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On three species of the spider genus *Pimoa* (Araneae, Pimoidae) from China

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Abstract

Two new species of the spider genus *Pimoa* Chamberlin & Ivie, 1943 are described from Hunan and Yunnan Provinces, China: *P. binchuanensis* **sp. nov.** (♂♀) and *P. xinjianensis* **sp. nov.** (♂♀). In addition, the male of *P. lata* Xu & Li, 2009 is described for the first time. The DNA barcodes of the two new species are documented.

Keywords

Asia, description, diagnosis, taxonomy

Introduction

Pimoidae Wunderlich, 1986 is a relatively small family, with 44 described species belonging to four genera (Li and Quan 2017; WSC 2019). *Pimoa* Chamberlin & Ivie, 1943 is the largest genus of the family, with 33 valid species. As a relict group,

it has disjunct range and occurs in the western Nearctic (from Washington to California, USA), the western Mediterranean and Asia (from Himalaya to Beijing) (Li and Lin 2016; WSC 2019). Fifteen *Pimoa* species are known from Asia so far, nine from China, four from India and two from Nepal. Most of these species are well described in revisions (Hormiga 1994a; Xu and Li 2007). While studying material from Southwest China, we found two new species and the unknown male of *P. lata* Xu & Li, 2009. The goal of this paper is to provide descriptions of the new species and the unknown male.

Material and methods

Specimens were examined with a LEICA M205C stereomicroscope. Images were captured with an Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on an Olympus SZX12 dissecting microscope. Epigynes and male palps were examined after dissection from the spiders' bodies. The left palps were illustrated unless otherwise noted. Epigynes were removed and treated in a warmed 10% potassium hydroxide (KOH) solution.

All measurements were obtained using a LEICA M205C stereomicroscope and are given in millimeters. Eye sizes are measured as the maximum diameter from either dorsal or frontal views. Leg measurements are shown as: Total length (femur, patella + tibia, metatarsus, tarsus). The terminology used in the text and the figure legends follows Hormiga (1994a). Distribution maps were generated using ArcView GIS (ESRI) software.

Abbreviations used in this paper and in the figure legends: **ALE** = anterior lateral eye; **AME** = anterior median eye; **AME-ALE** = distance between **AME** and **ALE**; **AME-AME** = distance between **AME** and **AME**; **ALE-PLE** = distance between **ALE** and **PLE**; **AS** = alveolar sclerite; **C** = conductor; **CO** = copulatory opening; **CP** = cymbial process; **CS** = cymbial sclerite; **DP** = dorsal plate of the epigyne; **E** = embolus; **EP** = embolic process; **ET** = embolic tooth; **FD** = fertilization duct; **MA** = median apophysis; **P** = paracymbium; **PLE** = posterior lateral eye; **PME** = posterior median eye; **PME-PLE** = distance between **PME** and **PLE**; **PME-PME** = distance between **PME** and **PME**; **S** = spermatheca; **T** = tegulum; **VP** = ventral plate of epigyne.

DNA barcodes were obtained for the two new species by amplifying and sequencing a partial fragment of the mitochondrial gene cytochrome oxidase subunit I (COI) using primers LCO1490-oono (5'-CWACAAAYCATARRGATATTGG-3') (Folmer et al. 1994; Miller et al. 2010) and HCO2198-zz (5'-TAAACTTCCAGGTGACCAAAAAATCA-3') (Folmer et al. 1994; Zhao and Li 2017). For additional information on extraction, amplification and sequencing procedures, see Wang et al. (2008). All sequences were checked using BLAST and are deposited in GenBank. The accession numbers are provided in Table 1.

All specimens (including molecular vouchers) are deposited in the Institute of Zoology, Chinese Academy of Sciences (**IZCAS**), Beijing, China.

Table 1. Voucher specimen information.

Species	GenBank accession number	Sequence length	Collection localities
Pimoa binchuanensis sp. nov.	MK910743	609bp	Binchuan County, Yunnan, China
Pimoa xinjianensis sp. nov.	MK910744	609bp	Longshan County, Hunan, China

Taxonomy

Family Pimoidae Wunderlich, 1986

Genus *Pimoa* Chamberlin & Ivie, 1943

Pimoa: Chamberlin and Ivie 1943: 9; Hormiga 1994a: 4; Hormiga and Lew 2014: 1; Mammola et al. 2016: 1.

Type species. *Labulla hespera* Gertsch & Ivie, 1936, from California, USA.

Diagnosis. Males of *Pimoa* can be distinguished from *Weintrauboa* Hormiga, 2003 by the elongate cymbial process (CP) with many cuspules (vs cymbial process (CP) and cuspules absent) (Fig. 1A–C; Hormiga 2003: figs 1, 2). From *Putaoa* Hormiga & Tu, 2008, it can be distinguished by the absence of distinctly large macrosetae on the palpal tibia (vs presence of a large macroseta) (Fig. 1A–C; Hormiga and Tu 2008: figs 3, 5–6). Females of *Pimoa* can be distinguished from *Weintrauboa* by the protruding epigyne with a distinct dorsal plate (DP) (vs dorsal plate absent) (Fig. 2A, B; Hormiga 2003: figs 2–3). From *Putaoa*, it can be distinguished by the absence of lateral openings on the epigyne (vs two distinct lateral openings) (Fig. 2A, B; Hormiga and Tu 2008: figs 2, 4, 8).

Composition. Thirty-three valid species of *Pimoa* are currently known from the western Nearctic (14), western Mediterranean (4) and South Asia (15) (WSC 2019).

Pimoa binchuanensis sp. nov.

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Figs 1–2, 7

Type material. Holotype ♂ (IZCAS-Ar39293): China: Yunnan: Dali Bai Autonomous Prefecture: Binchuan County: Jizushan Town, Mt. Jizu, 25.9667°N, 100.3746°E, 2568±4 m, 25.III.2019, Z. Chen. **Paratype:** ♀ (IZCAS-Ar39294): same area, 25.9639°N, 100.3712°E, 2658 m, 1.XII.2014, Y. Li & Z. Chen.

Etymology. The specific name refers to the type locality; adjective.

Diagnosis. The male of *P. binchuanensis* sp. nov. can be easily distinguished from other congeners, except for *P. anatolica* Hormiga, 1994 and *P. lihengae* Griswold, Long & Hormiga, 1999, by having a long and complex cymbial sclerite (CS) and an elongate cymbial process (CP). From *P. anatolica* and *P. lihengae*, it can be distinguished by the long embolic process (EP), about 2 times longer than the embolus (vs embolic

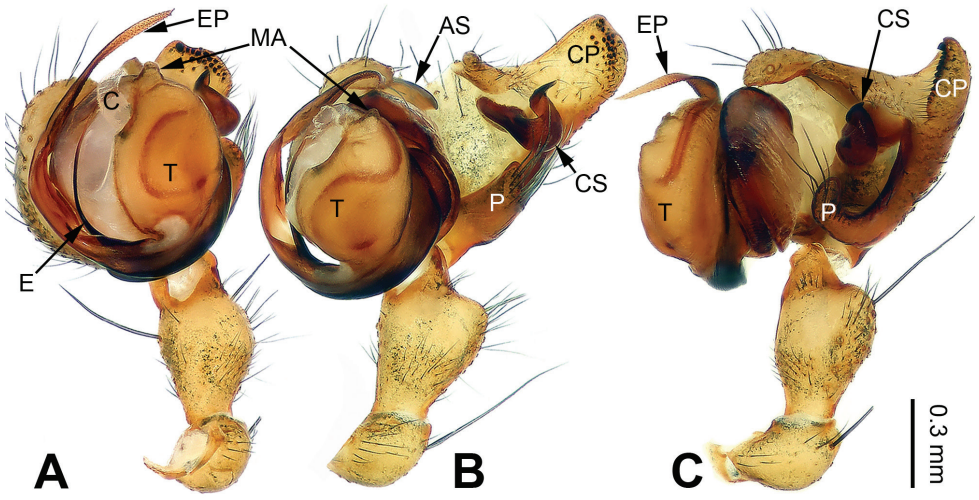

Figure 1. Left palp of *Pimoa binchuanensis* sp. nov., holotype **A** prolateral view **B** ventral view **C** retrolateral view. Abbreviations: **AS** = alveolar sclerite; **C** = conductor; **CP** = cymbial process; **CS** = cymbial sclerite; **E** = embolus; **EP** = embolic process; **MA** = median apophysis; **P** = paracymbium; **T** = tegulum. Scale bar: equal for **A, B** and **C**.

process shorter than embolus) (cf. Fig. 1A–C; Griswold et al. 1999: figs 15–17; Xu and Li 2007: figs 4–8). The female of *P. binchuanensis* sp. nov. can be distinguished from other congeners by having a broad dorsal plate (DP) of the epigyne with an oval tip and trapezoidal basal part (vs dorsal plate narrow or indistinct) (Fig. 2A, B).

