head slightly darker than pronotum and elytra; legs yellowish brown. *Head.* Subquadrate, approximately 1.0–1.1 times wider than long, widest across eyes, slightly narrower than pronotum; eyes small, about 0.8 times longer than tempora; infraorbital carina complete; gular sutures moderately separated, diverged basally. Antennae dilated apically, longer than head and pronotum combined; antennomeres 1–3 elongate, 1 longest, 4 about as long as wide, 5–10 distinctly transverse, 11 longer than wide, about as long as preceding two combined. *Thorax.* Pronotum transverse, approximately 1.3–1.4 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Elytra slightly transverse, slightly wider than pronotum, elytron approximately 1.7–1.8 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; meso- and metatarsomeres 1–4 subequal in length. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely



Figures 37–45. Male tergite VIII, dorsal aspect: **37** *Atheta* (*Microdota*) *formicetorum* **38** *A.* (*M.*) *jangtaesanensis* sp. n. **39** *A.* (*M.*) *kawachiensis* **40** *A.* (*M.*) *koreana* **41** *A.* (*M.*) *muris* **42** *A.* (*M.*) *pasniki* sp. n. **43** *A.* (*M.*) *spiniventris* **44** *A.* (*M.*) *spinula* **45** *A.* (*M.*) *subcrenulata*. Scale bars: 0.1 mm.

pubescent; male tergite VIII with 4 macrosetae on each side of midline, posterior margin emarginated at middle; male sternite VIII with 8 macrosetae on each side of midline, posterior margin broadly rounded. *Genitalia.* Median lobe oval, apical process slightly decurved at apex in lateral aspect.

Distribution. Korea (North) and Japan.

Remarks. This species was recorded by Paśnik (2001) in North Korea and a dissected specimen was unavailable. Accordingly, we could not describe the mouthparts and aedeagus in detail. This species is distinguished from similar species by the characters provided in Sawada (1974).

Atheta (*Microdota*) *sogamensis* Paśnik, 2001
Fig. 12

Atheta (*Microdota*) *sogamensis* Paśnik, 2001: 210; Smetana 2004: 388 (as valid species).

Material examined. Holotype, ♂, labeled as follows: 'KOREA-SOKAM distr-SUNAN lg. PAWLOWSKI VIII 1971; HOLOTYPE Atheta (Microdota) sogamensis sp. n. det. G. Paśnik 2000' [North Korea, Pyeongannam Prov., Pyeongyang-si, Sogam, viii.1971, Pawlowski].

Description. Length about 2.0 mm. Body (Fig. 12) slender and parallel-sided, more or less flattened; surface distinctly glossy and densely pubescent, with fine microsculpture. Body usually reddish brown to dark brown; head almost black; elytra paler than other parts; legs yellowish brown. *Head.* Slightly transverse, approximately 1.1–1.2 times wider than long, widest across eyes, slightly narrower than pronotum; eyes large and prominent, about 1.5 times longer than tempora; infraorbital carina incomplete; gular sutures moderately separated, diverged basally. Antennae dilated apically, longer than head and pronotum combined; antennomeres 1–3 elongate, 1 longest, 4 about as long as wide, 5–10 distinctly transverse, 11 longer than wide, about as long as preceding two combined. *Thorax.* Pronotum transverse, approximately 1.3–1.4 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Elytra slightly transverse, slightly wider than pronotum, elytron approximately 1.7 times longer than wide, pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed. *Legs.* Slender and long, with dense pubescence and setae; tibiae with two spurs at apex; meso- and metatarsomeres 1–4 subequal in length. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely pubescent; male tergite VIII with 4 macrosetae on each side of midline, posterior margin broadly rounded; male sternite VIII with 7 macrosetae on each side of midline, posterior margin rounded. *Genitalia.* Median lobe (Paśnik 2001: figs 28–29) elongated oval, apical process convergent at apex in ventral aspect.

Distribution. Korea (North).

Remarks. This species was recorded by Paśnik (2001) in North Korea and a dissected specimen was unavailable. Accordingly, we could not describe the mouthparts and aedeagus in detail.

Atheta (*Microdota*) *spiniventris* Bernhauer, 1907
Figs 13, 34, 43, 52, 61, 70, 79

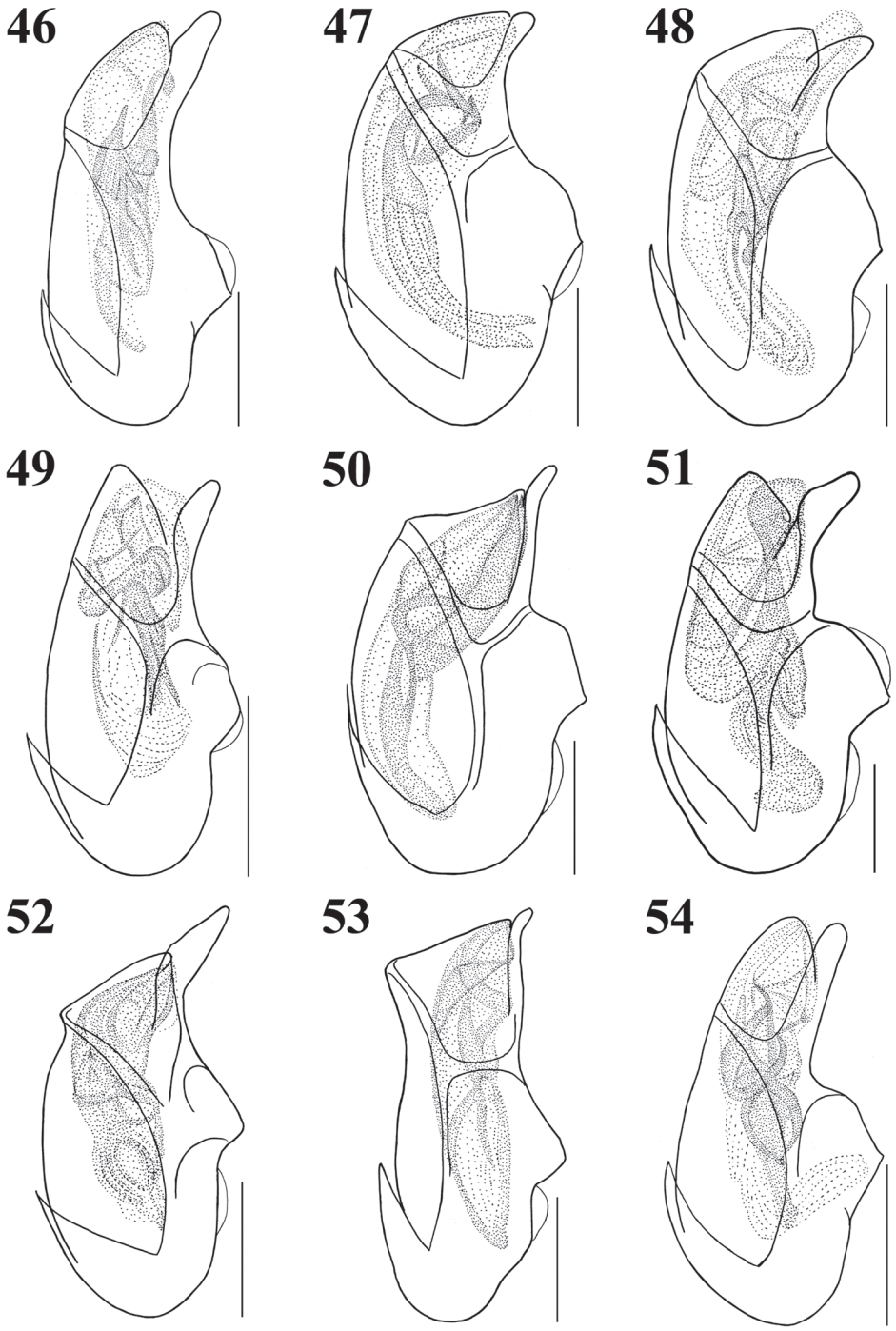
Atheta (*Microdota*) *spiniventris* Bernhauer, 1907: 402; Smetana 2004: 388 (as valid species).

Atheta (*Microdota*) *spinicauda* Bernhauer, 1907: 404 (as valid species); Sawada 1974: 149 (as synonym of *Atheta spiniventris*).

Atheta (*Amidobia*) *spiniventris*; Sawada 1974: 149 (as valid species).

Material examined. Syntype, 1 ex., labeled as in Fig. 86. SOUTH KOREA: Chungbuk Prov.: 109 exx., Danyang-gun, Yeongchun-myeon, Mt. Taehwasan, 14.vii–14.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT; Chungnam Prov.: 11 exx., Gongju-si, Mt. Gyeryongsan, Nammaetap, N36°21'11.8", E127°13'20.8",, 1–18.vi.2004, SM Choi, SJ Park, FIT; 7 exx., same data as the former except 'Eunseon waterfall, N36°20'58.7", E127°12'41.3",'; 6 exx., same data as the former except 'Donghaksa, N36°21'17.4", E127°14'55.7",'; 8 exx., Gongju-si, Uidang-myeon, Yongam-ri, 25.vii.2000, MH Kim, mushroom; 10 exx., Daejeon-si, Yuseong-gu, Chungnam National University, 18.vi–15.vii.2003, JH Choi, DH Lee, SM Choi, FIT; 3 exx., same data as the former except '4–18.vi.'; Gangwon Prov.: 13 exx., Hoengseong-gun, Gangrim-myeon, Bugok-ri, Mt. Chiaksan, 15.viii.2000, MH Kim, mushroom; 136 exx., Pyeongchang-gun, Cheondong-ri, Mt. Sambangsan, 13.vii–15.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT in *Pinus* forest; 34 exx., Sokcho-si, Mt. Seoraksan, Biseondae, 30.vii–15.ix.2002, SJ Park, JS Park, FIT; Gyeonggi Prov.: 30 exx., Yangju-gun, Jangheung-myeon, Songchu-ri, Mt. Bukhansan, 26.vii–31.viii.2001, KJ Ahn, SJ Park, CW Shin, FIT; Jeonnam Prov.: 13 exx., Jangseong-gun, Mt. Naejangsan, Baekyangsa, 15.vi.2000, US Hwang, HJ Kim, Dung.

Description. Length 1.6–2.1 mm. Body (Fig. 13) relatively broad and subparallel-sided, surface slightly glossy and densely pubescent, with slightly coarse punctures. Body dark yellow to yellowish brown; head dark brown to black; basal articles of antennae paler; abdominal segments V–VII darker than other segments; legs yellowish brown. *Head.* Slightly transverse, approximately 1.1–1.2 times wider than long, widest across eyes, slightly narrower than pronotum; eyes distinctly large and prominent, about 1.8–2.0 times as long as tempora; infraorbital carina complete; gular sutures moderately separated; cervical carina complete. Antennae (Fig. 34) long and slender; antennomeres 1–3 elongate, 1 longest, 4–10 distinctly transverse, 11 about as long as 1, slightly longer than preceding two combined. *Mouthparts.* Labrum transverse, anterior margin slightly emarginate; two lateral sensilla and about 8 macrosetae present on each side of midline, α-sensillum setaceous, about twice as long as ε-sensillum, β- and γ-sensilla reduced. Mandibles asymmetrical, pointed apically, approximately 1.5–1.6 times longer than wide; right one with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb, two isolated spines present, distal comb and isolated spines close; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about twice as long as wide, 2 about 2.4–2.7 times longer than wide, 3 slightly longer than 2, about 2.4–2.6 times as long as wide, 4 digitiform; filamentous sensilla reaching to basal half. Labium with ligula narrowly long, divided into two lobes in basal half; two medial setae narrowly separated; two basal pores closed together; median pseudopores absent; lateral pseudopores, one setal pore and two real pores present on prementum; palpus elongate, with many setulae; palpomere 1 largest and dilated basally, about 1.4–1.5 times longer than wide, γ-setula located between α- and b-setulae, closer b than α-setula, 2 shortest and about 1.3–1.5 times longer than wide, 3 more or less dilated apically, about as long as 1, about 3.0 times longer than wide. *Thorax.* Pronotum transverse, approximately



Figures 46–54. Median lobe of aedeagus, lateral aspect: **46** *Atheta* (*Microdota*) *formicetorum* **47** *A.* (*M.*) *jangtaesanensis* sp. n. **48** *A.* (*M.*) *kawachiensis* **49** *A.* (*M.*) *koreana* **50** *A.* (*M.*) *muris* **51** *A.* (*M.*) *pasniki* sp. n. **52** *A.* (*M.*) *spiniventris* **53** *A.* (*M.*) *spinula* **54** *A.* (*M.*) *subcrenulata*. Scale bars: 0.1 mm.

1.3–1.4 times wider than long, widest in apical third; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and two short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process more or less pointed at apex, as long as or slightly longer than isthmus and metaventral process combined; isthmus as long as or shorter than metaventral process. Elytra slightly wider than pronotum; elytron approximately 1.5–1.6 times longer than wide; pubescence directed posteriorly and postero-laterally; postero-lateral margin almost straight; hind wings fully developed, flabellum composited 4 setose lobes. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 14:16:18:50 (protarsus); 18:20:22:21:51 (mesotarsus); 25:25:25:25:59 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface glossy and densely pubescent, with fine and imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 43) with 4 macrosetae on each side of midline, posterior margin with two outer process and about 4–5 inner process, outer process longer than inner process decurved, slightly pointed at apex, inner process variable and blunt at apex, shorter than outer process; male sternites IV–VI with many pores in anterior margin, VIII with 7 macrosetae on each side of midline, posterior margin broadly rounded, with long marginal setae; posterior margin of female sternite VIII truncate, with long and short marginal setae. *Genitalia.* Median lobe (Figs 52, 61) oval; apical process elongate and convergent at apex in ventral aspect; internal sac complicated. Apical lobe of paramerites (Fig. 70) very long with short four setae; c- and d-setae longer than a- and b-setae, subequal in length, positioned apically. Spermatheca (Fig. 79) with small umbilicus, duct short and compactly coiled.

Distribution. Korea (South) and Japan.

Remarks. This species is very similar to *Atheta* (*Microdota*) *vagans*, but can be distinguished by the minute characters provided in Sawada (1974). Many specimens were found on mushrooms in forested habitats.

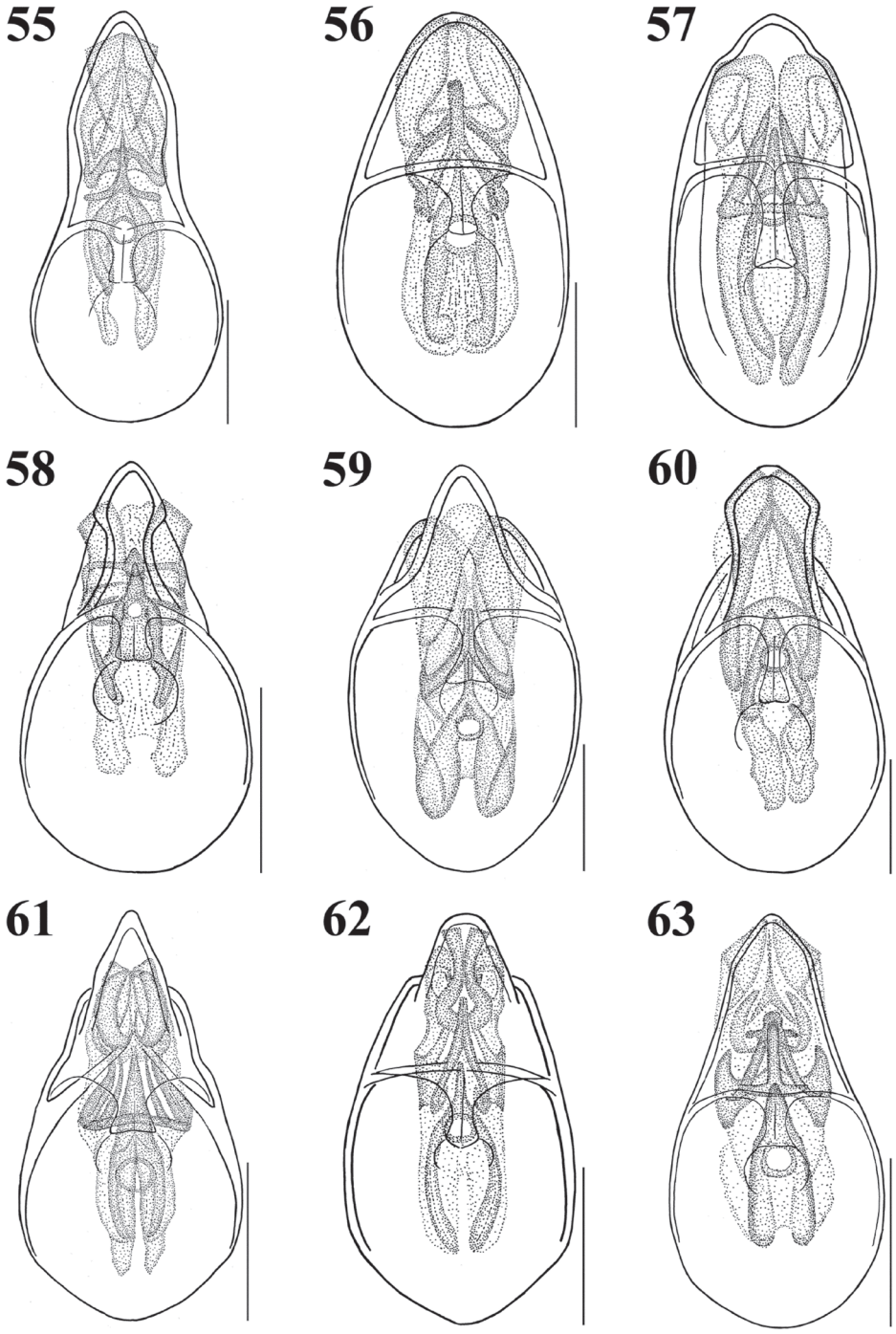
***Atheta* (*Microdota*) *spinula* (Sawada, 1970)**

Figs 14, 35, 44, 53, 62, 71, 80

Ischnopoda (*Hygroecia*) *spinula* Sawada, 1970: 60
Atheta (*Amidobia*) *spinula*: Sawada 1974: 175 (as valid species).
Atheta (*Microdota*) *spinula*: Smetana 2004: 388 (as valid species).

Material examined. SOUTH KOREA: Chungnam Prov.: 20 exx., Gongju-si, Mt. Gyeryongsan, N36°20'27.8", E127°15'11.5",, 1–18.vi.2004, KJ Ahn, SM Choi, JS Park, FIT.

Description. Length 1.4–1.8 mm. Body (Fig. 14) parallel-sided, more or less flattened dorso-ventrally; surface fairly glossy, densely pubescent, with fine microsculpture. Body usually yellowish brown; head and abdominal segments V–VII darker than other parts. *Head.* Subquadrate, about as wide as long, widest across eyes, slightly narrower

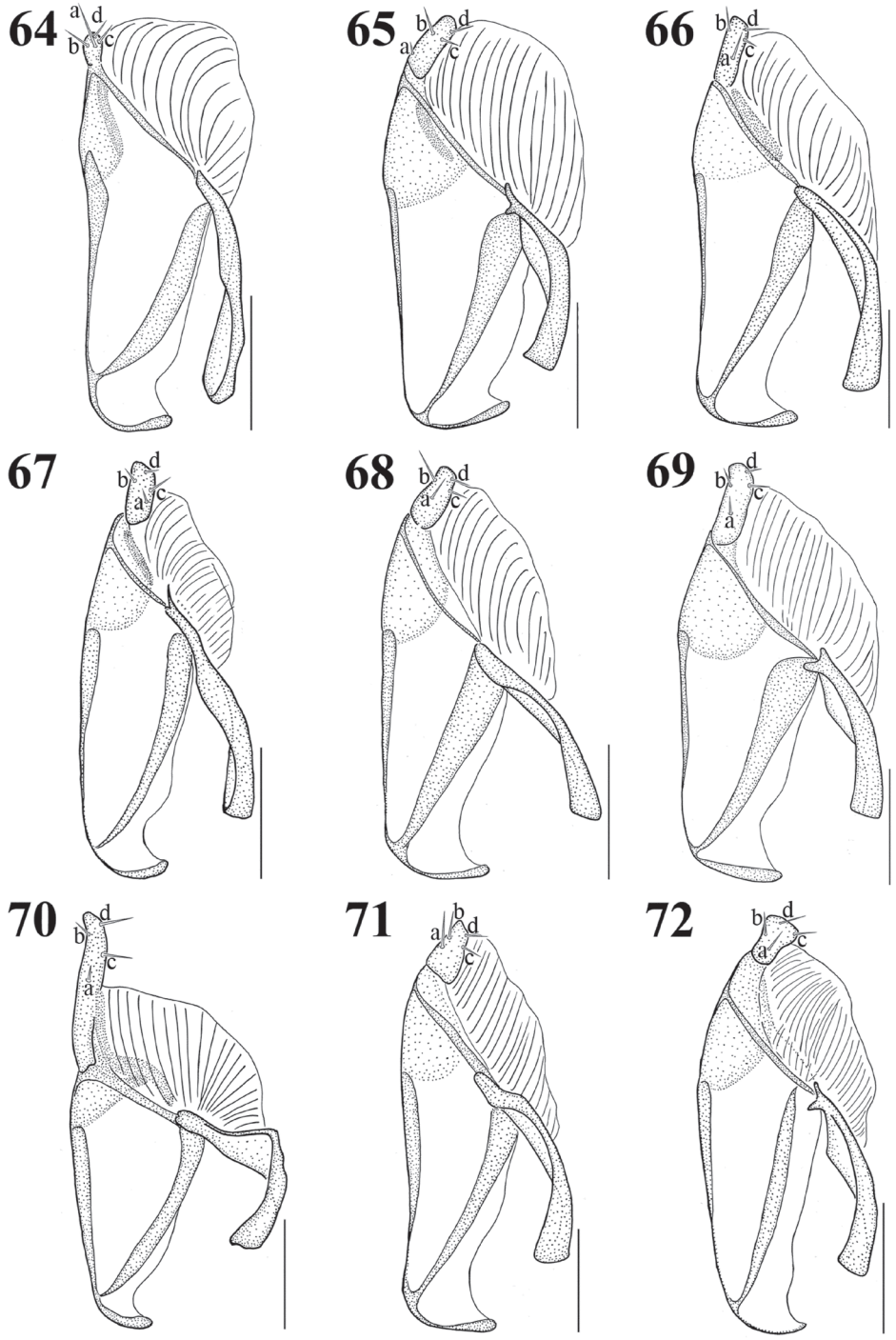


Figures 55–63. Median lobe of aedeagus, ventral aspect: **55** *Atheta* (*Microdota*) *formicetorum* **56** *A.* (*M.*) *jangtaesanensis* sp. n. **57** *A.* (*M.*) *kawachiensis* **58** *A.* (*M.*) *koreana* **59** *A.* (*M.*) *muris* **60** *A.* (*M.*) *pasniki* sp. n. **61** *A.* (*M.*) *spiniventris* **62** *A.* (*M.*) *spinula* **63** *A.* (*M.*) *subcrenulata*. Scale bars: 0.1 mm.

than pronotum; eyes moderate in size and prominent, about 1.2–1.3 times longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina incomplete; cervical carina complete. Antennae (Fig. 35) dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 slightly transverse to transverse, 11 longer than wide, about as long as preceding two combined. *Mouthparts.* Labrum transverse, anterior margin emarginate; two lateral sensilla, about 8 macrosetae present on each side of midline; α-sensillum setaceous, about twice longer than ε-sensillum, β- and γ-sensilla reduced, convergent at apex. Mandibles asymmetrical, pointed apically, about 1.6–1.7 times as long as basal width; right one with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about 1.6–1.8 times as long as wide, 2 about 2.5–2.7 times longer than wide, 3 longer than 2, about 2.2–2.4 times as long as wide, 4 digitiform, filamentous sensilla reaching to basal half. Labium with ligula narrowly long, divided into two lobes in basal half; two medial setae narrowly separated, two basal pores closed together; lateral pseudopores, one setal pore and two real pores present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest, about 1.3–1.5 times longer than wide, with γ-setula close b-setula, 2 shortest, about 1.2–1.4 times longer than wide, 3 about as long as 1, about 3.0 times longer than wide. *Thorax.* Pronotum transverse, approximately 1.3 times wider than long, widest at apical third; pubescence directed anteriorly in midline. Metanotal scutum with one long seta and three short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process pointed at apex, longer than metaventral process; length ratio of mesoventral process, isthmus and metaventral process 6:4:3. Elytra slightly wider than pronotum; elytron approximately 1.7 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited one setose lobe. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 16:17:19:49 (protarsus); 20:22:23:23:48 (mesotarsus); 28:28:28:27:60 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface distinctly glossy and densely pubescent, with fine and imbricate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 44) with 4 macrosetae on each side of midline, posterior margin slightly emarginate; male sternites V–VII with many pores in anterior margin, VIII with 7 macrosetae on each side of midline, posterior margin slightly rounded, with marginal setae; posterior margin of female tergite VIII similar to male; posterior margin of female sternite VIII slightly emarginate at middle, with long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 53, 62) oval, apical process more or less narrow apically, blunt at apex in ventral aspect. Apical lobe of paramerites (Fig. 71) subtriangular, narrow apically with four setae; a-seta longest, b-seta longer than c- and d- setae. Spermatheca (Fig. 80) with round bursa, duct relatively long, coiled apically.

Distribution. Korea (South) and Japan.

Remarks. This species has been known to be collected near marsh (Sawada 1970). All Korean specimens were collected by FIT in forest.



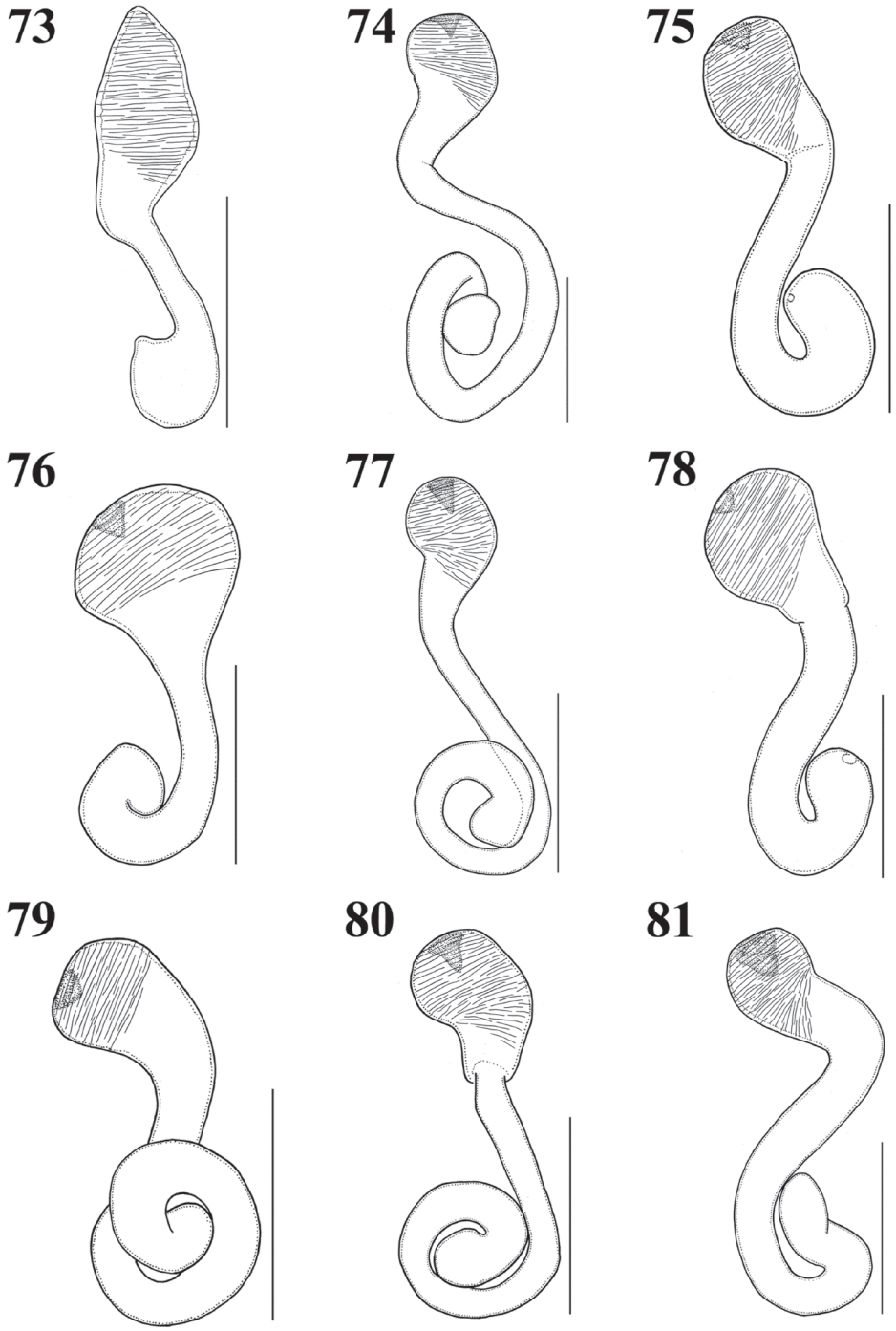
Figures 64–72. Paramere, lateral aspect: **64** *Atheta* (*Microdota*) *formicetorum* **65** *A.* (*M.*) *jangtaesanensis* sp. n. **66** *A.* (*M.*) *kawachiensis* **67** *A.* (*M.*) *koreana* **68** *A.* (*M.*) *muris* **69** *A.* (*M.*) *pasniki* sp. n. **70** *A.* (*M.*) *spiniventris* **71** *A.* (*M.*) *spinula* **72** *A.* (*M.*) *subcrenulata*. Scale bars: 0.1 mm.

***Atheta* (*Microdota*) *subcrenulata* Bernhauer, 1907**
Figs 15, 36, 45, 54, 63, 72, 81

Atheta (*Microdota*) *subcrenulata* Bernhauer, 1907: 403; Paśnik 2001: 209; Smetana 2004: 388 (as valid species).
Atheta (*Amidobia*) *subcrenulata*: Sawada 1974: 166 (as valid species).

Material examined. Syntype, 2♂♂, labeled as in Figs 87–88. NORTH KOREA: 1 ex., Korea 21–25. 5. 74 pr. Ćhongdźin-si Exp. Inst.Zool Cr. [North Korea, Hamgyeongbuk Prov., Cheongjin-si, 21–25.v.1974, ISEA]; 1 ex., Korea 1981 Pekson-ri A. Szeptycki [North Korea, Hwanghae Prov., Mt. Suyangsan, 15.vi.1981, A. Szeptycki]. SOUTH KOREA: Chungnam Prov.: 12 exx., Nonsan-si, Beolgok-myeon, N36°09'10.5", E127°18'24.9", 236 m, 22.v.2011, IS Yoo, decaying red pepper; 2 exx., Daejeon-si, Seo-gu, Jangan-dong, Jangtaesan Recreational Forest, N36°13'4.32", E127°20'34.44", 257 m, 17.iii.2011, IS Yoo, YH Kim, SG Lee, leaf litters; Chungbuk Prov.: 6 exx., Yeongdong-gun, Sangchon-myeon, Mulhan-ri, Mt. Minjujisan, N36˚03’35.2", E127˚52’31.3",, 518 m, 18.v.2011, JG Lee, TK Kim, decaying persimmon; Gangwon Prov.: 11 exx., Inje-gun, Inje-eup, Deoksan-ri, N38°04'46.1", E128°14'08.0", 384 m, 11.vi.2011, YH Kim, JH Song, SG Lee, decaying vegetables; Jeju Prov.: 10 exx., Jeju-si, Aewol-eup, N33°22'29.3", E126°30'37.9",, 21.v.2006, SI Lee, decaying vegetables.

Description. Length about 1.5–2.0 mm. Body (Fig. 15) slender and parallel-sided, more or less flattened dorso-ventrally; surface fairly glossy, densely pubescent, with fine microsculpture. Body usually reddish brown to dark brown; head and abdomen almost black, darker than other parts; legs yellowish brown. *Head.* Subquadrate, approximately 1.0–1.1 times wider than long, widest across eyes, slightly narrower than pronotum; eyes moderate in size and prominent, about 1.0–1.2 longer than tempora; gular sutures moderately separated, diverged basally; infraorbital carina complete; cervical carina complete. Antennae (Fig. 36) dilated apically; antennomeres 1–3 elongate, 1 longest, 4–10 transverse, 11 about as long as preceding two combined. *Mouthparts.* Labrum transverse, anterior margin emarginate; two lateral sensilla and about 8 macrosetae present on each side of midline; α-sensillum long and setaceous, twice longer than ε-sensillum, β- and γ-sensilla reduced. Mandibles asymmetrical, pointed apically, approximately 1.6–1.7 times as long as basal width; right one with small internal tooth, anterior margin serrulate; prostheca developed. Lacinia of maxilla with seven spines in distal comb region, two isolated spines present; maxillary palpus elongate, with pubescence and long setae; palpomere 1 smallest and about twice as long as wide, 2 about 2.5–2.6 times longer than wide, 3 slightly longer than 2, about 2.5–2.7 times as long as wide, 4 digitiform, filamentous sensilla convergent apically, reaching to basal half. Labium with ligula divided into two lobes in basal half; two medial setae closed together; two basal pores narrowly separated; lateral pseudopores, one setal pore and two real pore present on prementum; labial palpus elongate, with many setulae; palpomere 1 largest, about 1.4–1.5 times longer than wide, with γ-setula close b-setula, 2 shortest, about 1.2–1.4 times longer than wide, 3 dilated apically, about 2.3–2.5 times longer than wide. *Thorax.* Pronotum transverse, approximately 1.3 times wider



Figures 73–81. Spermatheca: **73** *Atheta* (*Microdota*) *formicetorum* **74** *A.* (*M.*) *jangtaesanensis* sp. n. **75** *A.* (*M.*) *kawachiensis* **76** *A.* (*M.*) *koreana* **77** *A.* (*M.*) *muris* **78** *A.* (*M.*) *pasniki* sp. n. **79** *A.* (*M.*) *spiniventris* **80** *A.* (*M.*) *spinula* **81** *A.* (*M.*) *subcrenulata*. Scale bars: 0.1 mm.

than long, widest at apical third; midline of pubescence directed anteriorly. Metanotal scutum with one long seta and two short setae on each side of midline; mesocoxal cavities narrowly separated, mesoventral process distinctly pointed at apex, longer than isthmus and metaventral process combined; metaventral process shorter than isthmus. Elytra slightly wider than pronotum; elytron approximately 1.6 times longer than wide, pubescence directed postero-laterally; postero-lateral margin almost straight; hind wings fully developed; flabellum composited five setose lobes. *Legs.* Slender and long, with dense pubescence and setae; tibia with two spurs at apex; length ratio of tarsomeres 18:19:20:47 (protarsus); 22:23:23:24:42 (mesotarsus); 30:29:29:26:50 (metatarsus); one empodial seta present, shorter than claw. *Abdomen.* Parallel-sided, widest at middle; surface fairly glossy and densely pubescent, with reticulate microsculpture; macrochaetal arrangement of tergites II–VI 01-02-12-12-13; male tergite VIII (Fig. 45) with 4 macrosetae on each side of midline, posterior margin truncate, minutely crenate; male sternites V–VII with many pores in anterior margin, VIII with 7 macrosetae on each side of midline, posterior margin slightly rounded, with long marginal seta; posterior margin of female tergite VIII subtruncate; posterior margin of female sternite VIII broadly rounded, with long and short marginal setae; minute setae present in median region. *Genitalia.* Median lobe (Figs 54, 63) oval, apical process convergent at apex in ventral aspect; internal sac complicated. Apical lobe of paramerites (Fig. 72) with four setae, subequal in length. Spermatheca (Fig. 81) with conical umbilicus, duct sinuate and coiled apically.

Distribution. Korea (South, North), China (Beijing and Zhejiang) and Japan.

Remarks. This species is very similar to *Atheta* (*Microdota*) *amicula*, but can be distinguished by the internal sac of median lobe and spermatheca.

Species removed from the Korean fauna

Atheta (*Microdota*) *scrobicollis* (Kraatz, 1859)

Material examined. Syntype, 1 ex., labeled as follows: type, C. cava, Coll. Jil. Moser, Type. NORTH KOREA: 1 ex., Korea 81/51 Kwail 18.VI. A.S. [North Korea, Hwanghae Prov., Kwail, 18.vi.1981, A. Szeptycki].

Remarks. The North Korean record of the species by Paśnik (2001) is a misidentification of other *Atheta* (*Microdota*) species. This species is unlikely to be found in Korea as its distribution has shown that it occurs in southern Europe and subtropical regions. This species differs from a syntype of *A.* (*M.*) *scrobicollis* by several diagnostic characters although we were not able to identify it due to a paucity of specimen.

Atheta (*Microdota*) *kobensis* Cameron, 1933

Material examined. Syntype, 3 exx., labeled as in Figs 89–91. NORTH KOREA: 2 exx., Korea 1981 Kymgangsan A. Szeptycki [North Korea, Gangwon Prov., Mt.

Figures 82–91. Label data of the type series: **82** *Atheta* (*Microdota*) *amicula*, syntype from NHM **83** *A.* (*M.*) *amicula*, syntype from MNHUB **84** *A.* (*M.*) *formicetorum*, syntype from FMNH **85** *A.* (*M.*) *koreana*, syntype from NHM **86** *A.* (*M.*) *spiniventris*, syntype from NHM **87** *A.* (*M.*) *subcrenulata*, syntype from NHM **88** *A.* (*M.*) *subcrenulata*, syntype from FMNH **89–91** *A.* (*M.*) *kobensis*, syntypes from NHM.

Geumgangsan, 1.viii.1981, A. Szeptycki]; 1 ex., Korea 1981 Pekson-ri A. Szeptycki [North Korea, Hwanghae Prov., Baeksong-ri, 1981, A. Szeptycki].

Remarks. The North Korean record of the species by Paśnik (2001) is a misidentification of other *Atheta* (*Microdota*) species. This species differs from the syntypes of *A.* (*M.*) *kobensis* by the shape of aedeagus and spermatheca. We cannot identify the species at this point because specimens are not in good shape.

Discussion

Microdota, one of the most species-rich subgenus of *Atheta*, is taxonomically reviewed and the subgenus is represented in Korea by 15 species. Most specimens were collected by flight intercept trap and some others collected by sifting leaf litter. Six species [*Atheta* (*Microdota*) *amicula*, *A.* (*M.*) *formicetorum*, *A.* (*M.*) *koreana*, *A.* (*M.*) *muris*, *A.* (*M.*) *palleola* and *A.* (*M.*) *spiniventris*] have been found in association with fungus but they

seem not to be mycetophagous. *Atheta* (*M.*) *subcrenulata* was usually found in decaying vegetables and straw piles. No habitat preference of North Korean species is available.

Since the first record of Korean *Microdota* species by Bernhauer (1923), 11 species were recorded in North Korea (Paśnik 2001). Two species are removed from the Korean fauna and six species are added to the Korean fauna in this study. Consequently, the number of *Microdota* species known to occur in the Korean Peninsula increases from 11 to 15. Five species [*Atheta* (*Microdota*) *hamgyongsani*, *A.* (*M.*) *Jangtaesanensis* Lee & Ahn, sp. n., *A.* (*M.*) *kangsonica*, *A.* (*M.*) *pasniki* Lee & Ahn, sp. n., and *A.* (*M.*) *sogamensis*] are found only in the Korean peninsula. Of the remaining species, two [*A.* (*M.*) *formicetorum* and *A.* (*M.*) *silvatica*] were previously known to occur in Japan and Korea, four [*A.* (*M.*) *kawachiensis*, *A.* (*M.*) *muris*, *A.* (*M.*) *spiniventris*, *A.* (*M.*) *spinula*] were previously considered endemic to Japan, two [*A.* (*M.*) *koreana* and *A.* (*M.*) *subcrenulata*] inhabit Korea, China and Japan, one [*A.* (*M.*) *palleola*] occurs in Korea, Europe and Russia and the last [*A.* (*M.*) *amicula*] is found in trans-Palaearctic, Nearctic and Neotropical regions.

Compared with other north temperate regions, such as Czech Republic (17 species), Great Britain (16 species), Spain (13 species), and Turkey (11 species), the diversity of Korean *Microdota* is close to that of the regions (Smetana 2004). However, it appears a bit lower than that of adjacent Japan (20 species). Although the Japanese archipelago is an area of relatively high endemism for *Microdota*, this study decreases the number of species considered endemic to this area from 14 (70%) to 11 (55%) (Smetana 2004). Without doubt, further collecting efforts and the study of Korean species will increase opportunity to discover additional *Atheta* (*Microdota*) species.

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References

Ashe JS (1984) Generic revision of the subtribe Gyrophaenina (Coleoptera: Staphylinidae: Aleocharinae) with a review of the described subgenera and major features of evolution. Quaestiones Entomologicae 20: 129–349.

Benick G (1975) Neue Atheten (Col. Staphyl.) aus Deutschland und den zunächst gelegenen Ländern. Stuttgarter Beiträge zur Naturkunde, Serie A (Biologie) 273: 1–23.

Benick G, Lohse GA (1974) 14. Tribus: Callicerini (Athetae). In: Freude H, Harde KW, Lohse GA (Eds) Die Käfer Mitteleuropas. Band 5, Staphylinidae II (Hypocyphtinae und Aleocharinae): Pselaphidae. Goecke & Evers Verlag, Krefeld, 72–220.

Bernhauer M (1907) Zur Staphylinidenfauna von Japan. Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien 57: 371–414.

Bernhauer M (1923) Neue Staphyliniden der palaearktischen Fauna. Koleopterologische Rundschau 10: 122–128.

Bernhauer M (1929) Neue Staphyliniden aus Mittelamerika. Wiener Entomologische Zeitung 46: 186–208.

Brundin L (1948) Microdota-Studien. (Col. Staphylinidae). Entomologisk Tidskrift 69: 8–66.

Cameron M (1933) New species of Staphylinidae (Coleoptera) from Japan. The Entomologist's Monthly Magazine 69: 208–219.

Cho YB, Ahn KJ (2001) Family Silphidae and Staphylinidae. Economic Insect of Korea 11. Insecta Koreana Supplement 18. National Institute of Agriculture Science and Technology, Suwon, Korea, 169 pp.

Erichson WF (1837) Die Käfer der Mark Brandenburg. Erster Band, Erster Abtheilung. FH Morin, Berlin, 384 pp.

Fenyes A (1920) Coleoptera. Fam. Staphylinidae, subfam. Aleocharinae. In: Wytsman P (Ed.) Genera Insectorum, Fascicule 173B. Louis Desmet-Verteneuil, Bruxelles, 111–414.

Ganglbauer L (1895) Die Käfer von Mitteleuropa. Die Käfer der österreichisch-ungarischen Monarchie, Deutschlands, der Schweiz, sowie des französischen und italienischen Alpengebietes. Zweiter Band. Familienreihe Staphylinoidea. I. Theil: Staphylinidae, Pselaphidae. Carl Gerold's Sohn, Wien, 881 pp.