Description. Male (holotype, IZCAS-Ar39293): Total length 5.25. Carapace 2.50 long, 2.00 wide. Abdomen 2.75 long, 1.75 wide. Eye sizes and interdistances: AME 0.20, ALE 0.16, PME 0.15, PLE 0.20; AME-AME 0.05, AME-ALE 0.05, PME-PME 0.10, PME-PLE 0.10. Leg measurements: I: missing; II: 17.00 (5.00, 5.25, 5.00, 1.75); III: 10.75 (3.25, 3.50, 3.00, 1.00); IV: missing. Promargin of chelicerae with 2 teeth, retromargin with 1 tooth. Carapace yellowish, with black lateral margins, the thoracic fovea and radial grooves distinct, sternum yellowish, nearly almond-shaped. Abdomen brownish with yellow transverse bands, nearly oval. Legs yellowish with black annulations. Palp: patella short, about 1/2 of tibial length; tibia long, about 1/2 of cymbial length; paracymbium short, about 1/3 of cymbial length, somewhat hook-shaped; cymbial sclerite (CS) long, about 1/2 of cymbial length, spindle-shaped; cymbial process (CP) broad and long, about 1/2 of cymbial length, with more than 20 cuspules; median apophysis (MA) indistinct; conductor distinct; embolic process (EP) long, about 1.5 times as long as embolus, tip with fine granulations; embolus bent and long, about the same length as the cymbium, beginning at the 7:30 o'clock position; embolic tooth absent (Fig. 1A–C).

Female: (paratype, IZCAS-Ar39294): Total length 7.12. Carapace 3.16 long, 2.47 wide. Abdomen 3.96 long, 3.28 wide. Eye sizes and interdistances: AME 0.15, ALE 0.20, PME 0.17, PLE 0.17; AME-AME 0.14, AME-ALE 0.11, PME-PME 0.14, PME-PLE 0.22. Leg measurements: I: 19.78 (5.71, 6.86, 5.06, 2.15);

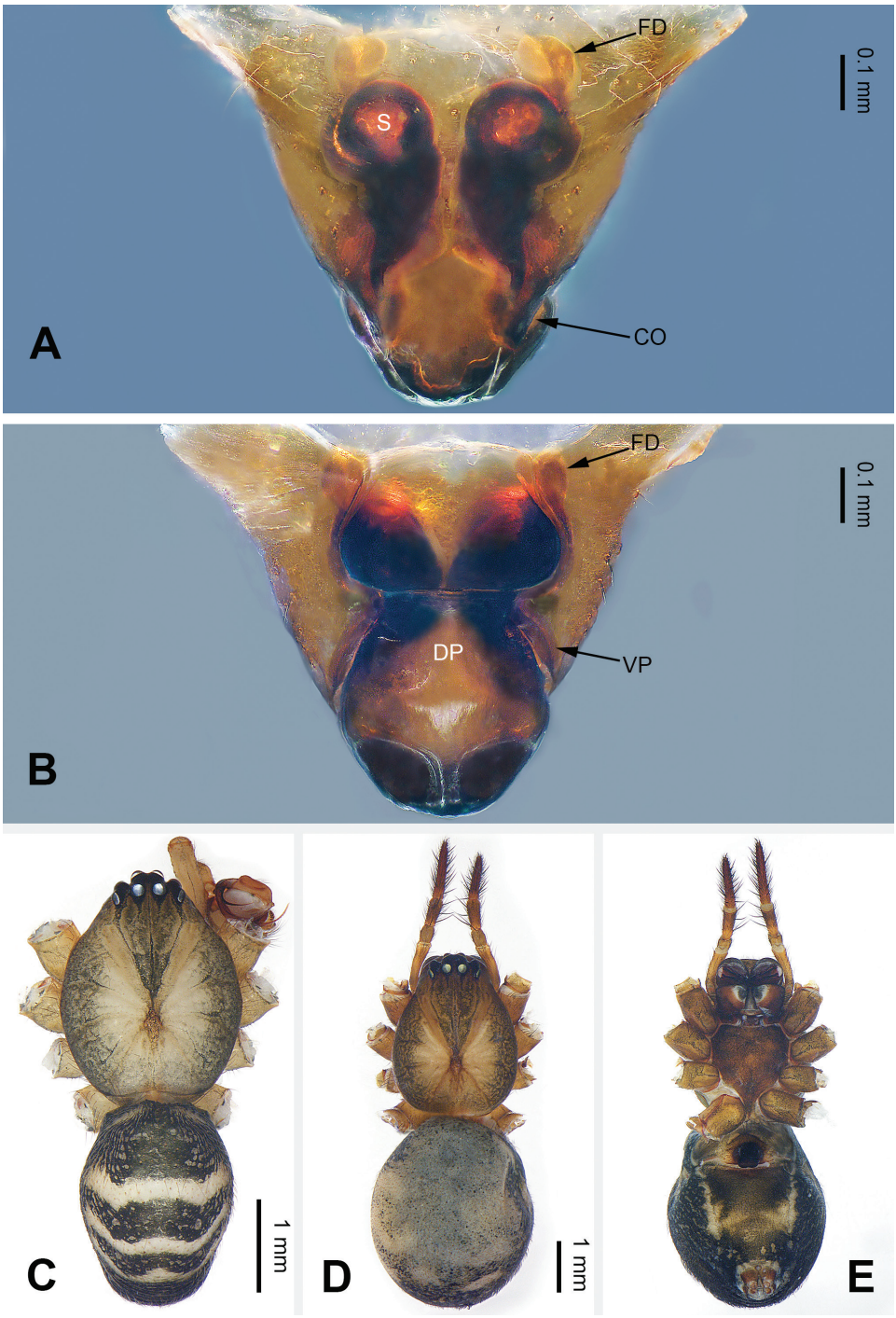

Figure 2. Epigyne and habitus of *Pimoa binchuanensis* sp. nov., female paratype and male holotype **A** epigyne, ventral view **B** vulva, dorsal view **C** male habitus, dorsal view **D** female habitus, dorsal view **E** female habitus, ventral view. Abbreviations: **CO** = copulatory opening; **DP** = dorsal plate of the epigyne; **FD** = fertilization duct; **S** = spermatheca; **VP** = ventral plate of epigyne. Scale bars: equal for **D** and **E**.

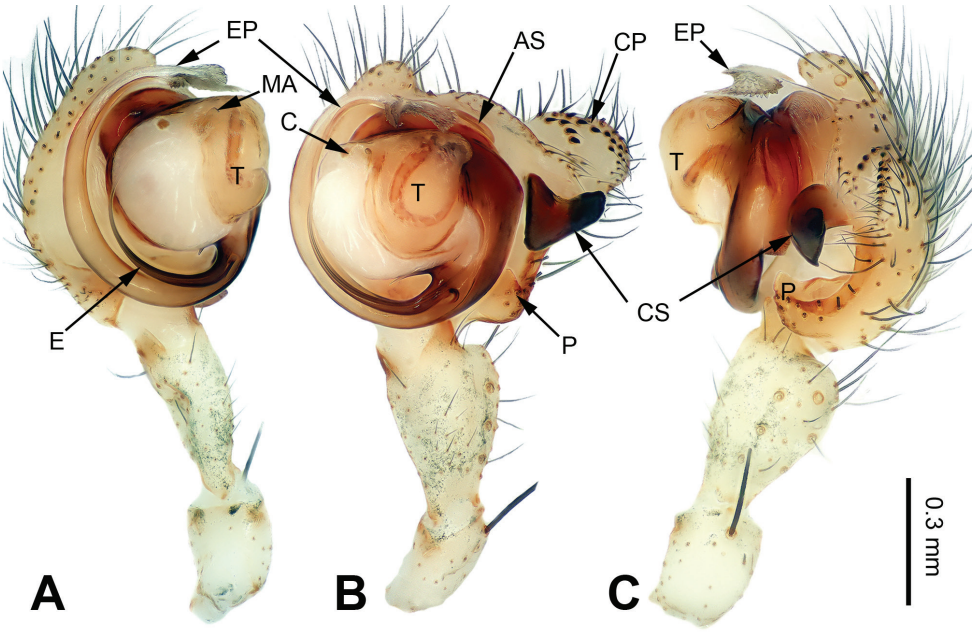

Figure 3. Left palp of *Pimoa lata* **A** prolateral view **B** ventral view **C** retrolateral view Scale bar: Abbreviations: **AS** = alveolar sclerite; **C** = conductor; **CP** = cymbial process; **CS** = cymbial sclerite; **E** = embolus; **EP** = embolic process; **MA** = median apophysis; **P** = paracymbium; **T** = tegulum. Scale bar: equal for **A, B** and **C**.