Heer O (1839) Fascicule II. In: Fauna Coleopterorum Helvetica Pars I: Turici: Orelii, Fursslini et Sociorum, 145–360.

Kraatz G (1859) Die Staphylininen-Fauna von Ostindien insbesondere der Insel Ceylan. Archiv für Naturgeschichte 25: 1–196. doi: 10.5962/bhl.title.66002

Lynch Arribálzaga F (1884) Los estafilinos de Buenos Aires. Boletín de la Academia Nacional de Ciencias en Córdoba 7: 5–392.

Mulsant E, Rey C (1852) Description de quelques coléoptères nouveux ou peu connus de la tribu des Brachélytres. Opuscules Entomologiques 1: 15–46.

Mulsant E, Rey C (1873a) Description de divers coléoptères brévipennes nouveaux ou peu connus. Opuscules Entomologiques 15: 147–189.

Mulsant E, Rey C (1873b) Histoire naturelle des coléoptères de France. Brévipennes Aleochariens. Suite. Deyrolle, Paris, 695 pp.

Kim JI, Kwon YJ, Paik JC, Lee SM, Ahn SL, Park HC, Chu HY (1994) Order 23. Coleoptera. In: The Entomological Society of Korea and Korean Society of Applied Entomology (Eds) Check List of Insects from Korea. Kon-Kuk University Press, Seoul, 117–214.

Pace R (1990) Aleocharinae nepalesi del Museo di Ginevra. Parte III. Revisione delle specie himalayane del sottogenere *Microdota* Mulsant & Rey. (Coleoptera, Staphylinidae) (106° Contributo alla conoscenza delle Aleocharinae). Revue Suisse de Zoologie 97: 901–979.

Palm T (1970) Svensk Insektfauna: Skalbaggar. Coleoptera. Kortvingar: Fam. Staphylinidae. Underfam. Aleocharinae (*Atheta*), Häfte 6. Entomologiska Föreningen I Stockholm 6: 117–296.

Paśnik G (2001) The North Korean Aleocharinae (Coleoptera, Staphylinidae): diversity and biogeography. Acta Zoological Cracoviensia 44: 185–234.

Peyerimhoff PM (1938) Notes sur les *Amischa* Thomson (Col. Staphylinidae). Revue Française d'Entomologie 5: 64–73.

Quedenfeldt M (1884) Beiträge zur Kenntniss der Staphylinen-Fauna von Süd-Spanien, Portugal und Marokko. Berliner entomologische Zeitschrift 28: 97–112, 351–379.

Saulcy FHC de (1865) Description d'une espèce nouvelle du genre *Articerus* propre à la faune méditerranéenne et d'une espèce nouvelle de *Machaerites* propre à la faune française. Annales de la Société Entomologique de France (4) 5: 13–17.

Sawada K (1970) Aleocharinae (Staphylinidae, Coleoptera) of the IBP-station in the Shiga Heights, Central Japan (I). Bulletin of the National Science Museum 13(1): 21–64.

Sawada K (1972) Methodological Research in the Taxonomy of Aleocharinae. Contributions from the Biological Laboratory, Kyoto University 24: 31–59.

Sawada K (1974) Studies of the genus *Atheta* Thomson and its allies (Coleoptera, Staphylinidae). I. *Amidobia*. Contributions from the Biological Laboratory, Kyoto University 24(3): 145–186.

Scheerpeltz O (1976) Wissenschaftliche Ergebnisse der von Prof. Dr. H. Janetschek im Jahre 1961 in das Mt.-Everest-Gebiet Nepals unternommenen Studienreise (Col. Staphylinidae). Khumbu Himal, Ergebnisse des Forschungsunternehmens Nepal Himalaya 5: 1–75.

Seevers CH (1978) A generic and tribal revision of the North American Aleocharinae (Coleoptera: Staphylinidae). Fieldiana: Zoology 71: 1–289.

Smetana A (2004) Subfamily Aleocharinae Fleming, 1821. In: Löbl I, Smetana A (Eds) Catalogue of Palaearctic Coleoptera. Volume 2. Hydrophiloidea, Histeroidea, Staphylinoidea. Apollo Books, Denmark, Stenstrup, 353–494.

Stephens JF (1832) Illustrations of British entomology; or, a synopsis of indigenous insects: containing their generic and specific distinctions; with an account of their metamorphoses, time of appearance, localities, food, and economy, as far as practicable. Mandibulata, Volume 5. Baldwin and Cradock, London, 448 pp.

Thomson CG (1858) Försök till uppställning af Sveriges Staphyliner. Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar 15: 27–40.

Wollaston TV (1864) Catalogue of the coleopterous insects of the Canaries in the collection of the British Museum. The Trustees of the British Museum, London, 648 pp.

Yosii R, Sawada K (1976) Studies on the genus *Atheta* Thomson and its allies (Coleoptera, Staphylinidae). II: Diagnostic characters of Genera and Subgenera with description of representative Species. Contribution from the Biological Laboratory Kyoto University 25(1): 11–140.

Yuh JH, Paik WH, Kwon YJ, Lee SM (1985) Checklist of rove beetles from Korea (Coleoptera: Staphylinidae). Insecta Koreana 5: 223–255.

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The *Tetramorium squaminode* species group (Hymenoptera, Formicidae) in the Arabian Peninsula, with a new record from the Kingdom of Saudi Arabia and keys to Arabian species

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Abstract

The Arabian species of the *Tetramorium squaminode*-group are treated. *Tetramorium squaminode* Santschi, 1911 is recorded for the first time from the Kingdom of Saudi Arabia and the Arabian Peninsula. Keys to the two Arabian species of the *T. squaminode*-group, *T. latinode* Collingwood & Agosti, 1996 and *T. squaminode*, based on worker and queen castes, are given and a regional distribution map is provided. Notes on habitats of *T. squaminode* are presented.

Keywords

Myrmicinae, Middle East, Palearctic Region, Asir Mountains, taxonomy, keys, *squaminode*-group

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Introduction

The genus *Tetramorium* Mayr, 1855 is one of the largest and most species-rich ant genera in the Formicidae with 575 described species (www.antwiki.org) distributed worldwide (Brown 2000). Members of the genus are often generalized foragers, known to build nests in leaf-litter, decaying wood, or directly into the soil (Brown 2000). Globally, taxonomic studies have treated the genus in several zoogeographical realms or regions, namely the Afrotropical (Bolton 1976, 1980, 1985; Hita Garcia et al. 2010a, b, c; Hita Garcia and Fisher 2014a, b), Malagasy (Bolton 1979, Hita Garcia and Fisher 2011, 2012, 2014c), Oriental and Indo-Australian (Bolton 1977) and the Palearctic (Csösz et al. 2007; Csösz and Schulz 2010) and for the former Soviet republics (Radchenko 1992a, b).

The majority of the Arabian species of the genus *Tetramorium* can be readily distinguished by the combination of the following characters in the worker caste (Bolton 1994): lateral clypeal portions raised into a sharp ridge or shield in front of the antennal insertions; mandibles armed with 3-4 apical teeth followed by a variable number of denticles; antennae 12-segmented with a 3-segmented club; frontal carinae ranging from well developed (*e.g. T. simillimum*-group) to absent (*e.g. T. caespitum*-group); propodeal spiracles low on the side and distinctly behind the midlength of the sclerite; propodeal spines usually present; sting with an apicodorsal lamellate appendage projecting from the shaft.

The *T. squaminode*-group was characterized by Bolton (1980): petiole squamiform, higher than long in profile and much broader than long in dorsal view; postpetiole rounded-nodiform; anterior clypeal portion usually indented medially; frontal carinae strongly developed extending back nearly to posterior margin of head; antennal scrobes well developed; petiolar and postpetiolar nodes without sculpture dorsally; standing pilosity usually present and moderately dense. The distribution of species of the *squaminode*-group is mainly restricted to East and/or South Africa but with a single species *sitefrum* Bolton, 1980 in Ghana (Bolton 1980).

The *Tetramorium* fauna of the Arabian Peninsula is still relatively poorly known when taken in consideration of the vastness of the peninsula (3,100,000 km^2) and many areas are unexplored entomologically. The first contribution to the knowledge of the genus *Tetramorium* of the region was presented by Collingwood (1985) for the Kingdom of Saudi Arabia (KSA), the largest country (2,150,000 km^2) of the peninsula. He listed thirteen species, one of which, *T. jizani* Collingwood 1985 of the *simillimum*-group, was described as new. A more comprehensive work treating *Tetramorium* of the Arabian Peninsula was presented by Collingwood and Agosti (1996) reporting sixteen species, two of which were new to science, *T. latinode* of the *squaminode*-group and *T. yemene* of the *simillimum*-group, both from Yemen. The invasive species *T. bicarinatum* (Nylander, 1846) was recorded from the United Arab Emirates (UAE) by Collingwood et al. (1997). Recently, a faunistic list of Formicidae for the UAE was given including six *Tetramorium* species, with *T. latinode* from Sharjah (Collingwood et al. 2011). Only three invasive species have been reported from the Socotra Archipelago (Yemen), *T. lanuginosum* Mayr, 1870, *T. simillimum* (F. Smith, 1851) and *T. caldarium* (Roger, 1857) (Collingwood et al. 2004). Recently, Sharaf et al. (2012a)

described a new species, *T. amalae* of the *T. shilohense*-group from the southwestern mountains of KSA based on two workers. Additionally, in the above paper *T. latinode* was recorded for the first time from KSA, redescribing the worker caste and describing the queen caste for the first time. More recently, Sharaf et al. (2013) reported three *Tetramorium* species from Rawdhat Khorim Nature Preserve near Riyadh, KSA, *T. chefketi* Forel, 1911, *T. sericeiventre* Emery, 1877 and the new species, *T. saudicum* Sharaf, 2013.

In the present study, the species of the *T. squaminode*-group occurring in the Arabian Peninsula are treated. Two species are known, *T. latinode* Collingwood & Agosti, 1996 and *T. squaminode* Santschi, 1911. The latter species is recorded for the first time from the KSA and the entire Arabian Peninsula. Keys to the two Arabian species are provided based on worker and queen castes with notes on habitats of *Tetramorium squaminode* Santschi.

Material and methods

Study area. The Raydah Protectorate in the mountains of southwestern KSA is one of the smallest areas set aside as a conservation reserve area in 1989 and is located 10 km west of the city of Abha, (18°12'N, 42°24'E). The total area is about 9 km^2, but given a drop of 1000 m in 3 km, the estimated total area is closer to 12 km^2. The village of Raydah lies at 1600 m just outside the protected area (Newton and Newton 1996).

Measurements and Indices. (Following Hita Garcia et al. 2010a)

Measurements

Head length (**HL**)	maximum distance from mid-point of anterior clypeal margin to mid-point of posterior margin of head, measured in full-face view.
Head width (**HW**)	width of head directly behind eyes measured in full-face view.
Scape length (**SL**)	maximum scape length excluding basal condyle and neck.
Eye length (**EL**)	maximum diameter of compound eye measured in oblique lateral view.
Pronotal width (**PW**)	maximum width of pronotum measured in dorsal view.
Weber's length (**WL**)	diagonal length of mesosoma in lateral view from the postero-ventral margin of propodeal lobe to anterior-most point of pronotal slope, excluding the neck.
Propodeal spine length (**PSL**)	in dorsocaudal view, tip of the measured spine, its base, and center of propodeal concavity between spines must all be in focus. Using a dual-axis micrometer spine length is measured from tip of spine to a virtual point at its base where spine axis meets orthogonally with a line leading to median point of the concavity.

Petiolar node length (**PTL**)	maximum length of dorsal face of petiolar node measured in dorsal view, excluding peduncle.
Petiolar node height (**PTH**)	maximum height of petiolar node measured in lateral view from the highest (median) point of the node to ventral outline. The measuring line is placed in an orthogonal angle to ventral outline of node.
Petiolar node width (**PTW**)	maximum width of dorsal face of petiolar node measured in dorsal view.
Postpetiole length (**PPL**)	maximum length of postpetiole measured in dorsal view.
Postpetiole height (**PPH**)	maximum height of postpetiole measured in lateral view from the highest (median) point of the node to the ventral outline. The measuring line is placed in an orthogonal angle to ventral outline of the node.
Postpetiole width (**PPW**)	maximum width of postpetiole measured in dorsal view.

Indices

Ocular index (**OI**):	EL / HW × 100
Cephalic index (**CI**):	HW / HL × 100
Scape index (**SI**):	SL / HW × 100
Propodeal spine index (**PSLI**):	PSL / HL × 100
Petiolar node index (**PeNI**):	PTW / PW × 100
Lateral petiole index (**LPeI**):	PTL / PTH × 100
Dorsal petiole index (**DPeI**):	PTW / PTL × 100
Postpetiolar node index (**PpNI**):	PTW / PW × 100
Lateral postpetiole index (**LPpI**):	PPL / PPH × 100
Dorsal postpetiole index (**DPpI**):	PPW / PPL × 100
Postpetiole index (**PPI**):	PPW / PTW × 100

Abbreviations of museums

The collection abbreviations follow Lattke (2000).

CASC	California Academy of Sciences, San Francisco, California, U.S.A.
NHMB	Naturhistorisches Museum, Basel, Switzerland.
KSMA	King Saud University Museum of Arthropods, Plant protection department, College of Food and Agriculture Sciences, King Saud University, Riyadh, Kingdom of Saudi Arabia.
WMLC	World Museum Liverpool, Liverpool, U. K.

The map was created by the ArcGIS 9.2 program, with the help of Prof. Mahmoud S. Abdeldayem (King Saud University).

Results

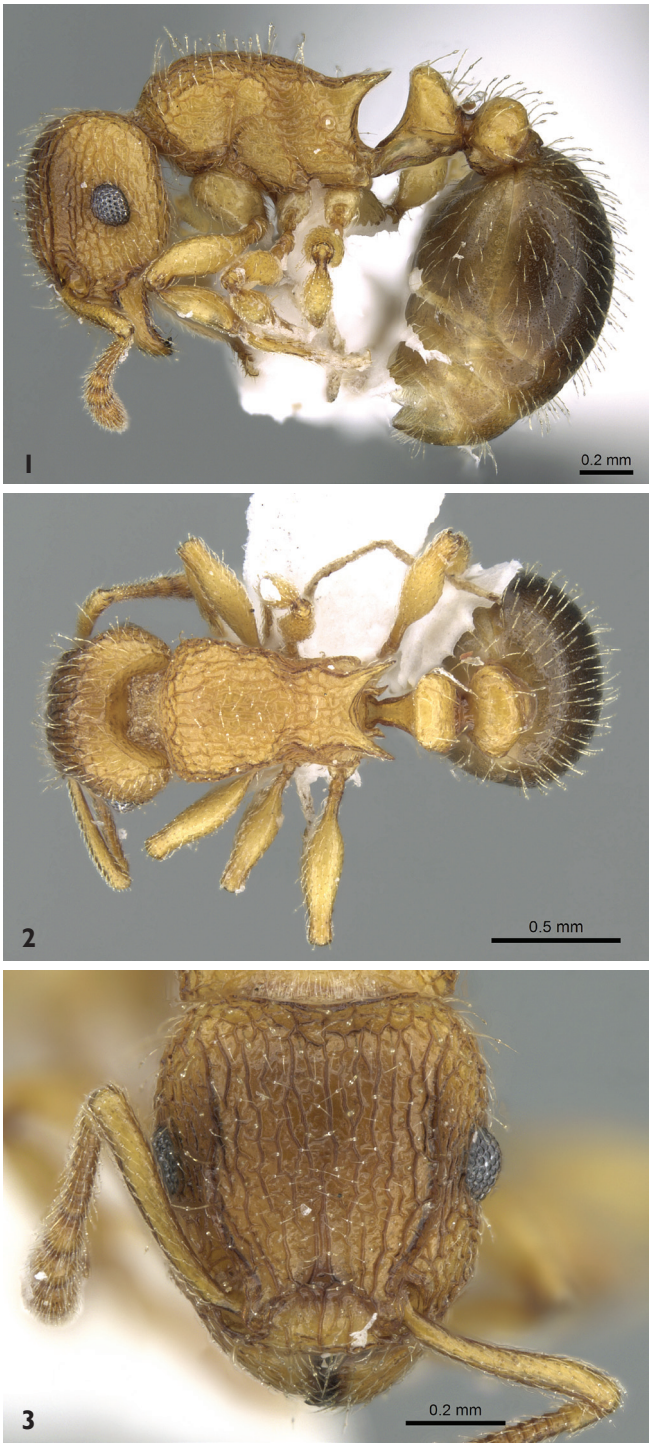
Tetramorium latinode Collingwood & Agosti, 1996

Tetramorium latinode Collingwood & Agosti, 1996: 335, fig. 12 (w.) YEMEN.
Holotype worker, YEMEN: Ma'bar, pitfall trap, 11.v.1992 *(M. Mahyoub & A. Drews)* (WMLC).

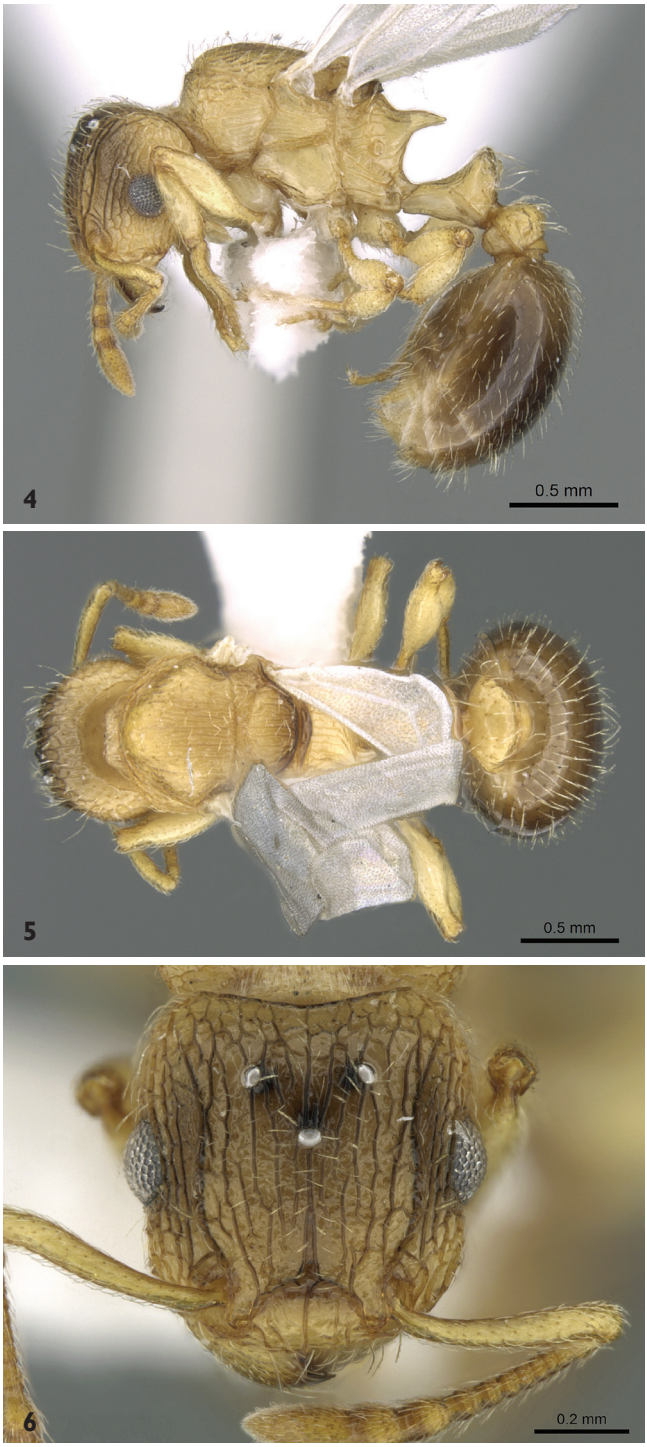
Diagnosis. ***Worker*** (Figs 1–6)**. Head.** Head longer than broad; anterior clypeal margin with a median notch or impression; frontal carinae long and sinuate, reaching back almost to posterior margin of head; antennal scrobes distinct; eyes large (EL 0.12-0.17) with ten ommatidia in longest row. **Mesosoma.** Mesosoma profile a continuous curve; metanotal groove very weakly impressed; propodeal spines long and strong. **Petiole.** Petiole much higher than long in profile, in dorsal view much broader than long but slightly narrower than postpetiole which is clearly broader than long. **Postpetiole.** Postpetiole in profile lower than petiole and broadly rounded. **Sculpture.** Mandibles feebly longitudinally striated; cephalic dorsum and mesosoma irregularly but quite densely longitudinally reticulate-rugulose, petiole dorsum smooth and shining, postpetiole dorsum more or less smooth and shining with vestiges of patchy pattern, gaster smooth and shining. **Pilosity.** Body dorsum densely clothed with long, fine, soft finely barbulate hairs which are fewer on mesosoma and waist; antennae and tibiae with dense decumbent pubescence. Colour yellow, gaster brown to brownish yellow.

Material examined. 34 workers, Saudi Arabia, Al Bahah, Amadan forest, Al Mandaq, 20°12.163'N, 41°13.906'E, 1881 m, 19.v.2010 (*M. R. Sharaf & A. S. Aldawood Leg.*); 1 worker, Saudi Arabia, Asir, Abha, Raydah, 18°11.679'N, 42°23.691'E, 1851 m, 8.vi.2014, (Pitfall trap) (*Al Dhafer* et al. *Leg.*); the following materials with data as the previous materials except coordinates and altitudes as follow: 1 worker, 18°11.618'N, 42°23.420'E, 1772 m; 2 workers, 18°11.695'N, 42°23.818'E, 1897 m; 2 workers, 18°12.265'N, 42°24.744'E, 2820 m; 5 workers, 18°12.315'N, 42°24.607'E, 2761 m; 5 workers, 18°12.095'N, 42°24.536'E, 2578 m. (KSMA).