II: 16.23 (4.94, 5.26, 4.23, 1.80); III: 11.47 (3.52, 3.56, 3.08, 1.31); IV: 15.64 (4.87, 5.13, 4.10, 1.54). Promargin and retromargin of chelicerae with 3 teeth. Carapace brownish, the thoracic fovea and radial grooves distinct, sternum yellowish, and shield-shaped. Abdomen greyish, somewhat oval, transverse bands indistinct. Legs brownish without annulations. Epigyne: triangular; ventral (VP) and dorsal plates (DP) broad, length subequal to width; copulatory openings hidden; spermathecae globose, separated by about half of the radius; fertilization ducts laterally oriented (Fig. 2).

Distribution. Type locality only, Yunnan, China (Fig. 7).

Pimoa lata Xu & Li, 2009

Figs 3–4, 7

Pimoa lata Xu & Li, 2009: 56, figs 1–8 (♀).

Type material. Holotype ♀: China: Sichuan: Lushan County: Weita Village, Shuiluodong Cave, (30.28°N, 102.97°E, 1338 m), 15.X.2005, S. Li.

Other material examined. 2♀1♂ (IZCAS-Ar39295-Ar39297): China: Sichuan: Lushan County: Weita Village, Shuiluodong Cave, 30.2750°N, 102.9690°E, 1302 m, 27.VI.2018, X. Zhang.

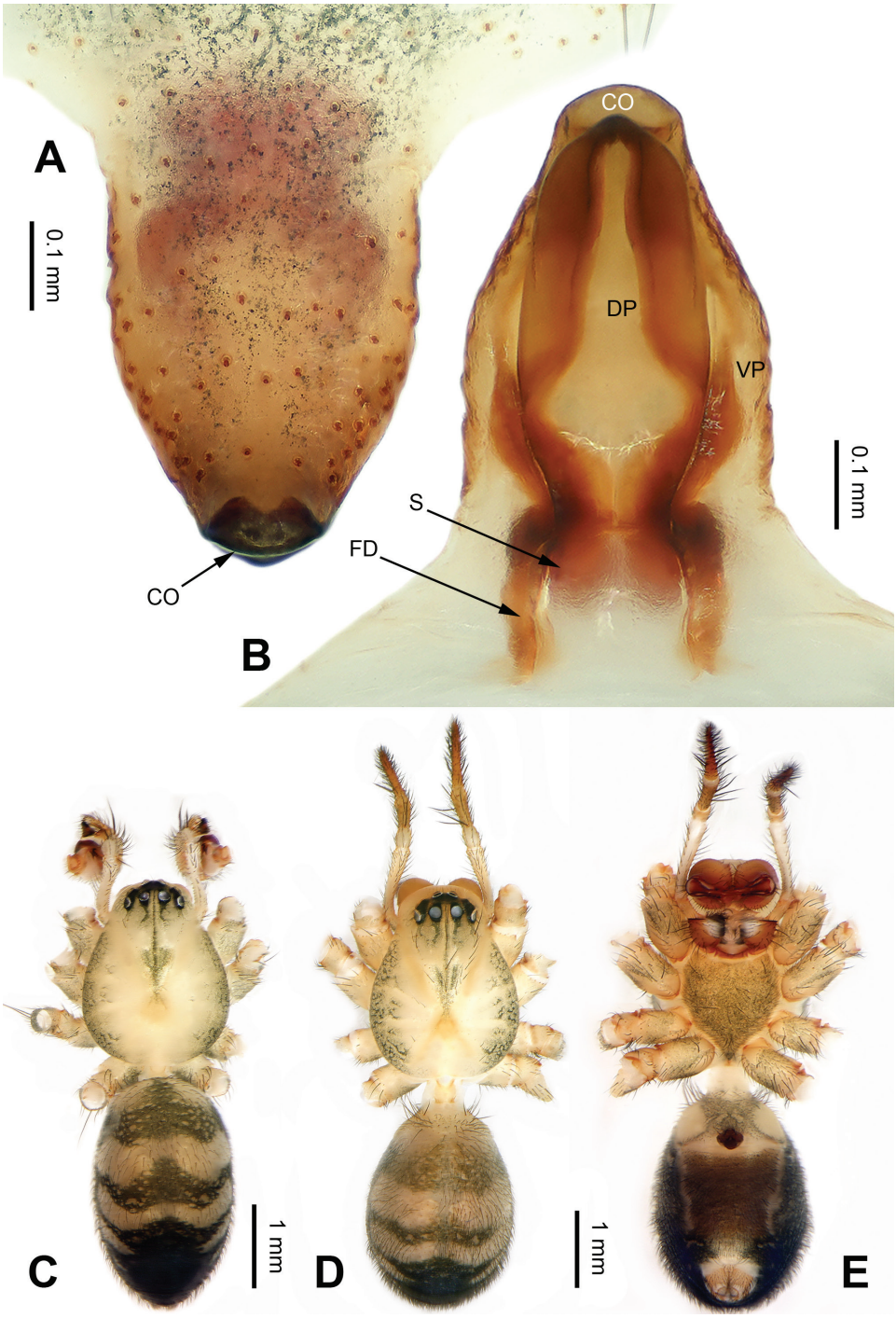

Figure 4. Epigyne and habitus of *Pimoa lata* **A** epigyne, ventral view **B** vulva, dorsal view **C** male habitus, dorsal view **D** female habitus, dorsal view **E** female habitus, ventral view. Abbreviations: **CO** = copulatory opening; **DP** = dorsal plate of the epigyne; **FD** = fertilization duct; **S** = spermatheca; **VP** = ventral plate of epigyne. Scale bars: equal for **D** and **E**.

Diagnosis. The male of *P. lata* can be easily distinguished from other congeners, except for *P. reniformis* Xu & Li, 2007 and *P. trifurcata* Xu & Li, 2007 by having a short paracymbium and a large and blunt cymbial process (CP), with many cuspules. From *P. reniformis*, it can be distinguished by the short cymbial sclerite (CS), about 1/3 of the cymbial length, with a blunt tip (vs a long cymbial sclerite (CS) in *P. reniformis*, about 1/2 of cymbial length, with a sharp tip). From *P. trifurcata*, it can be distinguished by the bifurcated embolic process (EP) (vs the embolic process (EP) in *P. trifurcata* with a trifurcate tip) (cf. Fig. 3A–C; Xu and Li 2007: figs 38–41, 49–54). The female of *P. lata* can be distinguished from all other congeners by the lip-shaped dorsal plate (DP) (vs dorsal plate narrow or indistinct) (Fig. 4A, B).

Description. Male (IZCAS-Ar39295): Total length 5.00. Carapace 2.25 long, 2.00 wide. Abdomen 2.75 long, 1.75 wide. Eye sizes and interdistances: AME 0.15, ALE 0.16, PME 0.15, PLE 0.16; AME-AME 0.05, AME-ALE 0.05, PME-PME 0.10, PME-PLE 0.10. Leg measurements: I: 21.00 (6.00, 6.75, 5.50, 2.75); II: 18.75 (5.25, 6.50, 5.00, 2.00); III: 13.40 (4.25, 4.00, 3.50, 1.65); IV: 15.00 (5.00, 4.75, 4.00, 1.25). Promargin and retromargin of chelicerae with 3 teeth. Carapace yellowish, with green lateral margins, the thoracic fovea distinct, sternum yellowish. Abdomen brownish with yellow transverse bands. Legs yellowish, with black annulations. Palp: patella short, about 1/3 of tibial length; tibia long, almost as long as cymbial length; paracymbium short, about 1/5 of cymbial length, with a blunt tip; cymbial sclerite (CS) short, about 1/3 of cymbial length, with a blunt, black tip; cymbial process (CP) broad and short, about 1/3 of cymbial length, with more than 15 cuspules; median apophysis (MA) indistinct; conductor indistinct; embolic process (EP) long, about 2 times as long as embolus, with two jagged tips; embolus bent and long, about the same length as the cymbium, beginning at 5:30 o'clock position; embolic tooth indistinct (Fig. 3A–C).