Alate gyne. Head little longer than broad with nearly straight or feebly convex sides; posterior margin of head weakly concave; eyes large and consist of 14 ommatidia in the longest row, EL about 0.27 × HW; antennae 12-segmented; frontal carinae long and sinuate, reaching back almost to posterior margin of head where they merge with the remaining sculpture of cephalic dorsum; antennal scrobes well developed; propodeal spines long and acute; petiole, postpetiole, pilosity and head sculpture as in worker. Bicoloured, body yellowish, gaster brown.



Figures 1–3. *Tetramorium latinode*, worker (casent0906432, Saudi Arabia). **1** body in profile **2** body in dorsal view **3** head in full-face view. Photographer Estella Ortega, from www.AntWeb.org



Figures 4–6. *Tetramorium latinode*, queen (casent0906431, Saudi Arabia). **4** body in profile **5** body in dorsal view **6** head in full-face view. Photographer Estella Ortega, from www.AntWeb.org

Tetramorium squaminode Santschi, 1911

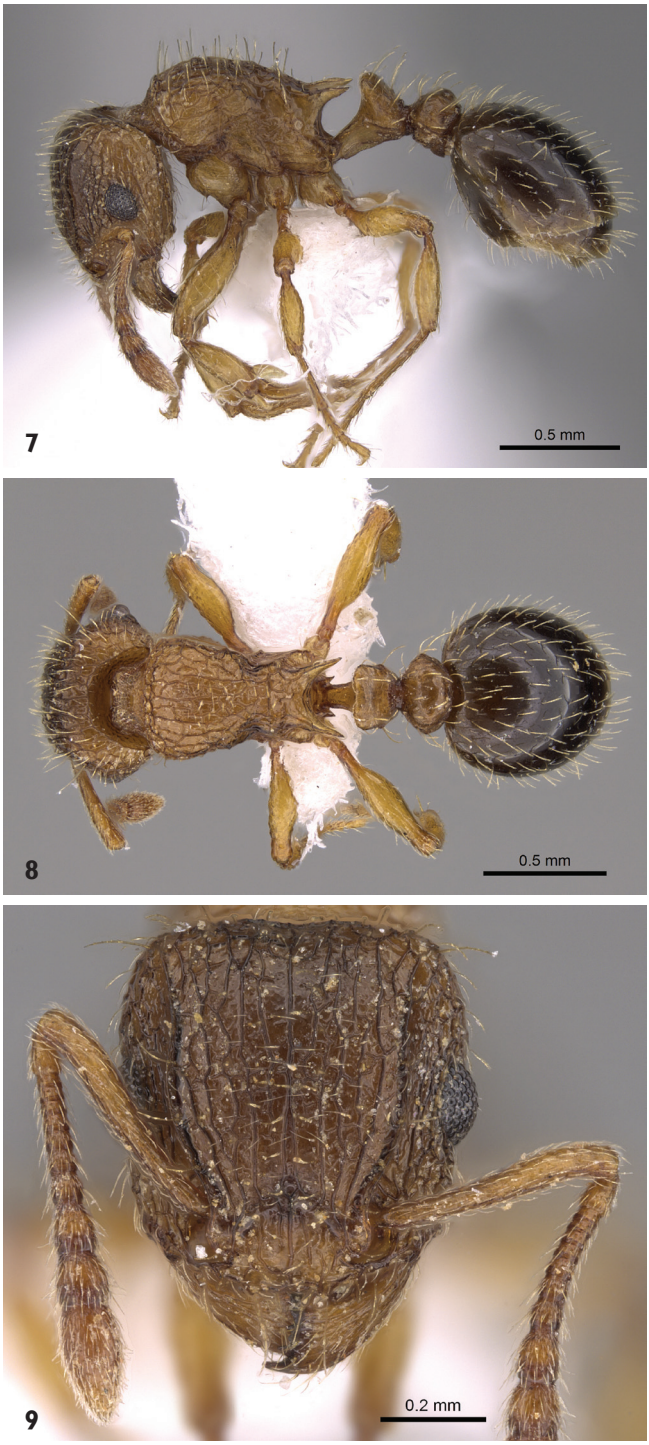
Tetramorium squaminode Santschi, 1911: 356, fig. (w) TANZANIA.
Santschi 1914: 102 (q.m.). See also: Bolton 1980: 260.

Diagnosis. ***Worker*** (Figs 7–9). **Head** in full-face view distinctly longer than broad with feebly convex sides and nearly straight posterior margin; anterior clypeal margin superficially concave medially; frontal carinae strongly divergent posteriorly, directed towards posterior corners of head; antennal scrobes well developed; eyes relatively large (OI 22-29) situated on midlength of head, with 13 ommatidia in longest row. **Mesosoma** with rounded pronotal corners when seen from above; in profile metanotal groove feebly impressed or absent; propodeal spines long and sharp; transverse dorsal crest of petiole scale thin and sharp, knife-edged. (DPeI 135-200); in larger specimens petiole dorsum weakly but distinctly emarginate in dorsocaudal view; postpetiole in profile rounded from above; in dorsal view postpetiole hexagonal and much broader than long (DPpI 159–233). **Sculpture.** Cephalic dorsum sharply and irregularly longitudinally rugulose, sculpture running broken from clypeus to posterior margin of head, area in front of eyes strongly reticulate-rugose, lateral sides of head similar but less strongly sculptured; mandibles faintly but distinctly longitudinally rugulose; clypeus with strong median carinae and two pairs of weaker lateral carinae; mandibles faintly but distinctly longitudinally striated; mesosomal dorsum coarsely irregularly reticulate-rugose; area between propodeal spines when seen from above with three transverse carinae; petiole, postpetiole and gaster dorsum more or less smooth and shining, with very faint superficial sculpture. **Pilosity.** Frontal carinae with seven pairs of relatively longer hairs straddling the entire line; posterior corners of head with a single pair of characteristically longer hairs compared to rest of cephalic pilosity which is much shorter; mesosomal pilosity relatively less dense and long, some hairs apically clubbed; petiole and postpetiole with abundant apically clubbed long hairs; legs and antennae with appressed hairs. **Colour.** Cephalic dorsum and gaster dark brown, head sides, mesosoma, petiole and postpetiole yellowish brown.

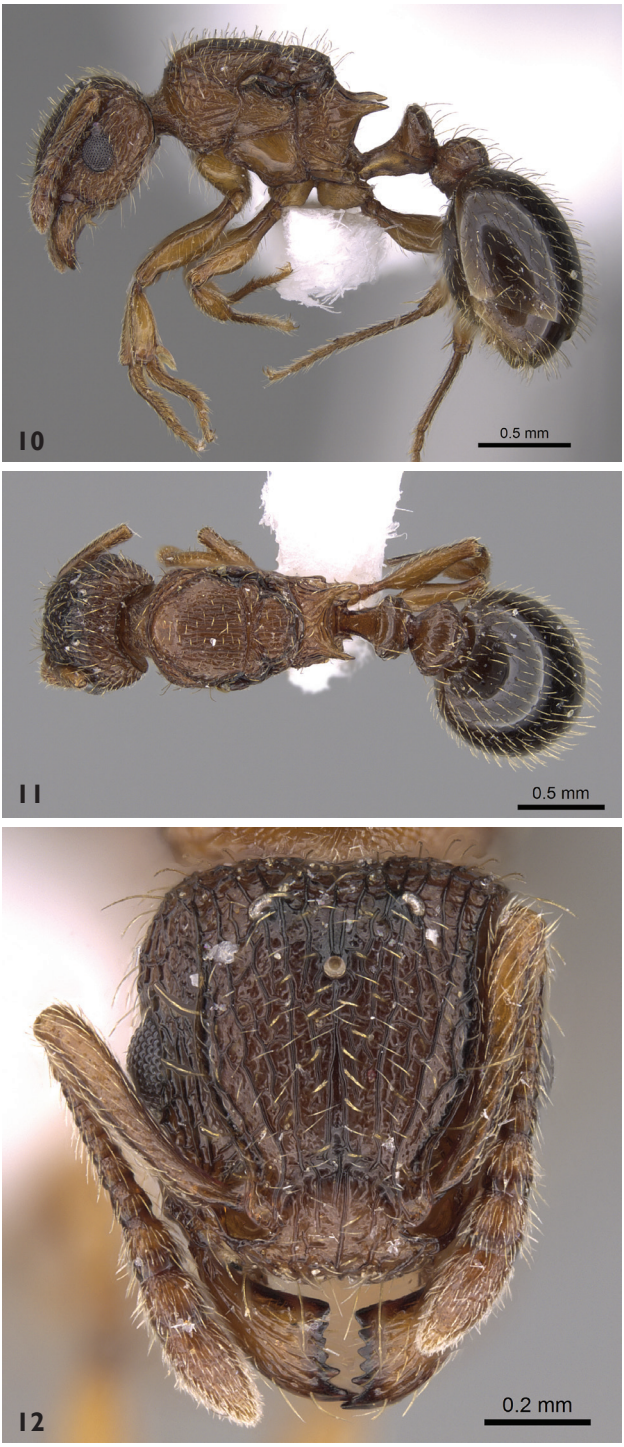
Measurements. Worker. TL 2.70–3.35; HL 0.70–0.75; HW 0.62–0.72; SL 0.42–0.57; EL 0.15–0.20; PW 0.47–0.57; WL 0.75–0.90; PSL 0.15–0.25; PTL 0.15–0.20; PTH 0.27–0.35; PTW 0.25–0.30; PPL 0.15–0.22; PPH 0.22–0.27; PPW 0.32–0.45; CI 84–97; SI 60–81; OI 22–29; DMI 55-67; PSLI 24–35; PeNI 29–60; LPeI 50–67; DPeI 135–200; PpNI 61–90; LPpI 63–100; DPpI 159–233; PPI 117–156 (n=12).

Queen (Figs 10–12)**. Head.** Head clearly longer than broad, narrower anteriorly than posteriorly, with straight posterior margin; median portion of anterior clypeal margin feebly concave; eyes situated nearly at midlength of head; eyes large (OI 28–29) with 16 ommatidia in longest row; antennae when laid back from their insertions fail to reach posterior margin of head. **Mesosoma.** Propodeal spines long thick and sharp; petiole, postpetiole and gaster as in worker caste.

Colour. Head, mesosomal dorsum, petiole and postpetiole dark brown or blackish brown, gaster dark blackish brown to black, antennae and legs yellowish. **Sculpture.**



Figures 7–9. *Tetramorium squaminode*, worker (casent0914585, Saudi Arabia). **7** body in profile **8** body in dorsal view **9** head in full-face view. Photographer Michele Esposito, from www.AntWeb.org



Figures 10–12. *Tetramorium squaminode*, queen (casent0914584, Saudi Arabia). **10** body in profile **11** body in dorsal view **12** head in full-face view. Photographer Michele Esposito, from www.AntWeb.org

Figure 13. Raydah Protected area, habitat of *Tetramorium squaminode*. Photographer Mahmoud S. Abdel-Dayem.

As in worker except mesosomal dorsum longitudinally rugose. **Pilosity.** Pilosity dense over entire body with apically clubbed hairs which are more abundant on postpetiole and rare on gaster; frontal carinae with five pairs of distinctly longer hairs straddling entire length, corners of posterior margin of head with a single pair of longer hairs.

Measurements. Queen. TL 3.65–3.75; HL 0.85; HW 0.75–0.80; SL 0.55–0.57; EL 0.22; PW 0.67–0.72; WL 1.12–1.25; PSL 0.20–0.25; PTL 0.20–0.22; PTH 0.40–0.42; PTW 0.35–0.37; PPL 0.20–0.22; PPH 0.32–0.35; PPW 0.45–0.47; CI 88–94; SI 69–76; OI 28–29; DMI 58-60; PSLI 24–29; PeNI 49–55; LPeI 48–55; DPeI 168–175; PpNI 65–67; LPpI 63; DPpI 205–235; PPI 122–134 (n=2).

Materials examined. 3 workers, 1 queen, Saudi Arabia, Asir, Abha, Raydah, 18°12.315'N, 42°24.607'E, 2761 m, 26.vii.2014, (Pitfall trap) (*Al Dhafer* et al. *Leg.*); 2 workers Saudi Arabia, Asir, Abha, Raydah, 18°12.095'N, 42°24.536'E, 2578 m; 3 workers Saudi Arabia, Asir, Abha, Raydah, 18°12.265'N, 42°24.744'E, 2820 m; 1 worker Saudi Arabia, Asir, Abha, Raydah, 18°11.695'N, 42°23.818'E, 1897 m (all in KSMA) (*Al Dhafer* et al. *Leg.*); 1 worker in **NHMB**; 1 worker (casent0914585) and 1 queen (casent0914584) in **CASC** (*Al Dhafer et al. Leg.*).

Habitat. *Tetramorium squaminode* was collected from Raydah Protectorate which includes one of the last remnants of dense juniper forest found on the KSA. The vegetation shows distinct altitudinal zonation, although there are variations within zones. The locality (Fig. 13) has a substantial high diversity of wild plants including: *Juniperus*

procera Hochst. ex Endlicher (Cupressaceae), *Olea europaea* ssp. *africana* (Mill.) P. Green. (Oleaceae), *Maerua crassifolia* (Capparceae), *Panicum turgidum* (Poaceae), *Lycium shawii roem* (Solanaceae), *Haloxylon salicornicum* (Chenopodiaceae), *Aloe officinalis* Forssk. (Xanthorrhoeaceae), *Ziziphus spina-christi* (Rhamnaceae), *Opuntia ficus-indica* (L.) Mill. (Cactaceae), *Coffea arabica* (Rubiaceae) and *Acacia* spp. (Mimosaceae).

Key to the Arabian species of the *Tetramorium squaminode*-group based on workers

1 Strongly bicoloured species, head, mesosoma, petiole and postpetiole yellow, gaster brown to brownish yellow; eyes with ten ommatidia in the longest row; posterior margin of head concave; pronotal corners angled from above; posterior margin of head with hairs of more or less equal lengths; clubbed pilosity distributed over the entire body (Yemen & KSA) .... ***T. latinode* Collingwood & Agosti**

– Weakly bicoloured species with cephalic dorsum and gaster dark brown, lateral head, mesosoma, petiole and postpetiole of lighter brown; eyes with 13 ommatidia in the longest row; posterior margin of head nearly straight; pronotal corners rounded from above; posterior margin of head with one pair of characteristically longer hairs on both corners; clubbed pilosity restricted to the gaster, few on mesosoma (KSA) ..... ***T. squaminode* Santschi**

Key to the Arabian species of the *Tetramorium squaminode*-group based on queens

1 Strongly bicoloured, mesosoma, petiole, postpetiole, antennae and legs yellowish, head dorsum yellowish with scattered brownish tint, gaster brown; posterior margin of head distinctly concave; frontal carinae with only two pairs of hairs straddling the entire length, posterior corners of head without a single pair of longer hairs, instead about 8 subdecumbent hairs straddling the corners (Figs 4–6) (Yemen & KSA) ..... ***T. latinode* Collingwood & Agosti**

– Weakly bicoloured species with, head, mesosomal dorsum, petiole and postpetiole dark brown or blackish brown, gaster dark blackish brown to black, antennae and legs yellowish; posterior margin of head straight; frontal carinae with five pairs of distinctly long hairs straddling the entire length, posterior corners of head with some short hairs and a characteristic single pair of longer hairs (KSA) ..... ***T. squaminode* Santschi**

Discussion

Geologically, the Ethiopian and Arabian Peninsula mountains and highlands were separated approximately 13 my by the formation of the Great Rift Valley through a rifting

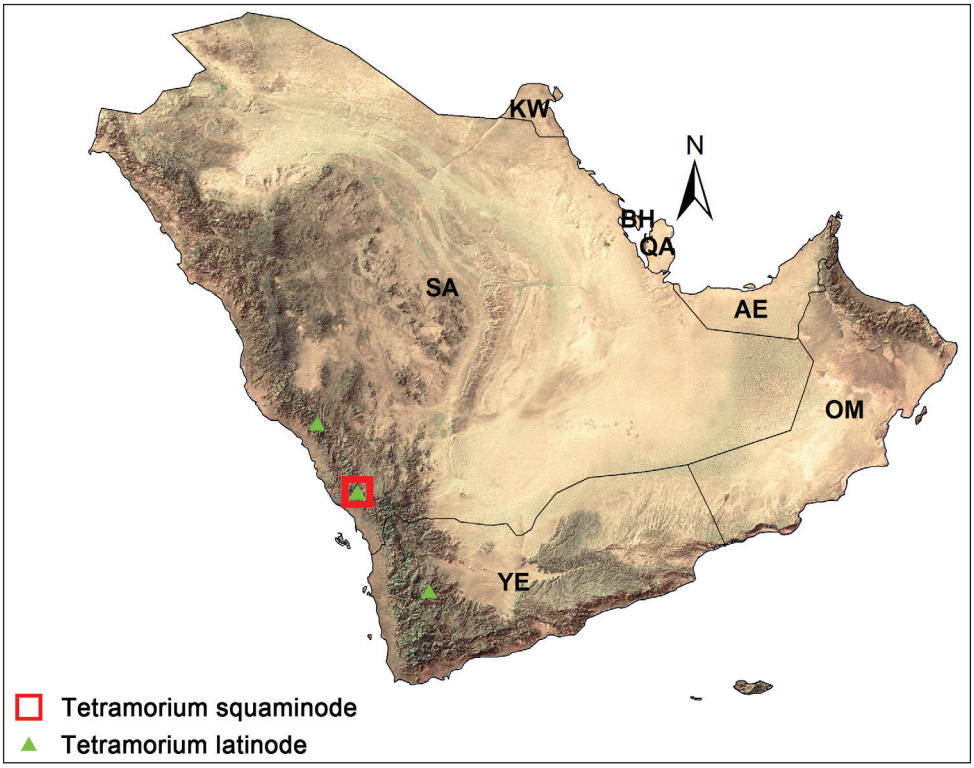


Figure 14. Distribution of *Tetramorium squaminode*-group in the Arabian Peninsula.

process as the African continental crust separated (Davison et al. 1994, Bosworth et al. 2005). Therefore, it is not surprising that the faunal composition of the southwestern region of the Arabian Peninsula is similar to the Afrotropical region. Several works have confirmed the mentioned faunal similarity (Eig 1938; Zohary 1973; Bolton 1994, Lehrer and Abou-Zied 2008; Doha 2009; Aldawood et al. 2011; Sharaf and Aldawood 2011, 2012; Sharaf et al. 2012a, b, c; El-Hawagryi et al. 2013; Sharaf and Aldawood 2013; Sharaf et al. 2014). Consequently, the biogeography of *T. squaminode* in the southwestern Mountains of the Arabian Peninsula is obviously similar to that of East African specimens. *Tetramorium squaminode* represents a very characteristic Afromontane faunal element confined to localities at higher elevations above 2500 m. The East African records are all from high elevations above the forest line, such as Mt. Kenya at ca. 3200 m (F. Hita Garcia, pers. comm.), at different elevations from Mt. Kilimanjaro, Tanzania, including 3800 m (Santschi 1911) and 2600-2800 m (Santschi 1914), as well as another unknown site in Tanzania (Bolton 1980). In general, one can say that the faunal composition of the southwestern Mountains of the Arabian Peninsula is a combination of two major elements, Arabian endemic and Afrotropical elements. The *squaminode* group is a clear example of this since it has a single endemic species (*latinode*) and one widespread East African species (*squaminode*).

From another aspect, the regional distribution of the two species of the *T. squaminode*-group appears to be restricted to the southwestern Mountains of the Arabian Peninsula (Fig. 14). *Tetramorium latinode* was reported from Yemen and Al Sarawat Mountain, southwestern region of the KSA, whereas *T. squaminode* is only known from Asir Mountains. It is anticipated that the Arabian *T. squaminode*-group members have a broader distribution in the region than currently known, and will be found in additional localities at higher elevations, as well as in the Yemeni regions of these mountains. In addition, the record of *T. squaminode* in the Mountains of southwestern KSA, as well as other Afrotropical faunal elements recorded in the region, provides additional confirmations of the similarity of the entomofauna with the Afrotropical Region (Eig 1938; Zohary 1973; Bolton 1994, Lehrer and Abou-Zied 2008; Doha 2009; Aldawood et al. 2011; Sharaf and Aldawood 2011, 2012; Sharaf et al. 2012a, b, c; El-Hawagryi et al. 2013; Sharaf and Aldawood 2013; Sharaf et al. 2014).

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References

Aldawood AS, Sharaf MR, Taylor B (2011) First record of the myrmicine ant genus *Carebara* Westwood, 1840 (Hymenoptera, Formicidae) from Saudi Arabia with description of a new species *C. abuhurayri* sp. n. ZooKeys 92: 61–69. doi: 10.3897/zookeys.92.770

Bolton B (1976) The ant tribe Tetramoriini. Constituent genera, review of smaller genera and revision of *Triglyphothrix* Forel. Bulletin of the British Museum (Natural History), Entomology 34: 281–379.

Bolton B (1977) The ant tribe Tetramoriini. The genus *Tetramorium* Mayr in the Oriental and Indo-Australian regions, and in Australia. Bulletin of the British Museum (Natural History), Entomology 36: 67–151.

Bolton B (1979) The ant tribe Tetramoriini. The genus *Tetramorium* Mayr in the Malagasy region and in the New World. Bulletin of the British Museum (Natural History), Entomology 38: 129–181.

Bolton B (1980) The ant tribe Tetramoriini. The genus *Tetramorium* Mayr in the Ethiopian zoogeographical region. Bulletin of the British Museum (Natural History), Entomology 40: 193–384.

Bolton B (1985) The ant genus *Triglyphothrix* Forel a synonym of *Tetramorium* Mayr. Journal of Natural History 19: 243–248. doi: 10.1080/00222938500770191

Bolton B (1994) Identification guide to the ant genera of the World. Cambridge, Mass, 222 pp.

Bosworth W, Huchon P, Mcclay K (2005) The red sea and Gulf of Aden basins. Journal of African Earth Sciences 43: 334–378. doi: 10.1016/j.jafrearsci.2005.07.020

Brown WL Jr (2000) Diversity of ants. In: Agosti et al. (Eds) Ants. Standard methods for measuring and monitoring biodiversity, Biological diversity hand book series. Smithsonian institution press, Washington and London, 280 pp.

Collingwood CA (1985) Hymenoptera: Fam. Formicidae of Saudi Arabia. Fauna of Saudi Arabia 7: 230–301.

Collingwood CA, Agosti D (1996) Formicidae of Saudi Arabia. (Part 2). Fauna of Saudi Arabia 15: 300–385.

Collingwood CA, Tigar BJ, Agosti D (1997) Introduced ants in the United Arab Emirates. Journal of Arid Environments 37: 505–512.

Collingwood CA, Pohl H, Güsten R, Wranik W, Van Harten A (2004) The ants (Insecta: Hymenoptera: Formicidae) of the Socotra Archipelago. Fauna of Arabia 20: 473–495.

Collingwood CA, Agosti D, Sharaf MR, Van Harten T (2011) Order Hymenoptera, Family Formicidae. Arthropod Fauna of the UAE 4: 405–474.

Csösz S, Radchenko A, Schulz A (2007) Taxonomic revision of the Palaearctic *Tetramorium chefketi* species complex. Zootaxa 1405: 1–38. doi: 10.1006/jare.1997.0309

Csösz S, Schulz A (2010) A taxonomic review of the Palaearctic *Tetramorium ferox* species-complex. Zootaxa 2401: 1–29.

Davison I, Al-Kadasi M, Al-Khirbash S, Al-Subbary AK, Baker J et al. (1994) Geological evolution of the southeastern Red Sea Rift margin, Republic of Yemen. Geological Society of America Bulletin 106: 1474–1493. doi: 10.1130/0016-7606(1994)106<1474:GEOTSR>2.3.CO;2

Doha SA (2009) Phlebotomine sand flies (Diptera, Psychodidae) in different localities of Al-Baha province, Saudi Arabia. Egyptian Academic Journal of Biological Sciences 1: 31–37.

Eig A (1938) Taxonomic studies on the Oriental species of the genus *Anthemis*. Palestine Journal of Botany (Jerusalem) 1: 161–224.

El-Hawagryi MS, Khalil MW, Sharaf MR, Fadl HH, Aldawood AS (2013) A preliminary study on the insect fauna of Al-Baha Province, Saudi Arabia, with descriptions of two new species. Zookeys 274: 1–88. doi: 10.3897/zookeys.274.4529

Hita Garcia F, Fischer G, Peters MK (2010a) Taxonomy of the *Tetramorium weitzeckeri* species group in the Afrotropical Zoogeographical region. Zootaxa 2704: 1–90. http://www.mapress.com/zootaxa/2010/f/z02704p090f.pdf

Hita Garcia F, Fischer G, Peters MK (2010b) *Tetramorium snellingi* sp. n. – a new leaf-litter ant species (Hymenoptera: Formicidae) from a Western Kenyan rainforest. Myrmecological News 13: 141–146.

Hita Garcia F, Fischer G, Kűck P, Thormann B, Peters MK (2010c) *Tetramorium boehmei* sp. n. – a new ant (Hymenoptera: Formicidae) species from the Kakamega Forest, Western Kenya. Bonn Zoological Bulletin 57(2): 359–366.

Hita Garcia F, Fisher BL (2011) The ant genus *Tetramorium* Mayr (Hymenoptera: Formicidae) in the Malagasy region – introduction, definition of species groups, and revision of the *T. bicarinatum*, *T. obesum*, *T. sericeiventre* and *T. tosii* species groups. Zootaxa 3039: 1–72.

Hita Garcia F, Fisher BL (2012) The ant genus *Tetramorium* Mayr (Hymenoptera: Formicidae) in the Malagasy region – taxonomic revision of the *T. kelleri* and *T. tortuosum* species groups. Zootaxa 3592: 1–85.

Hita Garcia F, Fisher BL (2014a) The ant genus *Tetramorium* Mayr in the Afrotropical region (Hymenoptera, Formicidae, Myrmicinae): synonymisation of *Decamorium* Forel under *Tetramorium*, and taxonomic revision of the *T. decem* species group. ZooKeys 411: 67–103. doi: 10.3897/zookeys.411.7260

Hita Garcia F, Fischer G (2014b) Additions to the taxonomy of the Afrotropical *Tetramorium weitzeckeri* species complex (Hymenoptera, Formicidae, Myrmicinae), with the description of a new species from Kenya. European Journal of Taxonomy 90: 1–16.

Hita Garcia F, Fisher BL (2014c) The hyper-diverse ant genus *Tetramorium* Mayr (Hymenoptera, Formicidae) in the Malagasy region - taxonomic revision of the *T. naganum*, *T. plesiarum*, *T. schaufussii*, and *T. severini* species groups. ZooKeys 413: 1–170. doi: 10.3897/zookeys.413.7172

Lattke JE (2000) Specimen processing, building and curating an ant collection. In: Agosti et al. (Eds) Ants. Standard methods for measuring and monitoring biodiversity. Biological diversity hand book series. Smithsonian Institution Press, Washington and London, 280 pp.

Lehrer AZ, Abou-Zied EM (2008) Une espèce nouvelle du genre Engelisca Rohdendorf de la faune d'Arabie Saoudite (Diptera, Sarcophagidae). Fragmenta Dipterologica 14: 1–4.

Newton SF, Newton AV (1996) Seasonal changes in the abundance and diversity of birds in threatened juniper forest in the southern Asir Mountains, Saudi Arabia. Bird Conservation International 6: 371–392. doi: 10.1017/S0959270900001829

Radchenko AG (1992a) Ants of the genus *Tetramorium* in the fauna of the USSR. Part 1. Zoologicheskii Zhurnal 71(8): 39–49.

Radchenko AG (1992b) Ants of the genus *Tetramorium* in the fauna of the USSR. Part 2. Zoologicheskii Zhurnal 71(8): 50–58.

Santschi F (1911) Nouvelles fourmis d'Afrique. Annales de la Société Entomologique de France 79: 351–369.

Santschi F (1914) Voyage de Ch. Alluaud et R. Jeannel en Afrique Orientale (1911–1912). Résultats scientifiques. Insectes Hyménoptères 2. Paris, Formicidae, 41–148.

Sharaf MR, Aldawood AS (2011) *Monomorium dryhimi* sp. n., a new ant species (Hymenoptera, Formicidae) of the *M. monomorium* group from Saudi Arabia, with a revised key to the Arabian species of the group. ZooKeys 106: 47–54. doi: 10.3897/zookeys.106.1390

Sharaf MR, Aldawood AS (2012) A new ant species of the genus *Tetramorium* Mayr, 1855 (Hymenoptera, Formicidae) from Saudi Arabia, including a revised key to the Arabian species. PLoS ONE 7(2): e30811. doi: 10.1371/journal.pone.0030811

Sharaf MR, Aldawood AS (2013) First occurrence of the *Monomorium hildebrandti*-group (Hymenoptera: Formicidae), in the Arabian Peninsula, with description of a new species *M. kondratieffi* n. sp. Proceedings of the Entomological Society of Washington 115(1): 75–84. doi: 10.4289/0013-8797.115.1.75

Sharaf MR, Aldawood AS, Taylor B (2012a) A new ant species of the genus *Tetramorium* Mayr, 1855 (Hymenoptera: Formicidae) from Saudi Arabia, including a revised key to the Arabian species. PLoS ONE 7(2): e30811. doi: 10.1371/journal.pone.0030811

Sharaf MR, Aldawood AS, El-Hawagry MS (2012b) A new ant species of the genus *Tapinoma* (Hymenoptera, Formicidae) from Saudi Arabia with a key to the Arabian species. ZooKeys 212: 35–43. doi: 10.3897/zookeys.212.3325

Sharaf MR, Aldawood AS, El-Hawagry MS (2012c) First record of the ant subfamily Aenictinae (Hymenoptera, Formicidae) from Saudi Arabia, with the description of a new species. ZooKeys 228: 39–49. doi: 10.3897/zookeys.228.3559

Sharaf MR, Abdeldayem MS, Aldhafer H, Aldawood AS (2013) The ants (Hymenoptera: Formicidae) of Rawdhat Khorim nature preserve, Saudi Arabia, with description of a new species of the genus *Tetramorium* Mayr. Zootaxa 3709(6): 565–580.

Sharaf MR, Aldhafer H, Aldawood AS (2014) First record of the myrmicine ant genus *Meranoplus* Smith, 1853 (Hymenoptera: Formicidae) from the Arabian Peninsula with description of a new species and notes on the zoogeography of southwestern Kingdom Saudi Arabia. Accepted by PLoS ONE 9(11): e111298. doi: 10.1371/journal.pone.0111298

Zohary M (1973) Geobotanical foundations of the Middle East. Vol. 1–2. G. Fischer, Stuttgart, Swets & Zeitlinger, Amsterdam, 738 pp.

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Two new species of *Tribonium* Saussure, 1862 (Blattodea, Blaberidae, Zetoborinae), with a key to males of the genus

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Abstract

This contribution describes and illustrates the male genitalia of two new species of Blaberidae collected in the state of Minas Gerais, Brazil: *T. caldensis* **sp. n.** resembles *T. neospectrum* Lopes, 1978, differing in the coloration, size and genitalia; and *T. morroferrensis* **sp. n.**, which resembles *T. guttulosum* (Walker, 1868) but also differs in the size and coloration of specimen and genital pieces morphology. The genital plates were removed after dissection of the posterior part of the abdomen, and were stored in microvials containing glycerin, attached to the respective exemplar in the collection of the Museu Nacional of Rio de Janeiro, Brazil. A key to males of the species of the genus is also presented. Illustrations of *T. neospectrum* and *T. guttulosum* are provided to clarify the comparisons with the new species described here.

Keywords

Blattodea, genitalia, key, new species, taxonomy

Introduction

The genus *Tribonium* was described by Saussure (1862), who designated *Blatta spectrum* Eschscholtz, 1822 as the type species. Originally, Saussure described the genus as encompassing species with the following characteristics: antennae slightly longer than body; pronotum transverse; supranal plate of male enlarged; cerci short; coloration

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brown with scattered black spots, mainly on tegmina. Species identification within the genus is difficult, requiring morphological studies of the genitalia. Saussure described *Tribonium* in a key, where he separated the genus from *Proscratea* Burmeister, 1838, which is characterized by a shorter antenna, not reaching beyond apex of abdomen; pronotum with apical margin sinuous; tegmina broad; and sides of abdomen and extremities elevated. Saussure (1864) redescribed the genus and provided additional diagnostic characters: dilated in general shape; abdomen significantly widened, dorsoventrally flattened, with serriform ridges; subgenital plate with short styles.

Brunner von Wattenwyl (1865) described the genus *Philobora*, which was later synonymized with *Tribonium*, and characterized it by the head facing down, with vertex exposed; pronotum shaped as lid over the head, with dorsal margin forming an obtuse angle; tegmina wide basally; scapular area with folded comb; anal field triangular; wings rounded, with median vein complete; legs sturdy; abdomen flattened.

Hebard (1933) described a new species of *Tribonium* from Colombia: *Tribonium colombicum*.

Princis (1964) cataloged five species, recording the genus from Brazil, Argentina, Paraguay, Bolivia and Colombia.

Roth (1970) quoted Rehn (1932) as stating that "the genera *Zetobora*, *Lanxoblatta*, *Zetoborella*, and *Schizopilia* ... are clearly derivatives of a single phylum," whereas *Schistopeltis* and *Tribonium* ".... typifies a distinct and clearly marked phylogenetic series." In general, the structure of the male genitalia tends to support Rehn's hypothesis. However, Roth separated *Zetobora* from the other three genera of his grouping because of the "relatively poorly developed L2d", and described the genitalia of some species of *Tribonium*, which he assigned to the subfamily Zetoborinae. He characterized the genitalia of the genus as having the anterior portion of the median sclerite well developed, extended dorsally, with posterior portion extended upward; and subapical incision of right phallomere well defined at middle of hook.

In a footnote, Roth (1974) made corrections to the figures of *T. conspersum* (Guérin-Méneville & Percheron, 1835) and *T. spectrum* (Eschscholtz, 1822) that he had published (Roth 1970).

Roth (1974) suggested that *Tribonium* is not closely related to *Schistopeltis* Rehn, 1916, and separated the former based on the uniformly rounded shape of the pronotum. In *Schistopeltis* the pronotal margin is tapered and cropped dorsally.

Lopes (1978) revised *Tribonium*, and diagnosed the genus with the following characters: triangular head with interocular space less than distance between antennae, ocelli present; maxillary palps well developed; tegmina with marginal field extended; veins numerous and irregular; wings with marginal field narrow, subcostal vein reaching basal third of scapular field; cubital vein with numerous complete and few incomplete veins, apical triangle absent; fore femur with row of tiny spines on anteroventral margin; pulvilli well developed; claws symmetrical and without specializations; arolia moderately developed; supra-anal plate cordiform, symmetrical, subgenital plate asymmetrical, with digitiform styles.

Lopes (1978) mentioned that the genus is essentially Neotropical, with its species having an overall brown coloration with scattered black spots, mainly on the tegmina; and that the general similarities make species identification difficult, and further morphological studies of the genitalia are needed. Lopes (1978) added that members of *Tribonium* are distributed from French Guiana, Colombia, Brazil, Bolivia, and Paraguay to Argentina.

Grandcolas (1993) included *Tribonium* in his phylogenetic study of the subfamily Zetoborinae, and described the species *Tribonium guyanense* based on a female. Roth (2003) listed the species that had been described after the publication by Princis (1964), and supported the idea that the genus belongs in Zetoborinae.

Lopes and Silva (2010) described a new species from the state of Amazonas, Brazil, contributing to the understanding of the genus and its geographical distribution.

Valverde et al. (2012), in their morphological study of individuals belonging to *Schistopeltis lizeri* Rehn, 1928, commented on their similarity with species of *Tribonium*, from which they differ in the configurations of the median sclerite and the pronotum.

Eight of the 11 presently known species are from Brazil: *T. conspersum* (Guérin & Percheron), *T. conspurcatum* (Burmeister), *T. delicatum* Lopes, *T. elegans* (Brunner), *T. guttulosum* (Walker), *T. litoris* Lopes, *T. neospectrum* Lopes, and *T. spectrum* (Eschscholtz).

In this contribution two new species of *Tribonium* are added, from the state of Minas Gerais, Brazil, and present illustrations of their internal genitalia and a key for the available males of the genus. *T. guyanense*, *T. conspurcatum*, and *T. elegans* are not included in the key because they were described based only on females.

Materials and methods

The type species (*T. spectrum*) was not used in the key because the description by Saussure provides few morphological characters. Unfortunately, we received no response to our request for the loan of the type material, because of the absence of a researcher in the Moscow Museum where it is deposited. *Tribonium colombicum* was not examined because the Philadelphia Academy of Natural Sciences failed to respond to our request for the loan of the specimen deposited under number 1215. It is necessary to include color characters in the key, because these are essential for the identification of species of *Tribonium*, as is the shape of the genitalia.

The genital plates were removed after dissection of the posterior part of the abdomen, using traditional dissection techniques as described by Lopes and Oliveira (2000). After analysis, the genital plates and pieces were stored in microvials containing glycerin, and attached to the respective exemplar, a procedure developed by Gurney et al. (1964). The terminology for the genitalia and the taxonomic classification follow Roth (2003). The specimens were also compared with other specimens of *Tribonium* depos-

ited in the Blattodea Collection of the Museu Nacional of Rio de Janeiro (MNRJ), and with descriptions in the literature.

After observation and comparison of specimens of different species of *Tribonium* under the stereomicroscope, distinguishing characteristics were selected for use in the key.

The holotypes are deposited in the collection of the Department of Entomology at the Museu Nacional of Rio de Janeiro (MNRJ).

Results

***Tribonium caldensis* sp. n.**
http://zoobank.org/037F4C0B-C7EC-4953-A639-C7EAECFB9449
Figs 1–8

Type-material. Holotype ♂, BRAZIL, Minas Gerais, Poços de Caldas, Morro do Ferro, 07/IX/1967, J. Becker, O. Roppa, O. Leoncini cols.

Etymology. The species name refers to the city of Poços de Caldas, where the material was collected.

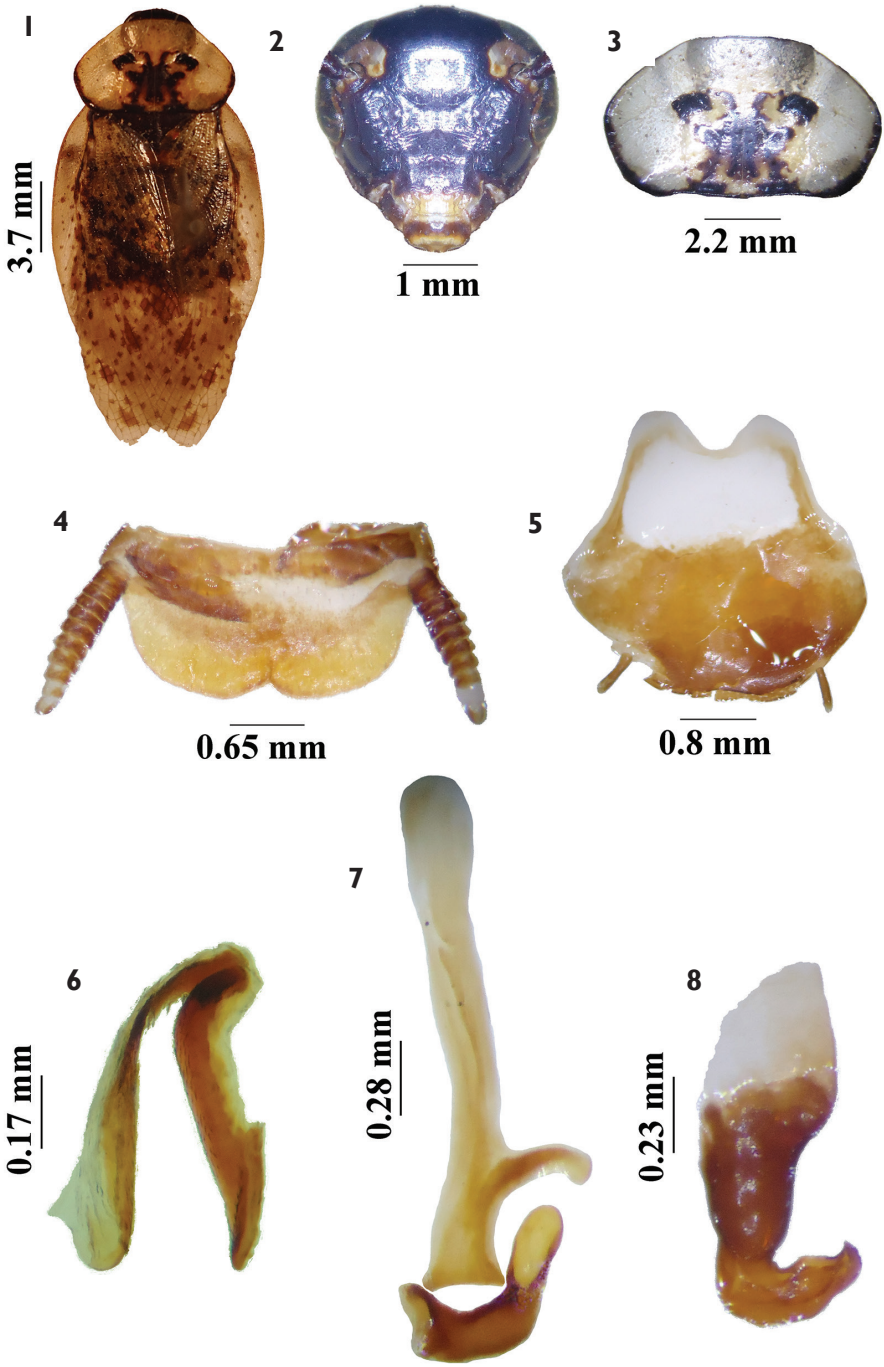
Description. Dimensions (mm): Male holotype, total length 23.2; length of pronotum 4.2; width of pronotum 7.9; length of tegmen 19.8; width of tegmen 6.5.

Male holotype. Coloration yellowish brown with dark brown spots (Fig. 1). Head black with yellowish brown ocellar and clypeal areas (Fig. 2). Pronotum medially with symmetrical dark brown spots of no definite shape (Fig. 3). Apex of anal field of tegmina pale with brown spots. Marginal fields and scapular with brown spots. Pulvilli light brown. Arolia and claws dark brown.