Female (Fig. 4). Description see Xu and Li (2009: figs 1–8).

Distribution. Shuiluodong Cave, Sichuan, China (Fig. 7).

Remark. The male of this species is described for the first time.

***Pimoa xinjianensis* sp. nov.**

http://zoobank.org/C804AFD1-875B-4960-8EBC-DC77C30929D7

Figs 5–7

Type material. Holotype ♂ (IZCAS-Ar39298): China: Hunan: Xiangxi Tujia and Miao Autonomous Prefecture: Longshan County: Xichehe Town: Xinjian Village, Xianren Cave, 29.0855°N, 109.5109°E, 503 m, 26.X.2018, X. Zhang & Z. Chen. **Paratypes:** 3♀ (IZCAS-Ar39299-Ar39301), same data as holotype; 2♀1♂ (IZCAS-Ar39302-Ar39304), Longshan County: Xichehe Town: Shuitong Village, Yangjia Cave, 29.0879°N, 109.4945°E, 431 m, 26.X.2018, X. Zhang & Z. Chen; 2♀ (IZCAS-Ar39305-Ar39306), Longshan County: Wuya Town: Xiyan Village, Mt. Tianma, unnamed cave, 29.5701°N, 109.7051°E, 840 m, 28.X.2018, X. Zhang & Z. Chen.

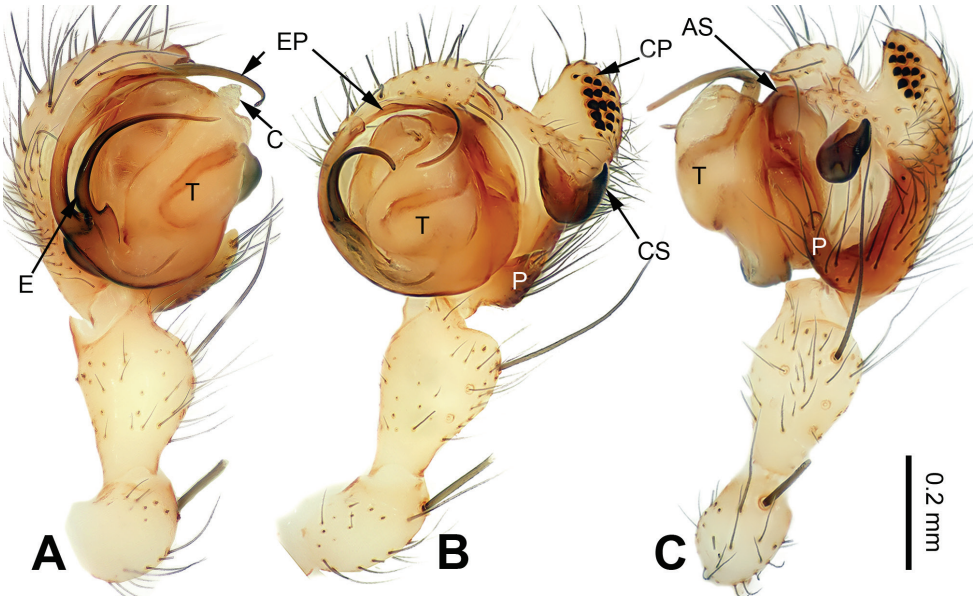

Figure 5. Left palp of *Pimoa xinjianensis* sp. nov., holotype **A** prolateral view **B** ventral view **C** retrolateral view. Abbreviations: **AS** = alveolar sclerite; **C** = conductor; **CP** = cymbial process; **CS** = cymbial sclerite; **E** = embolus; **EP** = embolic process; **P** = paracymbium; **T** = tegulum. Scale bar: Equal for **A, B** and **C**.

Etymology. The specific name refers to the type locality; adjective.

Diagnosis. Both sexes of *P. xinjianensis* sp. nov. can be easily distinguished from other congeners by the strongly reduced (vestigial) eyes. The palp of *P. xinjianensis* sp. nov. can be distinguished from that of other congeners by the long embolic process (EP), about 2 times longer than the embolus (vs a short embolic process, almost as long as the embolus) (cf. Figs 5, 6). The epigyne of *P. xinjianensis* sp. nov. differs from other congeners by having distinct (unhidden) copulatory openings (vs hidden or indistinct) (Fig. 6).

Description. Male (holotype, IZCAS-Ar39298): Total length 3.75. Carapace 1.50 long, 1.30 wide. Abdomen 2.25 long, 1.70 wide. Eyes vestigial (strongly reduced in size). Leg measurements: I: 21.50 (6.50, 6.00, 6.75, 2.25); II: 20.20 (6.00, 5.75, 6.15, 2.30); III: 17.40 (4.75, 5.50, 5.15, 2.00); IV: 20.00 (6.00, 6.75, 5.50, 1.75). Promargin of chelicerae with 3 teeth, retromargin with 2 teeth. Carapace yellowish, the thoracic fovea distinct, sternum yellowish. Abdomen brownish. Legs yellowish, without annulations. Palp: patella short, about 1/2 of tibial length; tibia long, almost as long as cymbial length; paracymbium short, about 1/3 of cymbial length, with rounded tip; cymbial sclerite (CS) short, about 1/3 of cymbial length, with a tapering, black tip; cymbial process (CP) long, about 1/2 of the cymbial length, with more than 13 cuspules; median apophysis (MA) indistinct; embolic process (EP) long, about 2 times longer than the embolus, tip without granulation; embolus bent and long, about 1/2 of cymbial length, beginning at 6:30 o'clock position; embolic tooth distinct (Fig. 5A–C).

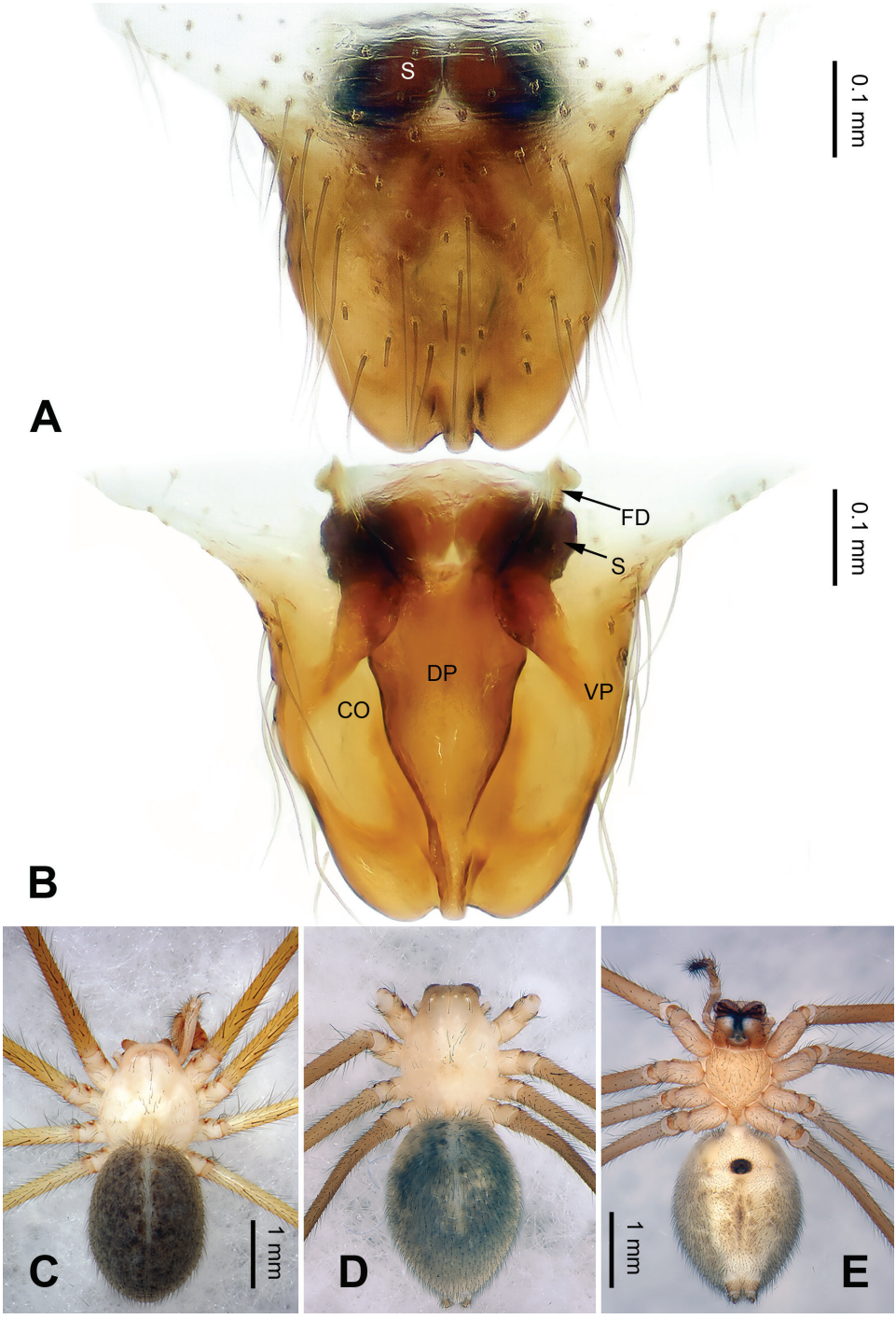

Figure 6. Epigyne and habitus of *Pimoa xinjianensis* sp. nov., female paratype and male holotype **A** epigyne, ventral view **B** vulva, dorsal view **C** male habitus, dorsal view **D** female habitus, dorsal view **E** female habitus, ventral view. Abbreviations: **CO** = copulatory opening; **DP** = dorsal plate of the epigyne; **FD** = fertilization duct; **S** = spermatheca; **VP** = ventral plate of epigyne. Scale bars: Equal for **D** and **E**.

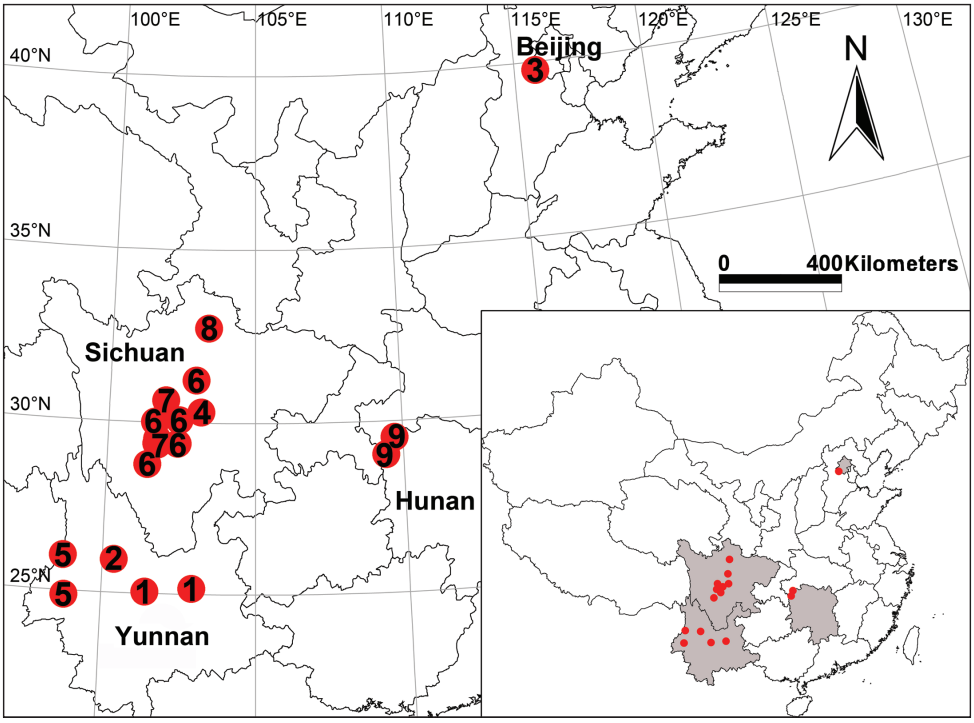

Figure 7. Distribution records of Pimoa species from China **1** *P. anatolica* **2** *P. binchuanensis* sp. nov. **3** *P. clavata* **4** *P. lata* **5** *P. lihengae* **6** *P. reniformis* **7** *P. trifurcata* **8** *P. wanglangensis* **9** *P. xinjianensis* sp. nov.

Female (paratype, IZCAS-Ar39299): Total length 4.75. Carapace 1.75 long, 1.50 wide. Abdomen 3.00 long, 2.25 wide. Eyes vestigial (only with 6 white spots). Leg measurements: I: 20.60 (6.20, 6.00, 6.10, 2.30); II: 19.30 (5.95, 5.75, 5.50, 2.10); III: 14.75 (4.75, 4.50, 4.00, 1.50); IV: 18.35 (6.10, 5.25, 5.00, 2.00). Cheliceral teeth as in male. Carapace yellowish; sternum flavescent. Abdomen greyish. Legs reddish, without annulations. Epigyne: trapezoidal; ventral plate (VP) broad, length subequal to width; dorsal plate (DP) triangular; copulatory openings distinct; spermathecae oval, touching each other; fertilization ducts medially oriented (Fig. 6).

Distribution. Type locality only, Hunan, China (Fig. 7).

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On the genus *Flexicrurum* Tong & Li, 2007 (Araneae, Psilodercidae) from Hainan Island, China

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Abstract

Three new species of the genus *Flexicrurum* Tong & Li, 2007, from Hainan Island, China are described: *F. wuzhishanense* **sp. nov.** (♂♀), *F. yangjiao* **sp. nov.** (♂♀), and *F. qishi* **sp. nov.** (♂♀). A key to males of species of *Flexicrurum* is provided. Additionally, the female of *F. minutum* Tong & Li, 2007, is described for the first time. To date, the genus is endemic to Hainan Island, China. Types are deposited in the Institute of Zoology, Chinese Academy of Sciences (IZCAS) in Beijing.

Keywords

Endemic, Ochyroceratidae, Southeast Asia, spider, taxonomy, tropical

Introduction

The spider family Psilodercidae Machado, 1951, was only recently elevated to family rank from a subfamily of Ochyroceratidae Fage, 1912. This taxonomic rearrangement is based on the presence of book-lungs, the position of tracheal stigma, the number of promarginal cheliceral teeth, the shape of the labium, and the point of attachment of the bulbus (Wunderlich 2004, 2008).

Psilodercidae currently contains 11 genera and 120 species (World Spider Catalog 2019; Li and Quan 2017). Psilodercids are restricted to tropical Asia and are diverse within China. Thirteen species from six genera have been reported in China: *Althepus chengmenensis* Li & Li, 2018, *A. christae* Wang & Li, 2013, *A. menglaensis* Li & Li, 2018, *A. qingyuani* Li & Li, 2018, *A. xuae* Li & Li, 2018, *Leclercera undulata*

Wang & Li, 2013, and *Psiloderces incomptus* Wang & Li, 2013, from Yunnan Province; *Flexicrurum flexicrurum* Tong & Li, 2007, *F. longispina* Tong & Li, 2007, *F. minutum* Tong & Li, 2007, and *Qiongocera hongjunensis* Li & Li, 2017, from Hainan Island; and *Sinoderces exilis* Wang & Li, 2013, and *S. nawanensis* Li & Li, 2017, from Guangxi Zhuang Autonomous Region. All of them are locally endemic.

Prior to this study, only three species from the genus *Flexicrurum* Tong & Li, 2007, have been described (Tong and Li 2007): *F. flexicrurum*, *F. longispina*, and *F. minutum*. These species are confined to Hainan Island, China, and have been the only representatives of the genus (World Spider Catalog 2019).

While studying new material collected in Hainan Island, we recognized the matched pairs of three new species of *Flexicrurum*, and a hitherto unknown female of *F. minutum*, one of the three species described by Tong and Li (2007). This paper describes all of these new discoveries by providing images of their genital organs and close-up photos of their chelicerae.