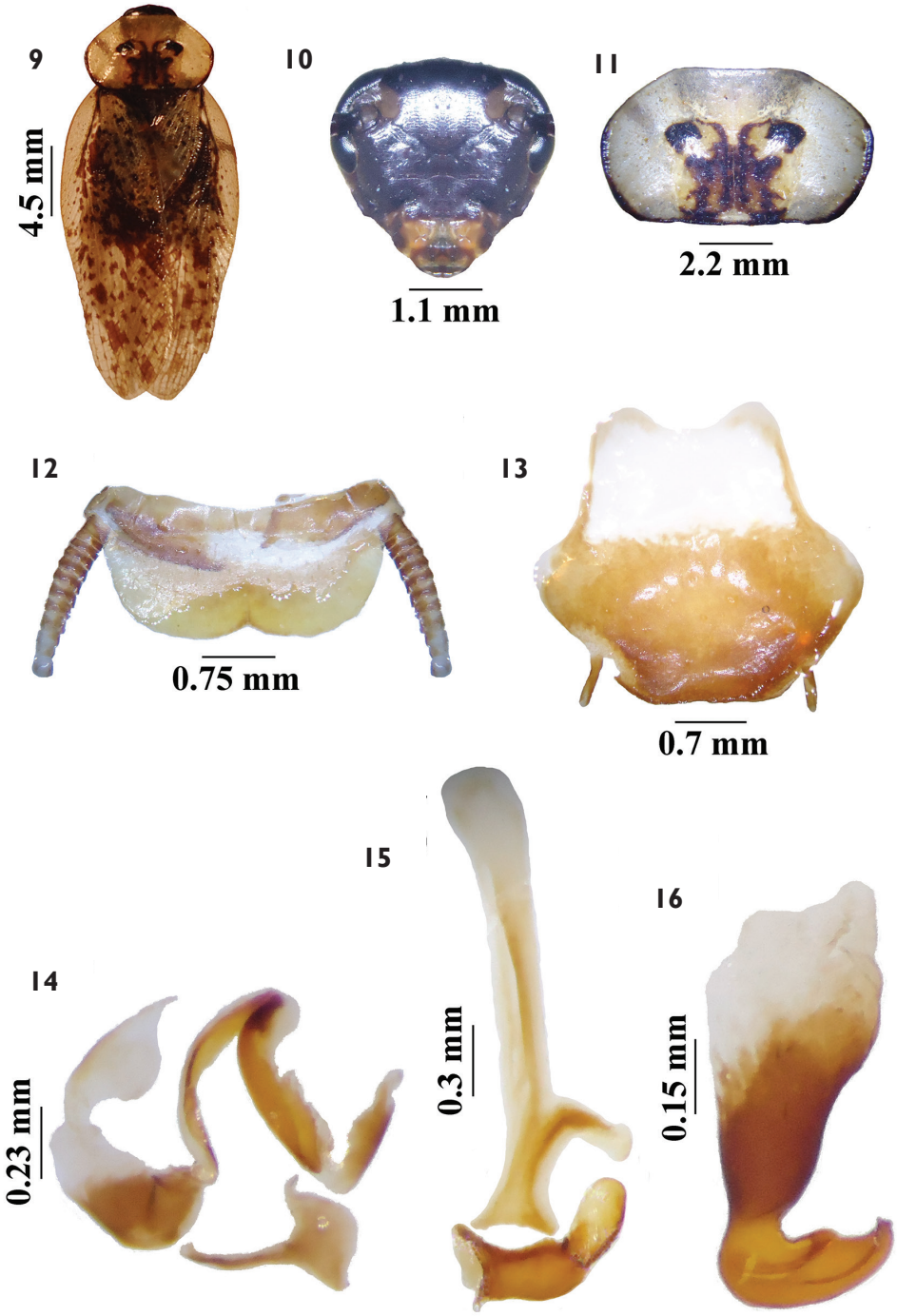
Head. Triangular; vertex slightly exposed; interocular space ample, 1.6 mm, wider than 2/3 distance between antennae. Antenna not reaching apex of tegmen. Palps and antennae tomentose; second segment of maxillary palps small, third segment 0.71 mm in length, fourth segment same size as second, fifth segment clavate, similar in size to third segment.

Thorax. Pronotum convex, transverse, apical surface embossed, with rounded edges and straight basal surface. Tegmina developed, extending beyond apex of cerci; marginal field short and slightly concave; scapular field tapering toward apex, mid-field discoidal, extended apically, slightly angular along veins. Wings with marginal field narrow, subcostal vein reaching basal third of scapular field; cubital vein with numerous complete and few incomplete veins; apical triangle absent. Legs short, robust, inner side of femora with narrow posterior apical projection. Fore, mid and hind femora sparsely ciliate along anteroventral margin. Pulvilli small, present on fourth tarsal segments; claws simple, symmetrical, with concave arolia.

Abdomen. Supranal plate ciliated, with prominent median edges between enclosures and with slight invagination in middle portion; cerci short, ciliated, with 11 segments (Fig. 4). Subgenital plate asymmetrical (Fig. 5). Right phallomere hook-shaped,



Figures 1–8. *Tribonium caldensis* sp. n. male **1** *habitus*, dorsal view **2** head, ventral view **3** pronotum, dorsal view **4** supranal plate, dorsal view **5** subgenital plate, ventral view **6** left phallomere, dorsal view **7** median sclerite, dorsal view **8** right phallomere, dorsal view.



Figures 9–16. *Tribonium morroferrensis* sp. n. **9** *habitus*, dorsal view **10** head, ventral view **11** pronotum, dorsal view **12** supranal plate, dorsal view **13** subgenital plate, ventral view **14** left phallomere, dorsal view **15** median sclerite, dorsal view **16** right phallomere, dorsal view.

with subapical slit (Fig. 6); median sclerite with pre-apical lateral projection and apical sclerite elongated (Fig. 7); left phallomere slightly sclerotized (Fig. 8).

Diagnosis. *Tribonium caldensis* sp. n. resembles *T. neospectrum* Lopes, 1978 in the coloration of the head (Figs 2, 26), pronotum (Figs 3, 27), differing in the coloration of the tegmina (Figs 1, 25) and the configuration of the genital parts (Figs 6–8, 30–32). The supranal and subgenital plates are the blaberoid type (Figs 4–5, 28–29).

***Tribonium morroferrensis* sp. n.**
http://zoobank.org/D39A1E8A-8BD5-4244-81A4-64C4862E49F9
Figs 9–16

Type material. Holotype ♂, BRAZIL, Minas Gerais, Poços de Caldas, Morro do Ferro, 07/IX/1967, J. Becker, O. Roppa, O. Leoncini cols.

Etymology. The species name refers to Morro do Ferro, where the material was collected.

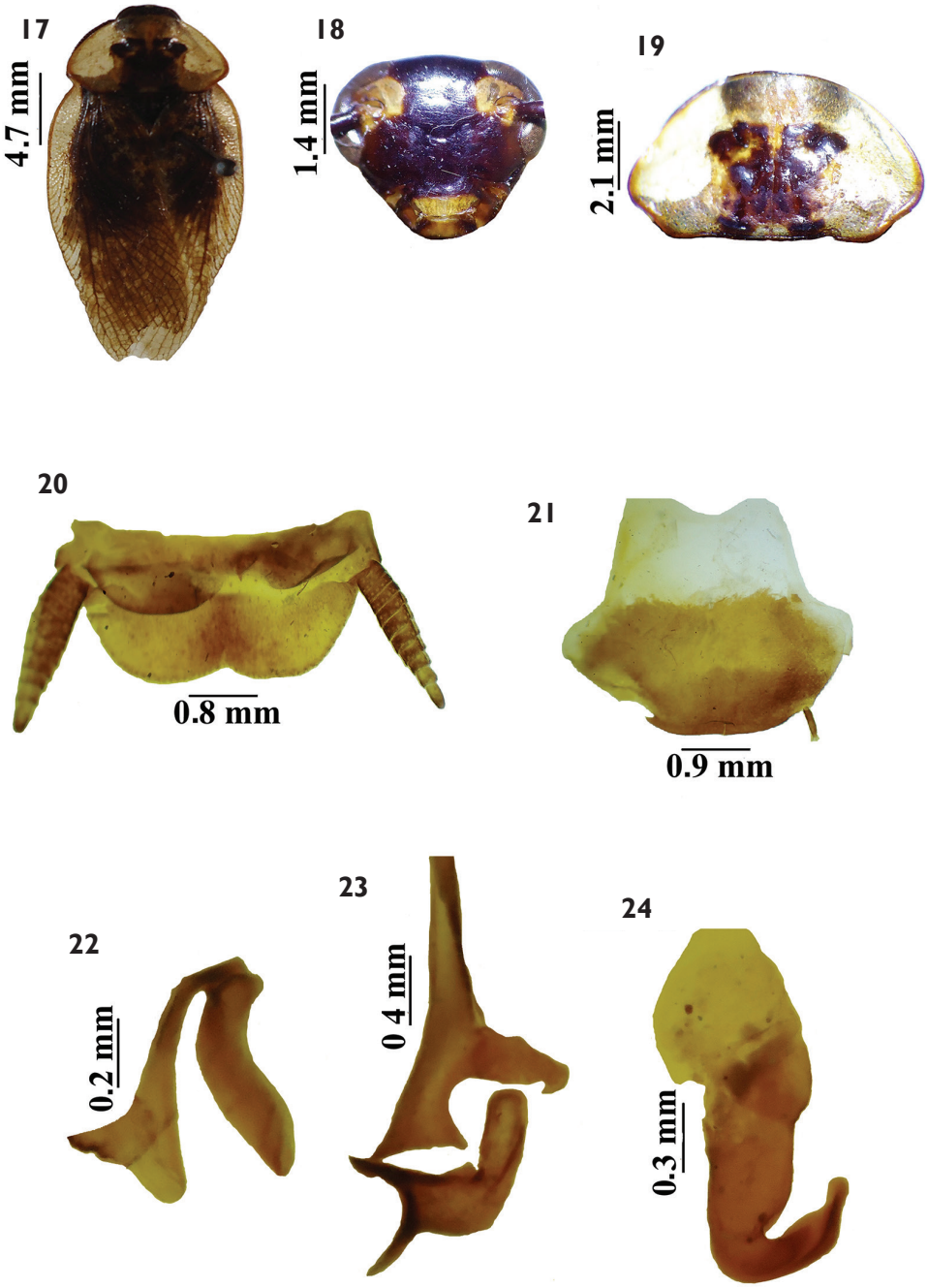
Description. Dimensions (mm): Male holotype, total length 25.3; length of pronotum 4.6; width of pronotum 8.2; length of tegmina 21.6; width of tegmina 7.7.

Male holotype. Coloration yellowish brown with dark brown spots (Fig. 9). Head black with yellowish brown ocellar and clypeal areas (Fig. 10). Pronotum medially with symmetrical spots, without definite shape (Fig. 11). Tegmina with anal field with brown spots. Marginal and scapular fields light brown with brown spots. Pulvilli light brown. Arolia and claws brown.

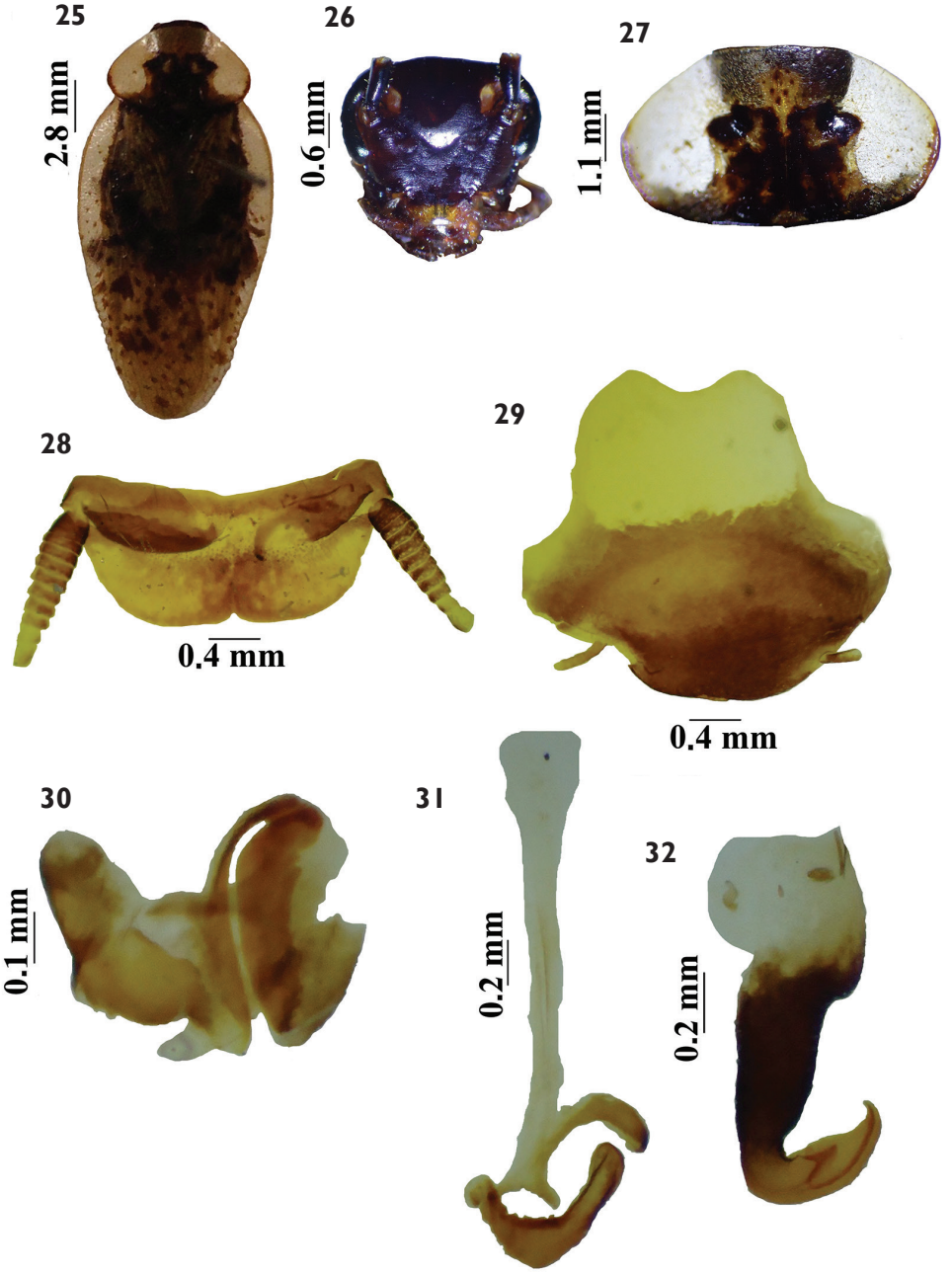
Head. Triangular, vertex slightly exposed, interocular space ample, 1.9 mm, approximately 2/3 distance between antennae. Antenna not reaching apex of tegmen. Palpi and antennae ciliated; second segment of maxillary palpi small, third segment 0.70 mm in length, fourth segment same size as second, fifth segment clavate, similar in size to third segment, conspicuously ciliated.

Thorax. Pronotum convex, transverse, apical surface embossed, with rounded margin and straight basal surface. Tegmina developed, extending beyond apex of cerci; marginal field short and slightly concave; scapular field tapering toward apex, discoidal field extended apically, slightly angular along veins. Wings with marginal field narrow, subcostal vein reaching basal third of scapular field; cubital vein with numerous complete and few incomplete veins; apical triangle absent. Legs short, robust, inner thigh narrow with clear apical projection. Fore, mid and hind femora sparsely ciliated along anteroventral border. Pulvilli small, present on fourth tarsal segments; claws simple, symmetrical, with concave arolia.

Abdomen. Supranal plate ciliated, with prominent median edges between enclosures, with slight median invagination; cerci short, ciliated, with 12 segments (Fig. 12). Subgenital plate asymmetrical (Fig. 13). Right phallomere hook-shaped, with subapical cleft (Fig. 14); median sclerite with pre-apical lateral projection (Fig. 15); left phallomere slightly sclerotized (Fig. 16).



Figures 17–24. *Tribonium guttulosum* (Walker, 1868). **17** *habitus*, dorsal view **18** head, ventral view **19** pronotum, dorsal view **20** supranal plate, dorsal view **21** subgenital plate, ventral view **22** left phallomere, dorsal view **23** median sclerite, dorsal view **24** right phallomere, dorsal view.



Figures 25–32. *Tribonium neospectrum* Lopes, 1978. **25** *habitus*, dorsal view **26** head, ventral view **27** pronotum, dorsal view **28** supranal plate, dorsal view **29** subgenital plate, ventral view **30** left phallomere, dorsal view **31** median sclerite, dorsal view **32** right phallomere, dorsal view.

Diagnosis. *Tribonium morroferrensis* sp. n. resembles *T. guttulosum* (Walker, 1868) in general coloration and pronotum (Figs 11, 19), but differs in size and coloration of the tegmina (Figs 9, 17), color of head (Figs 10, 18), and genital parts (Figs 14–16, 22–24). The supranal and subgenital plates are blaberoid type (Figs. 12–13; 20–21).

Key to adult males of the genus *Tribonium*

1 Total length of specimen 27 mm or more ..... ***T. conspersum*** **(Guérin-Méneville & Percheron, 1835)**
– Total length of specimen less than 27 mm **2**
2 Pronotum with compact, symmetrical dark-brown to black medial spot with no definite shape **3**
– Pronotum without compact medial spot **4**
3 Tegmina without concentration of dark-brown spots at base of discoidal field ..... ***T. delicatum*** **Lopes, 1978**
– Tegmina with concentration of dark-brown spots or spots scattered throughout its length **6**
4 Supranal with tapered paraprocts, cerci long and tapered... ***T. litoris*** **Lopes, 1978**
– Supranal with well-defined paraprocts, cerci short and wide **5**
5 Apex of the median sclerite arrow-shaped.... ***T. sagittum*** **Lopes & Silva, 2010**
– Apex of the median sclerite elongated ..... ***T. neospectrum*** **Lopes, 1978**
6 Head with vertex dark brown with yellowish-brown ocellar and clypeal areas ..... ***T. guttulosum*** **(Walker, 1868)**
– Head with vertex black with yellowish-brown ocellar and clypeal areas **7**
7 Tegmina with the base of discoidal field with spots less concentrated ..... ***T. caldensis*** **sp. n.**
– Tegmina with the base of discoidal field with more concentrated spot ..... ***T. morroferrensis*** **sp. n.**

Acknowledgements

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References

Brunner von Wattenwyl C (1865) Nouveau système des Blattaires. Société I.R. de Zoologie et de Botanique, Vienna, xi+426 pp.

Grandcolas P (1993) Monophylie et Structure Phylogénétique des [Blaberinae + Zetoborinae + Gyninae + Diplopterinae] (Dictyoptera: Blaberidae). Annales de la Société Entomologique de France 29(2): 195–221.

Gurney AB, Kramer JP, Steyskal GC (1964) Some Techniques for the Preparation, Study and Storage in Microvials of Insect Genitalia. Annals of the Entomological Society of America 57(2): 240–242. doi: 10.1093/aesa/57.2.240

Hebard M (1933) Studies in the Dermaptera and Orthoptera of Colombia. Transactions of the American Entomological Society (1890) 59: 13–67.

Lopes SM (1978) Redescrição do gênero *Tribonium* Saussure, 1862 com descrição de três espécies novas (Blaberidae, Blattaria, Dictyoptera). Revista Brasileira de Biologia 38(2): 395–405.

Lopes SM, Oliveira EH (2000) Descrição de uma espécie nova de *Panchlora* Burmeister, 1838 de Roraima, Brasil (Blattaria, Blaberidae). Contribuições Avulsas sobre História Natural do Brasil, Série Zoologia 19: 1–3.

Lopes SM, Silva LOC (2010) New species of *Tribonium* Saussure from the State of Amazonas, Brazil (Blattaria, Blaberidae, Zetoborinae). Zootaxa 2635: 67–68.

Princis K (1964) Blattaria. In: Beier M (Ed.) Orthopterorum Catalogus: Pars 6. W. Junk, The Netherlands, Gravenhage, 256 pp.

Rehn JAG (1932) Wissenschaftliche Ergebnisse der Schwedischen entomologischen Reisen des Herrn Dr. A. Roman in Amazonas 1914–1915 and 1923–1924. Arkiv föor Zoologi 24A: 1–73.

Roth LM (1970) The male genitalia of Blattaria. III. Blaberidae: Zetoborinae. Psyche 77(2): 217–236.

Roth LM (1974) A new cockroach genus (*Gurneya*) previously confused with *Pinaconota* (Blaberidae: Epilamprinae). Psyche 81: 288–302. doi: 10.1155/1974/87531

Roth LM (2003) Systematics and Phylogeny of Cockroaches (Dictyoptera: Blattaria). Oriental Insects 37: 1–183. doi: 10.1080/00305316.2003.10417344

Saussure H de (1862) Orthoptera Nova Americana (Diagnoses praeliminares), ser. III. Revue et Magasin de Zoologie, Paris (2)14: 163–171; 227–235.

Saussure H (1864) Orthoptères de l´Amérique moyenne. Famille des Blattides. (III and IV). Geneva, 279 pp.

Valverde AC, Crespo FA, Iglesias MS (2012) Morphologic study of male genitalia and female description of *Schistopeltis lizeri* Rehn (Blaberidae, Zetoborinae, Triboniini). Zootaxa 3326: 62–66.