Materials and methods

Types are deposited in the Institute of Zoology, Chinese Academy of Sciences (**IZCAS**) in Beijing. All specimens collected were observed and preserved in 95% ethanol. The specimens were measured and examined under a Leica M205 C stereomicroscope, and further morphological details were observed with an Olympus BX41 compound microscope. The left male palp was detached for closer examination. Carapace measurements include the clypeus. The internal genitalia and male bulb were dissected and immersed in lactic acid. An Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on an Olympus SZX12 stereomicroscope was used to take photos. Photos were stacked with Helicon Focus 6.7.1 to generate images with extended depth of field. The images were post-processed with Adobe Photoshop. Leg measurements are shown as total length (femur, patella, tibia, metatarsus, and tarsus). Leg segments were measured from the retrolateral side. All measurements are given in millimetres (mm). Terminology follows that of Li et al. (2014), Tong and Li (2007) and Deeleman-Reinhold (1995). Coordinates of collecting locations were recorded in Microsoft Excel and imported into ArcGIS 10.2 to generate a map which was subsequently exported to Adobe Photoshop CC 2014 for further editing. The following abbreviations are used in text: **ALE** anterior lateral eye, **ME** median eye, **PLE** posterior lateral eye.

Taxonomy

Family Psilodercidae Machado, 1951

Genus *Flexicrurum* Tong & Li, 2007

Type species. *Flexicrurum flexicrurum* Tong & Li, 2007 from China, Hainan Island, Wuzhishan, Wuzhishan City, 16.IV.2005 (IZCAS).

Emended diagnosis. *Flexicrurum* Tong & Li, 2007, resembles *Althepus* Thorell, 1898, and *Leclercera* Deeleman-Reinhold, 1995. However, *Flexicrurum* can be differentiated by the combination of the following characteristics: 1) the tibia of the male palp is strongly rotated inward (vs absence of rotated male palpal tibia in *Althepus* and *Leclercera*); 2) presence of a slender bulbal apophysis (vs absence of slender bulbal apophysis in *Althepus* and *Leclercera*); 3) cymbium with a strong lateral protrusion (vs cymbium with slightly tilted protrusion in *Althepus* and *Leclercera*); 4) cymbium bearing a one- or two-bulge posterolateral cymbial apophysis (vs cymbium with lateral lanceolate or hook-shaped, spine like apophysis in *Althepus*; cymbium with retrolateral apophysis in *Leclercera*); 5) absence of promarginal cheliceral teeth (vs 1–2 promarginal cheliceral teeth in *Althepus* and *Leclercera*); 6) embolus distinctly short (vs embolus long and slender in *Althepus* and *Leclercera*); 7) internal endogyne with the presence of a distinct vertical duct medially bearing different structures of spermathecae (vs absence of the vertical duct in *Althepus* and *Leclercera*).

Composition. *Flexicrurum flexicrurum* Tong & Li, 2007, *F. longispina* Tong & Li, 2007, *F. minutum* Tong & Li, 2007, *F. qishi* Li & Li, sp. nov., *F. wuzhishanense* Li & Li, sp. nov., and *F. yangjiao* Li & Li, sp. nov.

Distribution. Hainan Island, China.

Key to species of *Flexicrurum* (males only)

1 Cymbium with posterolateral apophysis with a divided tip, i.e., with two bulges or protuberances.....**2**
– Cymbium with posterolateral apophysis with a single tip or bulge **3**
2 Conductor simple, protruded; longer bulbal apophysis; bulb with scattered black spots.....***F. wuzhishanense* sp. nov.**
– Conductor comprising two parts that spiral inwards, resembling a broken ring; shorter bulbal apophysis; bulb without scattered black spots .....***F. qishi* sp. nov.**
3 Laminar apophysis and tip of cymbial protrusion parallel to one another.....**4**
– Laminar apophysis and tip of cymbial protrusion not parallel to one another ....***F. yangjiao* sp. nov.**
4 Absence of long spine on dorsolateral surface of bulb.....**5**
– Presence of a long spine on dorsolateral surface of bulb..... ***F. longispina***
5 Longer bulbal apophysis (exceeds length of entire bulb).....***F. flexicrurum***
– Shorter bulbal apophysis (does not exceed length of entire bulb).....***F. minutum***

***Flexicrurum wuzhishanense* Li & Li, sp. nov.**
http://zoobank.org/7295226A-D99A-458F-BAEB-1E536F77452D
Figs 1–2, 8A, 9

Types. Holotype: ♂ (IZCAS), China, Hainan Island, Wuzhishan City, Shuiman Village, Wuzhishan, 18°54.1944'N, 109°40.9266'E, 723 m, 31.III.2012, Chen Z. leg.; **Paratype:** 1♀ (IZCAS), same data as holotype.

Etymology. The species name is an adjective referring to the type locality; the Chinese pinyin "wǔ zhǐ" means five fingers, and "shān" means mountain. The name is a graphic interpretation of contour of the mountain ranges with a striking resemblance to five fingers.

Diagnosis. *Flexicrurum wuzhishanense* sp. nov. strongly resembles *F. qishi* sp. nov. Males of *F. wuzhishanense* sp. nov. can be distinguished by a longer bulbal apophysis (Fig. 2D) (vs shorter bulbal apophysis in *F. qishi* sp. nov.), the bulbal apophysis which is further from embolus (Fig. 2B) (vs bulbal apophysis and embolus nearer each other (Fig. 6B), simple protruded conductor comprises only a single part (Fig. 2B) (vs a rather slender conductor comprising two parts, resembling a broken ring in *F. qishi* sp. nov. (Fig. 6A, B)), the bulb with scattered black spots (Fig. 2A) (vs absence of scattered black spots on bulb of *F. qishi* sp. nov. (Fig. 6A)); females can be distinguished by a rather broad dome-shaped epigastric area (Fig. 1B) (vs a rather plump, triangular epigastric area in *F. qishi* sp. nov. (Fig. 5B)), spermathecae can be distinguished by a pair of lobed ducts laterally connected with bow-tie-shaped spermathecae (Fig. 1A) (vs a pair of spermathecae resembling the structure of a human uterus in *F. qishi* sp. nov. (Fig. 5A)).

Description. Male (Holotype). Total length 2.46; carapace 0.96 long, 0.94 wide; abdomen 1.50 long, 0.64 wide. Carapace round and brown, with three longitudinal dark brown bands, the middle band is 2 times wider than the lateral bands (Fig. 1C). Fovea shallow and dark brown. Anterior part of thoracic region distinctly elevated. Eye sizes and interdistances: ALE 0.09, ME 0.08, PLE 0.06; ALE–ALE 0.30, ME–ME 0.16, PLE–PLE 0.32, ALE–ME 0.14, PLE–ME 0.18, ALE–PLE 0.12. Chelicerae brown. Cheliceral promargin with lamina of three triangular extensions and no teeth, retromargin with two small teeth (Fig. 8A). Clypeus slanting 0.3 high, with dark brown trident and two pale areas laterally. Endites dark brown. Labium slanting and dark brown. Sternum circular with brown complex pattern delimiting a medial small pale spot anteriorly. Abdomen elongated, anterior of ventrum with pair of circular pale areas and dome-shaped epigastric area, posterior with random irregular dark brown spots. Legs uniformly brown; measurements: missing (detached from specimens, sequence of legs cannot be differentiated). Palp (Fig. 2A–D): femur slender swollen at the base, patella swollen and angled ventrally (Figs 1C, 2C), tibia more slender than femur, distally darker, cymbium pale, darker distally, with strong lateral protrusion darker distally, bearing posterolateral cymbial apophysis with two bulges (Fig. 2D); bulb brown and pyriform, with scattered dark spots, bearing a pointed laminar apophysis, a protruded conductor and embolus distally; embolus slender, hook-shaped, adjacent to laminar apophysis and conductor (Fig. 2B).

Female (Paratype). General features and coloration similar to male (Fig. 1D–E). Measurements: total length 2.12; carapace 0.75 long, 0.78 wide; abdomen 1.37 long, 0.93 wide. Eye sizes and interdistances: ALE 0.09, ME 0.06, PLE 0.08; ALE–ALE 0.30, ME–ME 0.14, PLE–PLE 0.32, ALE–ME 0.14, PLE–ME 0.18, ALE–PLE 0.15. Clypeus 0.35 high. Leg measurements: I missing, II missing, III missing, IV 7.38 (1.92, 0.31, 2.03, 2.03, 1.09). Internal genitalia: a pair of lobe-shaped ducts connected with a bow-tie-shaped spermathecae, divided by a distinct pair of vertical ducts with a pair of club-shaped ducts anteriorly (Fig. 1A).

Distribution. Known only from the type locality (Fig. 9).

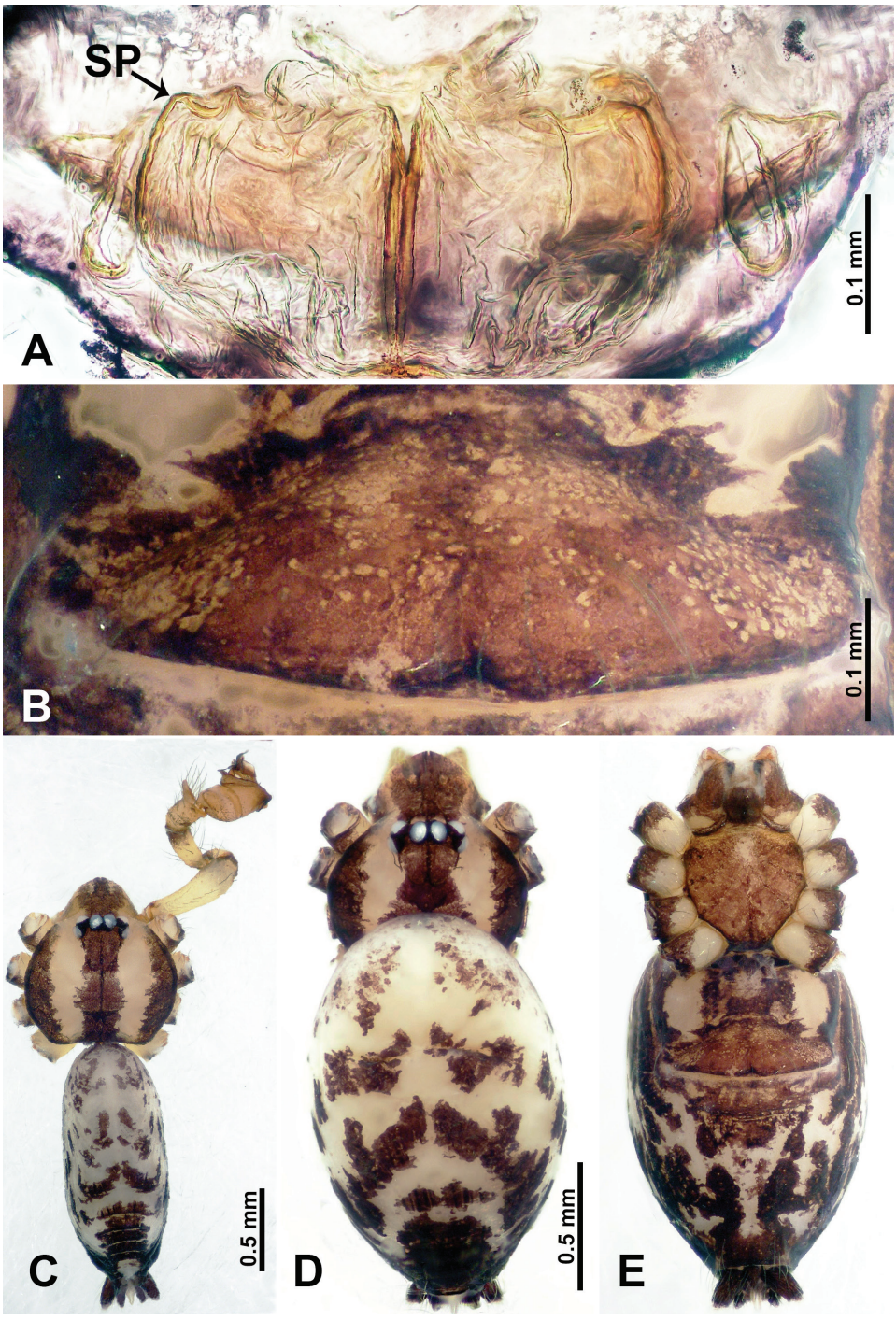

Figure 1. *Flexicrurum wuzhishanense* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric area, ventral view **C** male habitus, dorsal view **D** female habitus, dorsal view **E** female habitus, ventral view. Abbreviation: SP = spermathecae. **D** and **E** share the scale bar.

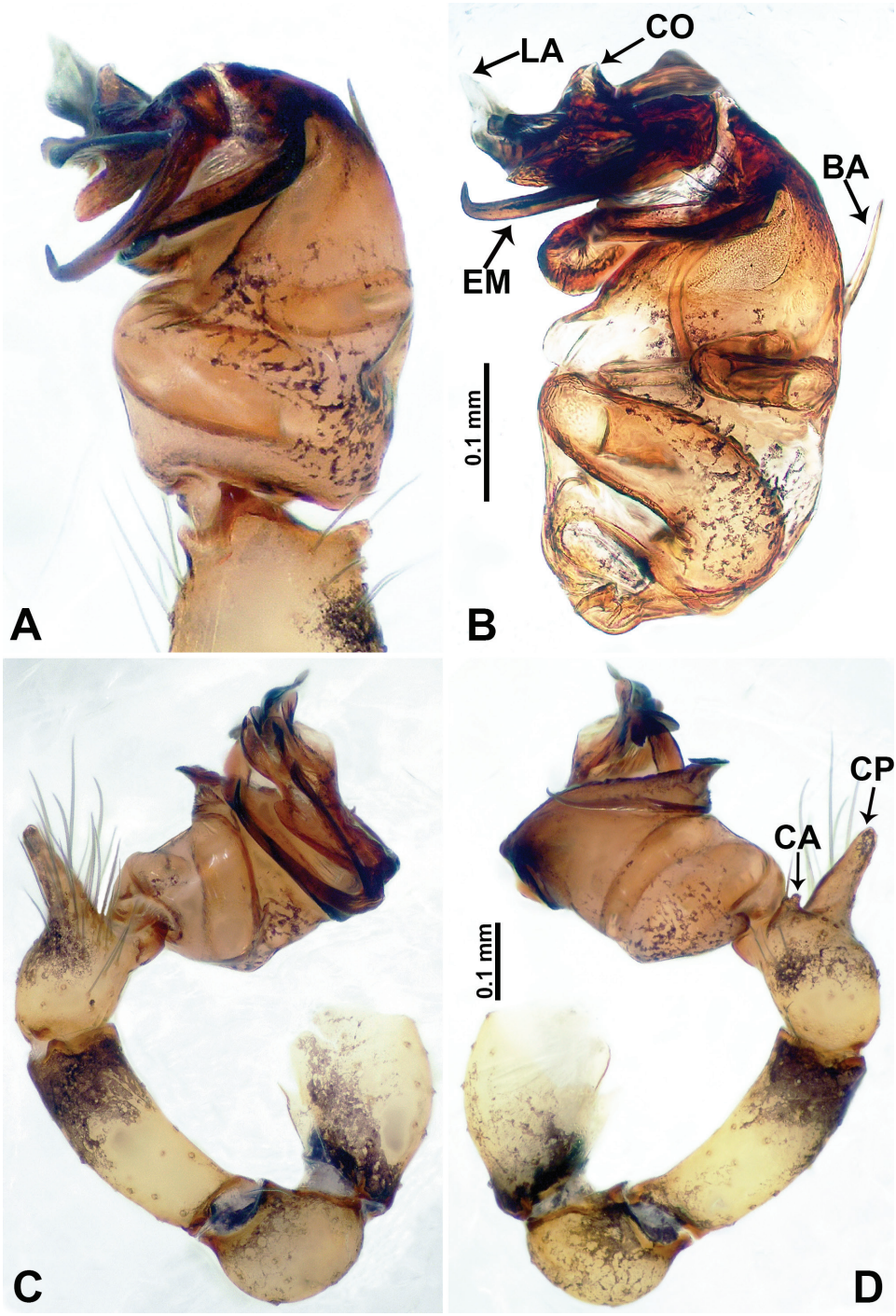

Figure 2. *Flexicrurum wuzhishanense* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palpal bulb, ventral view **C** palp, prolateral view **D** palp, retrolateral view. Abbreviations: BA = bulbal apophysis, CA = cymbial apophysis, CO = conductor, CP = cymbial protrusion, EM = embolus, LA = laminal apophysis. **A** and **B** share the scale bar as well as **C** and **D**.