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RESEARCH ARTICLE

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Three new species of the genus *Ripipteryx* from Colombia (Orthoptera, Ripipterygidae)

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Abstract

Three new species of *Ripipteryx* Newman (Orthoptera: Tridactyloidea: Ripipterygidae) are described from Colombia; namely *R. diegoi* **sp. n.** (Forceps Group) and *R. guacharoensis* **sp. n.** (Marginipennis Group) from Parque Nacional Natural Cueva de los Guacharos in Huila, and *R. gorgonaensis* **sp. n.** (Crassicornis Group) from Parque Nacional Natural Gorgona in Cauca. *Ripipteryx diegoi* **sp. n.** is characterized by the antennae black with white spots on flagellomeres 3–7, male subgenital plate with median ridge forming a bilobed setose process, epiproct produced laterally near its base and phallic complex with virga thickened distally and not reaching beyond the membrane. *Ripipteryx guacharoensis* **sp. n.** is characterized by the antennae thick with white spots present dorsally on flagellomeres 1–4 and 8, epiproct narrow and triangular, uncus reduced and lacking a distal hook, phallic complex with a concave ventral plate and a dorsal elevation in the middle extended to the virga, and the virga itself with two small projections basally. *Ripipteryx gorgonaensis* **sp. n.** is characterized by the epiproct with a lateral notch, antennae with a white dorsal spot on flagellomere 1 and flagellomeres 4–7 entirely white. The antennal color pattern of *R. gorgonaensis* **sp. n.** strongly resembles that of *R. atra* but differs from the latter in the absence of any significant morphological modification of the flagellomeres.

Resumen

Se describen tres nuevas especies de *Ripipteryx* Newman (Orthoptera: Tridactyloidea: Ripipterygidae) provenientes de Colombia; son nombradas *R. diegoi* **sp. n.** (Grupo Forceps) y *R. guacharoensis* **sp. n.** (Grupo Marginipennis) encontradas en el Parque Nacional Natural Cueva de los Guacharos en Huila

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y *R. gorgonaensis* **sp. n.** encontrada en el Parque Nacional Natural Gorgona en Cauca. *Ripipteryx diegoi* **sp. n.** se reconoce por presentar antenas negras con mancha blanca en flagelómeros 3–7, placa subgenital con proceso medial bilobulado con setas, epiprocto extendido lateralmente cerca a la base y complejo fálico con virga engrosada distalmente que no se extiende más allá de la membrana. *Ripipteryx guacharoensis* **sp. n.** se reconoce por presentar antenas gruesas con mancha dorsal blanca en flagelómeros 1–4 y 8, epiprocto angosto y triangular, uncus reducido y sin gancho distal, y complejo fálico con placa ventral cóncava y con elevación dorsomedial extendida hasta la virga, virga basalmente con dos puntas cortas. *Ripipteryx gorgonaensis* **sp. n.** se caracteriza por presentar epiprocto con muesca lateral, antenas con mancha dorsal blanca en flagelómero 1 y flagelómeros 4–7 completamente blancos. El patrón de coloración antenal en *R. gorgonaensis* **sp. n.** es similar al de *R. atra* pero se diferencia de esta especie por la ausencia de modificaciones morfológicas en los flagelómeros.

Keywords

Caelifera, Tridactyloidea, species groups, Neotropics, Colombian National Natural Park

Introduction

Ripipteryx Newman, 1834, or mud crickets (Orthoptera: Tridactyloidea: Ripipterygidae), comprises some 45 species of small, dark-colored, cricket-like orthopterans usually found near rivers, in bare soil, and in the moist zones of gallery forests. Like many of their relatives in the larger cosmopolitan family Tridactylidae, the mud crickets are able to jump from the surface of water. The genus is readily distinguished from *Mirhipipteryx*, the only other genus in the family, by its comparatively larger size (body 5.5–14.0 mm long), interocular distance at least half the width of the compound eyes, metatarsus approximately equal in length to the metatibial spurs, and the distinctly sclerotized lateral valvulae of the phallus (Günther 1969; Heads 2010). Species of the genus are usually black or very dark brown, often with contrasting white, yellow and occasionally red markings (Heads 2010). Some species are a dark metallic blue in life, though this coloration often fades to brown or black after death. While ripipterygids are common in many habitats throughout the Neotropics, they are often overlooked by collectors due both to their small size and their fast and very active movements making it difficult to secure specimens. In addition to the paucity of specimens in collections, chronic under-sampling and the difficulty in studying these insects in the field, means that very little is known of their distribution and basic biology (Heads and Taylor 2012; Baena-Bejarano 2015).

The genus is distributed from Mexico to Argentina with their highest diversity found in Ecuador. Some species are very widely distributed (e.g. *R. brunneri* Chopard, 1920, *R. carbonaria* Saussure, 1896, *R. hydrodroma* Saussure, 1896, *R. rivularia* Saussure, 1896, etc.) and are found across large ranges in South and Central America (Günther 1969, 1976, 1980, 1989, 1994), while others are more restricted in distribution. A number of endemic species are known from Peru (*R. difformipes* Chopard, 1956, *R. furcata* Günther, 1976, *R. luteicornis* Chopard, 1920 and *R. vicina* Chopard, 1956), Ecuador (*R. paraprocessata* Günther, 1989, *R. pasochoensis* Heads, 2010 and *R. trimacu-*

lata Günther, 1969), Brazil (*R. brasiliensis* Günther, 1969, *R. lawrencei* Günther, 1969 and *R. saopauliensis* Günther, 1969) and Colombia (*R. capotensis* Günther, 1970 and *R. sturmi* Günther, 1963) (Günther 1962, 1963, 1969, 1970, 1976, 1989, 1994; Heads 2010). Here, three new species from Colombia are described; namely *R. diegoi* sp. n. and *R. guacharoensis* sp. n. from Parque Nacional Natural Cueva de los Guacharos in Huila, and *R. gorgonaensis* sp. n. from Parque Nacional Natural Gorgona in Cauca.

Material and methods

The material studied here is deposited in the Instituto de Investigaciones Alexander von Humboldt, Villa de Leyva (IAvH-E) and the entomological museum of Universidad del Valle, Cali (MUSENUV). The male terminalia and the phallic complex were dissected and stored under glycerin in microvials mounted on the pin beneath the specimen. Some specimens were kept in alcohol. The description of morphological characters follows Heads (2010) and Heads and Taylor (2012) (Fig. 1). Interocular distance was measured using a calibrated micrometer slide adapted to a stereomicroscope. Other measurements were made from photographs analyzed with a calibrated digital scale in the program tpsdig2 (Rohlf 2006). Morphological characters were defined and documented in a Delta matrix and the description developed using Delta software (Dallwitz 1980, 1999). Photographs were taken with a Leica digital camera attached to a stereomicroscope and focus-stacked in CombineZP (Hadley 2009). Scanning electron micrographs were produced using FEI Quanta 200 scanning electron microscope. Drawings were produced in Adobe Illustrator CS5 and Photoshop CS5.

Systematics

Genus *Ripipteryx* Newman, 1834
Forceps Group *sensu* Heads, 2010

***Ripipteryx diegoi* Baena-Bejarano, sp. n.**
http://zoobank.org/9AA81DE2-96FB-463B-9B6A-7123BCCB4972
Fig. 2

Holotype. ♂ (no. IAvH-E 142877), COLOMBIA, Huila, PNN Cueva de Los Guácharos, Cabaña Cedros, 1°37'N, 76°6'W, 2100 m, Malaise, 6-27.iv.2002, Col. J. Fonseca. Specimen dried and pinned; deposited at Instituto Alexander von Humboldt, Villa de Leyva.

Paratypes. Five specimens from same locality as holotype: 1) ♂ (no. IAvH-E 137238), specimen preserved in alcohol; 2) ♂ (no. IAvH-E 137239), specimen preserved in alcohol; 3) ♀ (no. IAvH-E 137240), specimen preserved in alcohol; 4) ♀ (no. IAvH-E 137241), specimen preserved in alcohol; 5) ♀ (no. IAvH-E 142878), specimen dried and pinned. Specimens deposited at same institution as holotype.

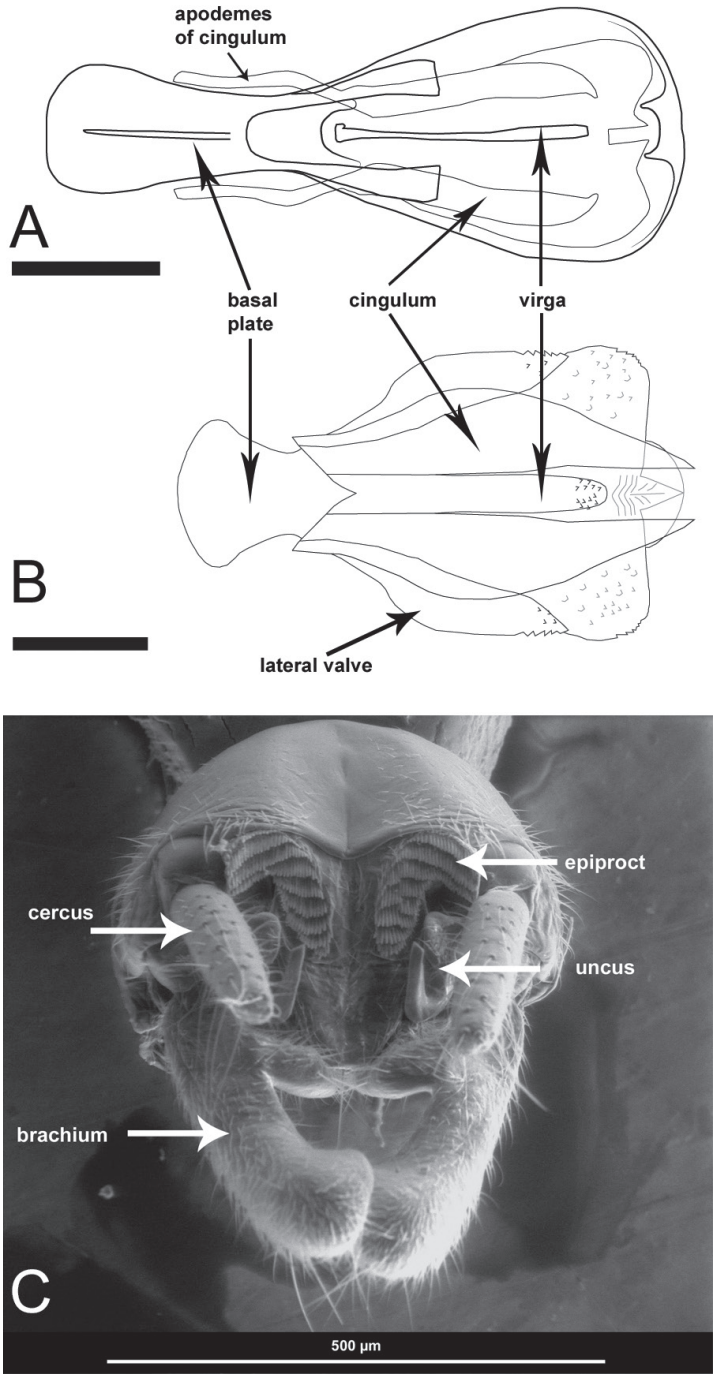


Figure 1. Genitalia and terminalia with labels indicating main morphological features. **A–B** Comparison of phallic complex in dorsal view **A** *Ripipteryx diegoi* sp. n. (IAvH-E 142877) (Scale bar 0.3 mm) **B** *Ripipteryx guacharoensis* sp. n. (IAvH-E 137238) (Scale bar 0.2 mm) **C** *Ripipteryx diegoi* sp. n. scanning electron micrographs of dissected paratype terminalia (IAvH-E 137238) in dorsal view.

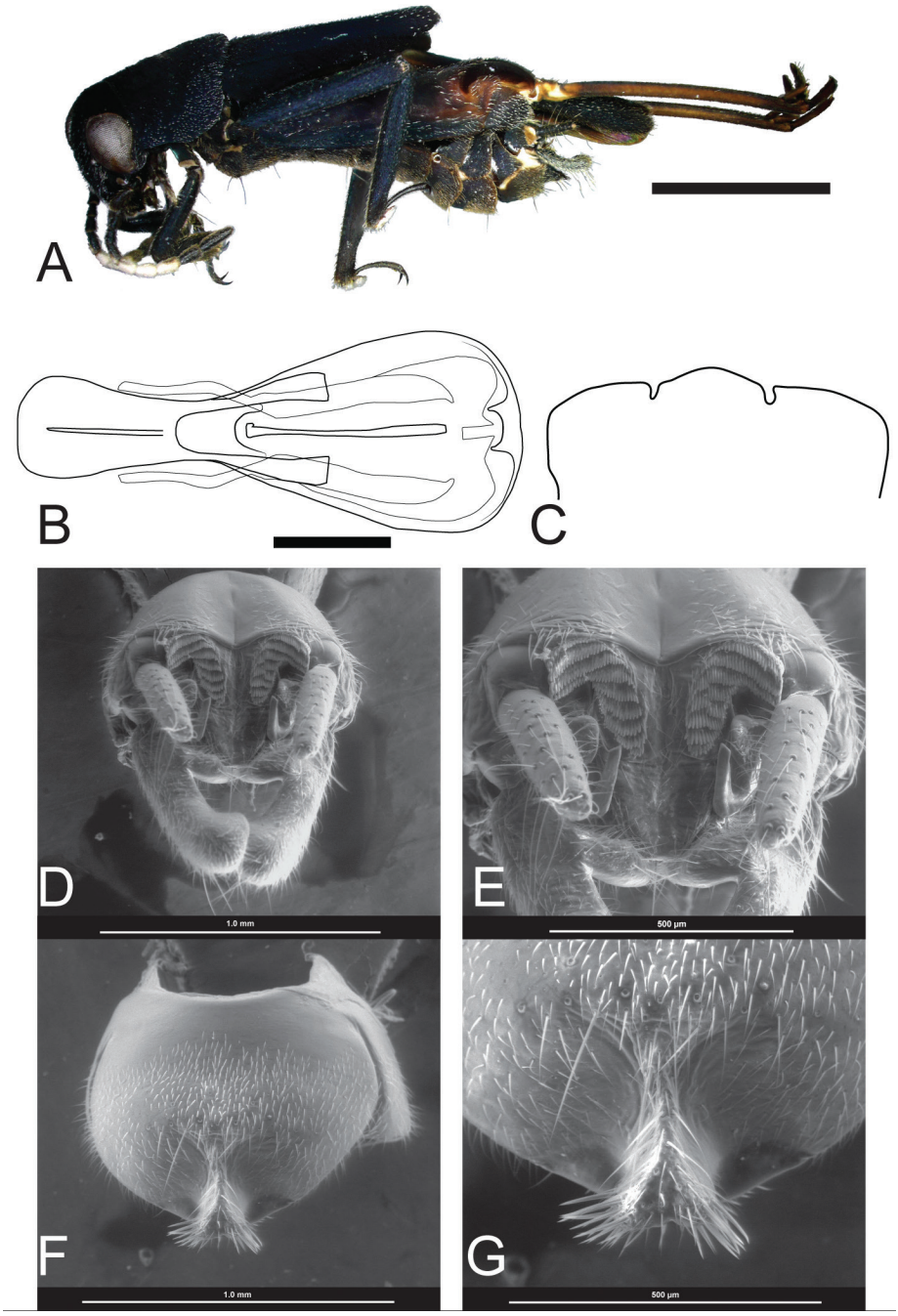


Figure 2. *Ripipteryx diegoi* sp. n. **A** Holotype lateral habitus (IAvH-E 142877) (Scale bar 2.3 mm) **B** Dorsal view of holotype phallic complex (IAvH-E 142877) (Scale bar 0.3 mm) **C** Outline of the subgenital plate in females (ventral view) **D–G** scanning electron micrographs of dissected paratype terminalia (IAvH-E 137238) **D** Dorsal view of terminalia **E** Dorsal view of epiproct and uncus **F** Ventral view of subgenital plate **G** Ventral view of medial bifurcated ridge of subgenital plate.

Diagnosis. The new species is almost cryptically similar to *R. forceps* Saussure, 1896 in that the uncus is elongate and strongly recurved, and that the median ridge of the male subgenital plate is produced distally, forming a short and densely setose bilobed process. However, it can be readily distinguished from the latter species by [1] antennae with white spots on flagellomeres 3–4 and 6–7 with flagellomere 5 entirely white; [2] epiproct produced laterally near its base; [3] brachium curved along its entire length without prominent apical bulge; and [4] phallic complex with virga thickened distally and not reaching beyond the membrane.

Description. *Male* (holotype). Body length including wings 8.1 mm, excluding wings 7.9 mm; pronotum length 1.6 mm, pronotum width 1.9 mm; tegmina length 3.1 mm; hind wings length 6.0 mm; interocular distance 0.39 mm. (n=1) (Fig. 2A).

Head. Interocular distance more than half the eye width. Median ocellus fully developed. Patch that circumscribes anterodorsal margin of compound eyes absent. Internal margin of compound eyes convergent dorsally. Maxillary palp black, five segmented, with second segment reduced. Labial palp black. Gena below the compound eye and antennae insertion black.

Antennae black and filiform. Number of antennae segments 10. Scape wider than pedicel. Pedicel as long as 1stflagellomere. White spot on scape absent. White spot on pedicel absent. White dorsal spot on flagellomere 1 and 2 absent. White dorsodistal spot on flagellomere 3 present. Flagellomere 4 white with a brownish slender anterior ring. Flagellomere 5 completely white. Flagellomere 6 white with a brownish slender distal ring extended ventrally to the segment half. Flagellomere 7 and 8 black.

Thorax. Pronotum black. Mesonotum black. Tegmina black. Hind wings with white, transverse groove. Procoxa black. Profemora black with an inner distal white spot. Protibiae black with three distal spines and an anterior external white rounded spot close to tibiae-femora articulation. Mesocoxa black. Mesotrochanter black. Mesofemora black. Mesotibiae black. Metafemora black. Semi-lunar process brown. Metatibia brown. Metatarsi brown and longer than metatibial posterior spurs.

Abdomen. Cerci unsegmented, black. Brachium black with a yellow-white distal spot, in lateral view curved along its entire length without prominent apical bulge. Brachium spine present. Epiproct produced laterally near its base. Epiproct lateral lobes narrow. Medial epiproct (distal section) tongue-like. Uncus not embedded in brachium lobe basis, 1-hooked (Fig. 2D, E). Male subgenital plate with a medial bifurcated ridge covered with setae at rounded end (Fig. 2F, G).

Basal plate heavily sclerotized, long, basally strongly widened and distally strongly split. Cingulum with apodemes elongate and well-sclerotized. Sclerotized region of cingulum discontinuous with a distal membranous region in-between. Virga very slender near base and distally thickened. Virga not extended beyond cingulum (Fig. 2B).

Variations. Body length including wings 7.9–8.3 mm, excluding wings 7.6–8.3 mm; pronotum length 1.6–1.7 mm, pronotum width 1.9–2.0 mm; tegmina length 3.1–3.2 mm; hind wings length 5.8–6.0 mm; interocular distance 0.39–0.44 mm. (n=3). Antennae: flagellomere 4 white with a brownish slender anterior ring extended

ventrally to the segment half. Flagellomere 6 white with a brownish slender distal ring extended ventrally over the segment. Flagellomere 7 white dorsal spot on base.

Female. Body similar to male, except for antennal sexual dimorphism and abdominal sexual structures. White dorsodistal spot often present on flagellomere 2. Flagellomere 4 to 7 completely white. Subgenital plate smooth with two distal notches forming a rounded lobe in middle (Fig. 2C). The color is a lighter brown close to the notches.

Females variation. body length including wings 7.9–8.6 mm, excluding wings 7.2–8.6 mm; pronotum length 1.7–1.8 mm, pronotum width 2.1–2.2 mm; tegmina length 3.4–4.1 mm; hind wings length 5.5–6.1 mm; interocular distance 0.46–0.47 mm. (n=3). Antenna: White dorsal spot on flagellomere 3 sometimes begins from middle. Flagellomere 7 sometimes presents ventral black color.

Etymology. The specific epithet is patronymic and honours Señor Diego Baena, father of the senior author, in thanks for his care and dedication.

Distribution. This species is currently known from the type locality.

Sympatric species. The new species was found in one of the malaise samples together with *R. guacharoensis* and *R. ecuadoriensis,* with which it is believed to live sympatrically.

Remarks. *Ripipteryx diegoi* sp. n. is assigned to the Forceps group based on the predominately black coloration, the form of the subgenital plate, morphology of the phallic complex and the body size 7.2-8.7 mm. This species is similar to *R. forceps* with which it shares the form of the subgenital plate presenting a median ridge forming a bilobed setose process in ventral view (Fig. 2G). This character allows differentiating it from the other species of the group. Moreover, it differs from *R. forceps* by the shape of the terminalia (Fig. 2D) where the epiproct is produced laterally near its base (Fig. 2E), the brachium in lateral view distally curved without prominent apical bulge; (see Günther 1969). Also, the new species differs in the color pattern of the male antennae with white spots on flagellomeres 3 to 7 of *R. diegoi* while these are present on the flagelomeres 1, 2, 4 and 5 of *R. forceps*.

Marginipennis Group *sensu* Heads, 2010

Ripipteryx guacharoensis Baena-Bejarano & Heads, sp. n.

http://zoobank.org/DC599EBF-E57F-4266-94C4-3E849483EB6D
Fig. 3

Holotype. ♂ (no. IAvH-E 113834), COLOMBIA, Huila, PNN Cueva de Los Guácharos, Cabaña Cedros, 1°37'N, 76°6'W, 2100 m, Malaise 2, 28.xi–2.xii.2001, Col. D. Campos. Specimen dried and pinned; deposited at Instituto Alexander von Humboldt, Villa de Leyva.

Paratypes. Two specimens from same locality as holotype: 1) ♂ (no IAvH-E 137236), 04–18.ii.2001, Col. D. Cortés, specimen preserved in alcohol; 2) ♀ (no. IAvH-E 137237), 27.iv–5.v.2002, Col. J. Fonseca, specimen preserved in alcohol. Specimens deposited at same institution as holotype.

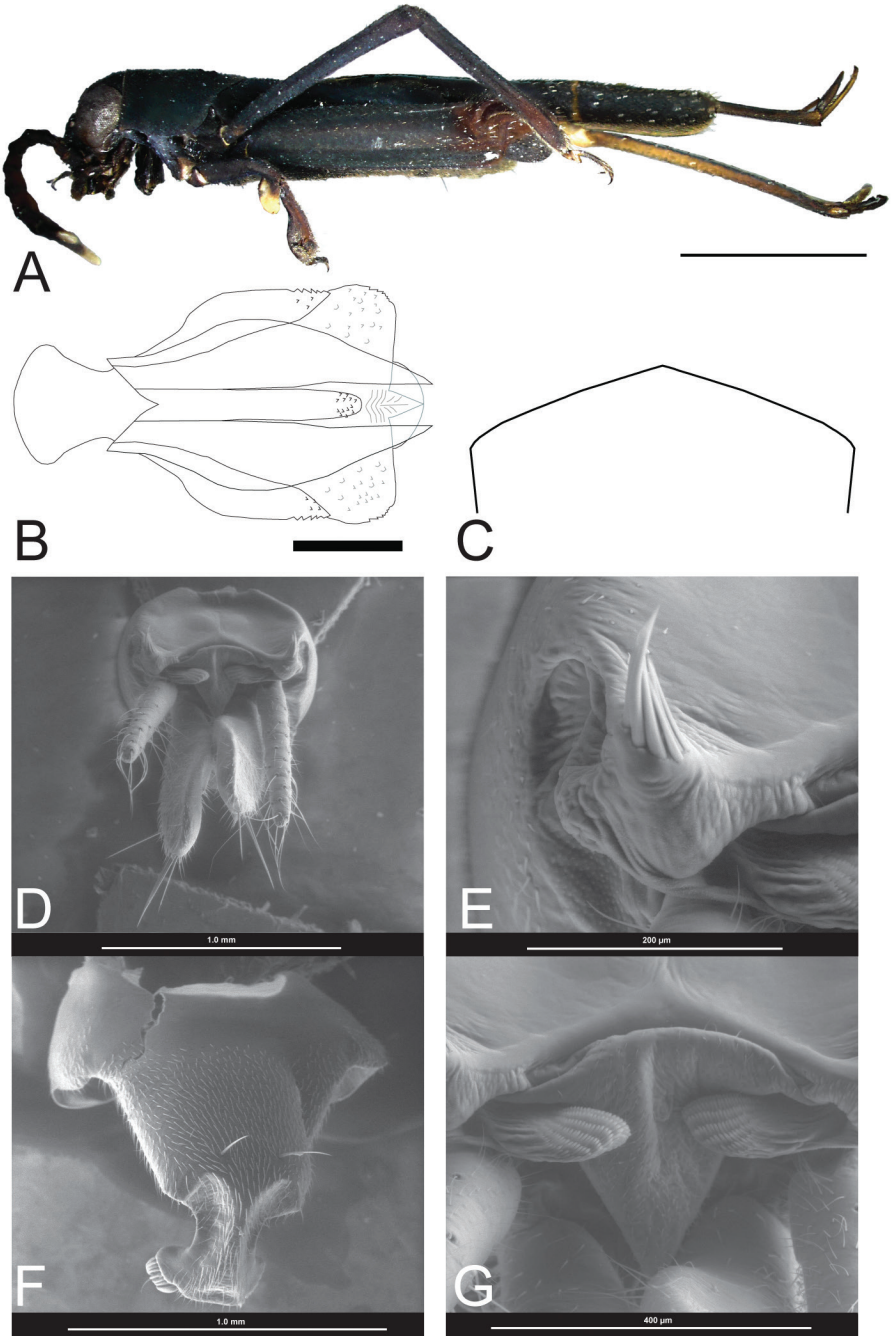


Figure 3. *Ripipteryx guacharoensis* sp. n. **A** Holotype lateral habitus (IAvH-E 113834) (Scale bar 2.2 mm) **B** Dorsal view of phallic complex (IAvH-E 113834) (Scale bar 0.2 mm) **C** Outline of the subgenital plate in females (ventral view) **D–G** scanning electron microscope micrographs of dissected male **D** Dorsal view of terminalia **E** Dorsal view of erect vertical setae at edges **F** Ventral view of subgenital plate **G** Dorsal view of epiproct.

Diagnosis. The new species is distinguished from congeners by the following characters: [1] antennae with white dorsal spots on flagellomeres 1–4 and flagellomere 8 black with the distal half completely white; [2] epiproct lateral lobes narrow and posterior margin triangle-like (Fig. 3B); [3] ventral plate concave with a dorsal elevation in the middle extended to the virga; [4] virga basally with two slight tips.

Description. *Male* (holotype). Body length including wings 7.55 mm; pronotum length 1.38 mm, pronotum width 1.64 mm; tegmina length 2.91 mm; hind wings length 5.84 mm; interocular distance 0.37 mm. (n=1) (Fig. 3A).

Head. Interocular distance more than half the eye width. Median ocellus fully developed. Internal margins of compound eyes convergent dorsally. Slight yellowish-white spot in the superior eyes corner. Gena below compound eye and antennae insertion black and below eye slightly yellowish. Maxillary palp black, distally slightly yellowish white, five segments with second reduced, fifth with strong setaes. Labial palp black.

Antennae thick and mainly black. Number of antennal segments 10. Scape wider than pedicel. Pedicel as long as 1st flagellomere. Slight white distal spot on scape. White dorsal spot on pedicel. White dorsal spot on flagellomeres 1, 2 and 3. White dorsodistal spot on flagellomere 4. Flagellomeres 5, 6 and 7 black. Flagellomere 8 black with distal half completely white.

Thorax. Pronotum black with an anterior slender white line and an almost imperceptible yellowish at anterior corners. Tegmina black. Hind wing with white, transverse groove. Procoxa black. Protochanter black. Profemora black with a yellowish serrated distal inner lobe. Protibiae black with three distal spines. Mesocoxa black. Mesotrochanter black. Mesofemora black. Mesotibiae black distally brownish. Metafemora black; Semi-lunar process, metatibia and metatarsi brown.

Abdomen. Tergum 9 with a distal notch. Tergum 10 slightly concave, strongly sclerotized with erect vertical setae at edges (Fig. 3E). Cerci unsegmented, black. Brachium brownish, dorsolateral flat and wide with an inner protrusion. Brachium spine present. Epiproct lateral lobes narrow, covering base of cerci but not covered by tergum. Medial epiproct membranous, narrow and triangle-like (Fig. 3G). Uncus reduced without distal hook. Subgenital plate distally narrowed, constricted before end with conspicuous long and curved bristles (Fig. 3F).

Basal plate heavily sclerotized, very short and widened basally. Cingulum distally serrated without apodemes. Lateral valves pointed and serrated. Virga thick, distally rounded and serrated, basally with two slight tips. Ventral plate concave with a dorsal elevation in middle extended to virga (Fig. 3B).

Variations. Body length including wings 8.9 mm, excluding wings 7.2 mm; pronotum length 1.6 mm, pronotum width 1.8 mm; tegmina length 3.3 mm; hind wings length 6.3 mm; interocular distance 0.40 mm. (n=1). Antennae Scape black.

Female. Body similar to male except for abdominal sexual structures. Subgenital plate obtuse (Fig. 3C).

Female variation. body length including wings 8.5 mm, excluding wings 7.4 mm; pronotum length 1.4 mm, pronotum width 1.9 mm; tegmina length 3.5 mm; hind

wings length 6.7 mm; interocular distance 0.43 mm. (n=1). Antennae: scape black, white dorsodistal spot on pedicel. White dorsal small spot on flagellomeres 1, 2 and 3.

Etymology. The specific epithet is derived from the name of the type locality, Parque Nacional Natural Cueva de los Guácharos.

Distribution. This species is currently known from the type locality.

Sympatric species. This species was found in one of the malaise samples with the species *R. diegoi* and *R. ecuadoriensis*, which are believed to occur sympatrically.

Remarks. *Ripipteryx guacharoensis* sp. n. is assigned to the Marginipennis group based on the characters of the phallic complex, such as the very short and broad basal plate, the cingulum without apodemes, the presence of lateral valves, and the thickened virga (Fig. 3B).

The new species is similar to *R. femorata* in that both share a serrated distal inner lobe on the profemora, the shape of the male brachium in lateral view, the uncus reduced without distal hook and similar phallic complex (see Günther 1969). Nevertheless, it differs in the form of the ventral plate, which is concave in *R. guacharoensis* but is straight in *R. femorata*. The basal shape of the virga presents two slight tips in *R. guacharoensis* while in *R. femorata* it presents two strong and elongate tips (see Günther 1969). The most significant character separating both species is the posterior margin of the epiproct, which is triangular in *R. guacharoensis* (Fig. 3G) but parabolic in *R. femorata* (see Günther 1969).

According with Günther (1969) *R. femorata* is closely related to *R. vicina* and *R. difformipes*. *Ripipteryx guacharoensis* shares with these three species the form of the subgenital plate that in males is distally constricted with conspicuous long and curved bristles, supporting a probable relationship.

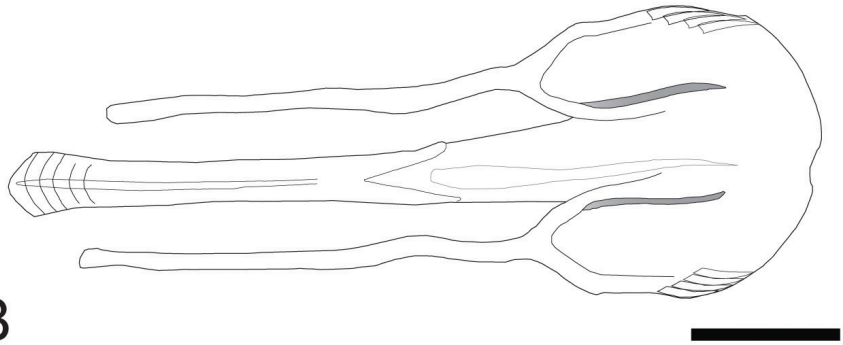
Crassicornis Group *sensu* Heads, 2010

Ripipteryx gorgonaensis Baena-Bejarano & Heads, sp. n.

http://zoobank.org/250F0723-AD54-4DCE-965F-71C5EA962171
Fig. 4

Holotype. ♂ (no. IAvH-E 113896), COLOMBIA, Cauca, PNN Gorgona, Alto el Mirador, 2°58'N, 78°11'W, 180 m, Malaise, 6-20.ix.2000, Col. H. Torres. Specimen dried and pinned; deposited at Instituto Alexander von Humboldt, Villa de Leyva.

Paratypes. 5 specimens from same locality as holotype: 1) ♂ (no. IAvH-E 113898), 08–30.xi.2000, specimen dried and pinned; 2) ♂ (no. IAvH-E 113901), 01-04.iii.2000, Col. M. Sharkey, specimen dried and pinned; 3) ♂ (no. IAvH-E 113908), 18.i.2001, specimen dried and pinned; 4) ♂ (no. IAvH-E 113899), 30.x-18.xii.2000, specimen dried and pinned; 5) ♂ (no. IAvH-E 143179), 18.xii.2000-03.i.2001, specimen preserved in alcohol. Specimens deposited at same institution as holotype. 6) ♂ (no. GOR 3728-1), Colombia, Cauca, PNN Gorgona, Sendero cerro Trinidad, 2°58'22"N, 78°10'43"W, 90 m, Captura directa (manual), 21.x.2010, Col. F. Sarria.



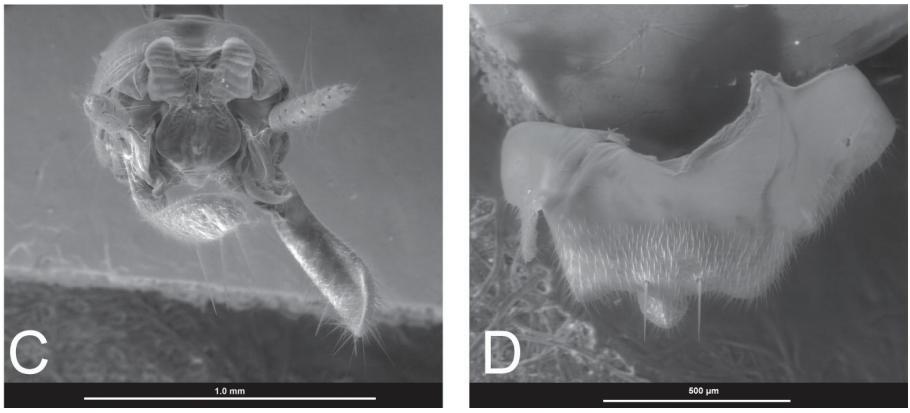


Figure 4. *Ripipteryx gorgonaensis* sp. n. male. **A** Holotype lateral habitus (IAvH-E 113896) (Scale bar 1.44 mm) **B** Dorsal view of phallic complex (IAvH-E 113899) (Scale bar 0.22 mm) **C** Scanning electron micrographs of dissected terminalia in frontal view (IAvH-E 143179) **D** Ventral view of subgenital plate.

Specimen dried and pinned; deposited at Colección de insectos del PNN Gorgona - Museo de Entomología de la Universidad del Valle (MUSENUV), Cali.

Diagnosis. The new species is almost cryptically similar to *R. atra* Serville, 1838 sharing with it the coloration of the antennae (white spots on flagellomeres 1 and 4–7). However, it is readily separated from the latter species by [1] flagellomeres 1 and 2 free (not fused as in *R. atra*); and [2] lateral lobes of epiproct with shallow lateral invagination.

Description. *Male* (holotype). Body length including wings 6.80 mm, excluding wings 5.72 mm; pronotum length 1.34 mm, pronotum width 1.55 mm, tegmina length 2.84 mm, hind wings length 5.25 mm, interocular distance 0.41 mm (n=1) (Fig. 4A).

Head. Interocular distance more than half the eye width. Median ocellus fully developed. Patch that circumscribes the anterodorsal margin of compound eyes absent. Internal margins of compound eyes convergent dorsally. Patch of setae at posteroventral border of eye present. Maxillary palp black. Four maxillary palps. Labial palp black.

Antennae black and filiform. Number of antennae segments 10. Scape wider than pedicel. Pedicel shorter than 1stflagellomere. Flagellomere 2 shorter than 1. White spots on scape and pedicel absent. White dorsal spot on flagellomere 1 present. White dorsal spot on flagellomere 2 and 3 absent. White dorsal spot on flagellomere 4–7 present. White dorsal spot on flagellomere 8 absent. Color of gena below compound eye and antennae insertion black.

Thorax. Pronotum, mesonotum and tegmen black. White transversal groove on hind wings present. Procoxa black. Profemora black with a distal white spot. Protibiae black. Mesocoxa black. Ventral Mesotrochanter black. Mesofemora black. Mesotibiae black. Metafemora black. Semi-lunar process brown. Metatarsi brown.

Abdomen. Cerci unsegmented, black, spots absent. Brachium black, in lateral view with parallel sides. Brachium spine present. Subgenital plate with medial ridge (Fig. 4D). Lateral lobes of epiproct narrow with shallow lateral invagination, not covered by tergum. Medial epiproct tongue-like with a middle lobe (Fig. 4C). Uncus not embedded in brachium basis, 1-hooked.

Basal plate heavily sclerotized, long and narrow; strongly widened distally. Virga very slender not extended beyond cingulum. Cingulum well-sclerotized, but discontinuous; apodemes of cingulum elongate, at base 2-hooked (Fig. 4B).

Variations. Body length including wings 6.56–7.74 mm, excluding wings 5.11–7.48 mm; pronotum length 1.24–1.43 mm, pronotum width 1.45–1.66 mm; tegmina length 2.65–3.31 mm; hind wings length 4.97–5.77 mm; interocular distance 0.40–0.44 mm. (n=7).

Female unknown.

Etymology. The specific epithet is derived from the name of the type locality.

Distribution. This species is currently known from the type locality.

Sympatric species. *Ripipteryx gorgonaensis* was found in sympatry with the species *R. atra* and *R. nodicornis*.

Remarks. The terminalia and the subgenital plate of the new species resemble those of *R. atra*, *R. laticornis* Günther, 1963 and *R. antennata* Hebard, 1924 suggest-

ing placement in the Crassicornis Group. It shares the presence of numerous sharp spiculae on the cingulum with *R. antennata* and *R. atra* and the antennal color pattern with *R. atra*. However, *R. gorgonaensis* differs from the former species by the absence of modifications of the antennae. In other members of the Crassicornis Group, certain antennomeres are fused (e.g. in *R. atra*) or otherwise modified (e.g. flattened and wide in *R. laticornis* and *R. antennata*); this is not the case in *R. gorgonaensis*. The latter is easily distinguished from other species of the Crassicornis and Forceps groups by the form of the terminalia (Figs 4C, D).

A number of soft-bodied mites were found between the metanota and abdomina of some individuals. These are presumed to be ectoparasitic though further research is needed to clarify their biology and interaction with *R. gorgonaensis* (O. Combita pers. comm.).

Discussion

Five species groups had been proposed in the genus *Ripipteryx* which are largely defined by the morphology of the male terminalia and the phallic complex (Günther 1969; Heads 2010). Of the species described herein, *Ripipteryx diegoi* sp. n. and *R. guacharoensis* sp. n. can be confidently assigned to the Forceps and Marginipennis species groups respectively based on coloration, body size and the morphology of the male terminalia and internal genitalia. In contrast, the species group placement of *R. gorgonaensis* is problematic due to the presence of characters found in both the Crassicornis and Forceps groups such as modified subgenital plate and brachium, distal half of phallic complex weakly sclerotized, long apodemes of the cingulum, virga long and slender. *Ripipteryx gorgonaensis* was assigned to the Crassicornis group because it shares several characters of the terminalia with the species *R. atra*, *R. antennata* and *R. laticornis* and possesses spines on the cingulum like other species in the group. However, it lacks antennal modifications (a diagnostic character of the Crassicornis group) with the antennae more similar to those of Forceps group species. In briefly reviewing Günther's (1969) species group classification, Heads (2010) noted that the monophyly of some of the groups is questionable. Preliminary morphological phylogenetic analysis of the genus (Baena-Bejarano, unpublished) suggest that this is indeed the case, but more morphological and molecular data and a comprehensive phylogenetic treatment are required before a refined classification can be presented.

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References

Baena-Bejarano N (2015) Aspects of the natural history of *Ripipteryx* (Orthoptera: Ripipterygidae) species in Colombia. Journal of Insect Behavior 28: 44–54. doi: 10.1007/s10905-014-9479-8

Dallwitz MJ (1980) A general system for coding taxonomic descriptions. Taxon 29: 41–6. doi: 10.2307/1219595, http://delta-intkey.com

Dallwitz MJ, Paine TA, Zurcher EJ (1999 onwards) User's Guide to the DELTA Editor. http://delta-intkey.com

Günther KK (1962) Eine neue *Rhipipteryx*-Art aus Ecuador (Orthoptera, Tridactylidae). Deutsche Entomologische Zeitschrift 9: 251–255. doi: 10.1002/mmnd.19620090306

Günther KK (1963) Über eine tridactyliden-ausbeute aus kolumbien (Orthoptera). Mitteilungen aus dem Zoologischen Museum in Berlin 39: 187–201. doi: 10.1002/mmnz.19630390104

Günther KK (1969) Revision der familie Rhipipterygidae Chopard, 1949 (Saltatoria, Insecta). Mitteilungen aus dem Zoologischen Museum in Berlin 45: 259–425. doi: 10.1002/mmnz.19690450209

Günther KK (1970) *Rhipipteryx capotensis* n. sp., eine neue Art aus Kolumbien (Rhipipterygidae, Saltatoria, Insecta). Deutsche Entomologische Zeitschrift 17: 353–356. doi: 10.1002/mmnd.19700170406

Günther KK (1976) Beiträge zur Systematik und geographischen Verbreitung der Rhipipterygiden (Rhipipterygidae,Tridactyloidea, Saltatoria). Mitteilungen aus dem Zoologischen Museum in Berlin 52(1): 357–369. doi: 10.1002/mmnz.19760520208

Günther KK (1980) Katalog der Caelifera-Unterordnung Tridactylodea (Insecta). Deutsche Entomologische Zeitschrift 27: 149–178. doi: 10.1002/mmnd.19800270114

Günther KK (1989) Neue und wenig bekannte Tridactyloidea aus Mittel- und Südamerika (Orthoptera: Caelifera). Deutsche Entomologische Zeitschrift 36(4-5): 347–379. doi: 10.1002/mmnd.19890360428

Günther KK (1994) Die Tridactyloidea-Fauna Kolumbiens (Orthoptera, Caelifera). Deutsche Entomologische Zeitschrift 1: 1–56. doi: 10.1002/mmnd.19940410102

Hadley A (2009) CombineZ-Pyramid: http://www.hadleyweb.pwp.blueyonder.co.uk/CZP/News.htm

Heads SW (2010) A new species of *Ripipteryx* from the Ecuadorian Andes (Orthoptera: Tridactyloidea: Ripipterygidae). Zootaxa 2476: 23–29.

Heads SW, Taylor SJ (2012) A new species of *Ripipteryx* from Belize with a key to the species of the Scrofulosa Group (Orthoptera, Ripipterygidae). ZooKeys 169: 1–8. doi: 10.3897/zookeys.169.2531

Rohlf FJ (2006) TpsDig version 2.10. Department of Ecology and Evolution, State University of New York at Stony Brook, New York.