***Flexicrurum yangjiao* Li & Li, sp. nov.**
http://zoobank.org/1FDF0627-CE14-4FCB-BA69-2B88FC6EB417
Figs 3–4, 8B, 9

Types. Holotype: ♂ (IZCAS), China, Hainan Island, Changjiang City, Bawangling, Yajia Conference Centre, 19°5.1042'N, 109°7.4343'E, 433 m, 10.IV.2012, Chen Z. leg.; **Paratypes**: 1♂1♀ (IZCAS), same data as holotype.

Etymology. The species name is a noun in apposition derived from the word for "goat horn" in Chinese pinyin "yángjiǎo". It refers to the shape of the conductor which curves strongly inwards, like a goat horn.

Diagnosis. *Flexicrurum yangjiao* sp. nov. can be distinguished from *F. wuzhishanense* sp. nov. and *F. qishi* sp. nov. by a posterolateral cymbial apophysis with a single tip or bulge (Fig. 4D) (vs a posterolateral cymbial apophysis with two bulges or protuberances (i.e., a divided tip) in *F. wuzhishanense* sp. nov. and *F. qishi* sp. nov.), a pointed embolic end (vs hook-liked embolic end in *F. wuzhishanense* sp. nov. and *F. qishi* sp. nov.), a shorter laminar apophysis (vs longer in *F. wuzhishanense* sp. nov. and *F. qishi* sp. nov.), and the position of the entire bulb is opposite that of the other two species—the laminar apophysis is parallel to the tip of cymbial protrusion (vs laminar apophysis and tip of cymbial protrusion not parallel in *F. wuzhishanense* sp. nov. and *F. qishi* sp. nov.).

Description. Male (Holotype). Total length 2.08; carapace 0.80 long, 0.96 wide; abdomen 1.28 long, 0.64 wide. Carapace round and brown, with three longitudinal dark brown bands, the middle band 2 times wider than the lateral bands (Fig. 3C). Fovea shallow and dark brown. Anterior part of thoracic region distinctly elevated. Eye sizes and interdistances: ALE 0.08, ME 0.08, PLE 0.09; ALE–ALE 0.30, ME–ME 0.13, PLE–PLE 0.32, ALE–ME 0.16, PLE–ME 0.19, ALE–PLE 0.16. Chelicerae brown. Cheliceral promargin with lamina of three triangular extensions and no teeth, retromargin with two small teeth (Fig. 8B). Clypeus slanting 0.20 high, medially dark brown and two pale areas laterally. Endites dark brown. Labium slanting and dark brown. Sternum circular with brown complex pattern delimiting a 1/3 medial pale spot anteriorly. Abdomen elongated, dorsum anterior 2/3 with random dark brown spots, posterior 1/3 with horizontal dark brown striated pattern medially, ventrum anterior half with pair of lobed pale areas and a dome-shaped epigastric area, posterior half with random, irregular dark brown spots. Legs uniformly brown; measurements: I 9.50 (2.56, 0.32, 2.88, 2.65, 1.09), II 6.64 (2.00, 0.25, 1.75, 1.71, 0.93), III 5.05 (1.20, 0.23, 1.37, 1.50, 0.75), IV missing. Palp (Fig. 4A–D): femur slender, swollen at the base, patella swollen and angled ventrally (Figs 3C, 4C), tibia swollen and dark distally, cymbium pale, darker distally, with strong lateral protrusion darker distally, bearing a posterolateral cymbial apophysis with a single bulge (Fig. 4D); bulb pale brown and pyriform, bearing a pointed laminar apophysis, a slender bulbal apophysis; conductor strongly spiralled forming a ring resembling a goat horn; embolus short and pointed, located below all other structures, further away from conductor (Fig. 4B).

Female (Paratype). General features and coloration similar to male (Fig. 3D–E). Measurements: total length 2.18; carapace 0.80 long, 0.80 wide; abdomen 1.38 long, 0.80 wide. Eye sizes and interdistances: ALE 0.08, ME 0.08, PLE 0.05; ALE–ALE 0.32,

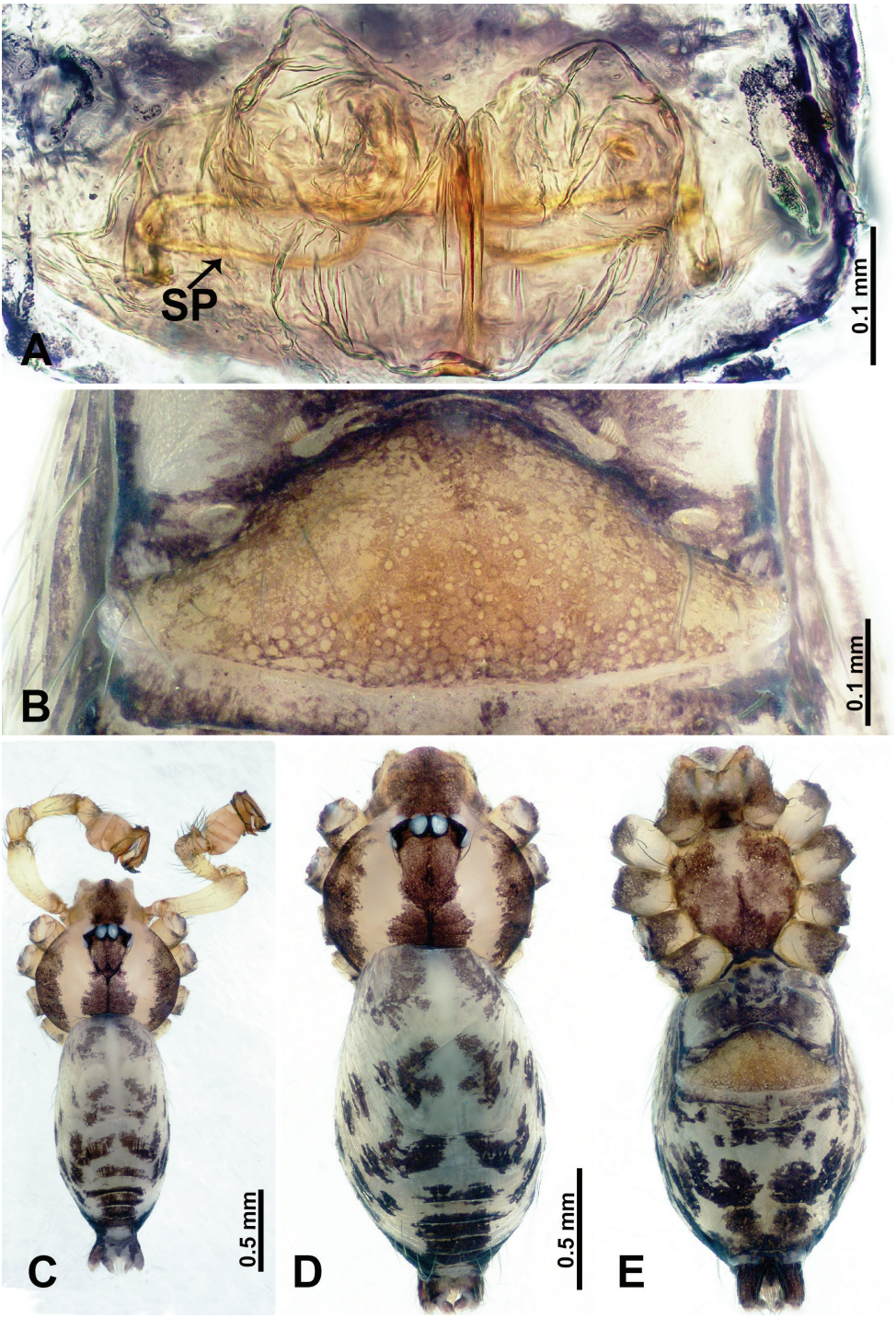

Figure 3. *Flexicrurum yangjiao* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric area, ventral view **C** male habitus, dorsal view **D** female habitus, dorsal view **E** female habitus, ventral view. Abbreviation: SP = spermathecae. **D** and **E** share the scale bar.

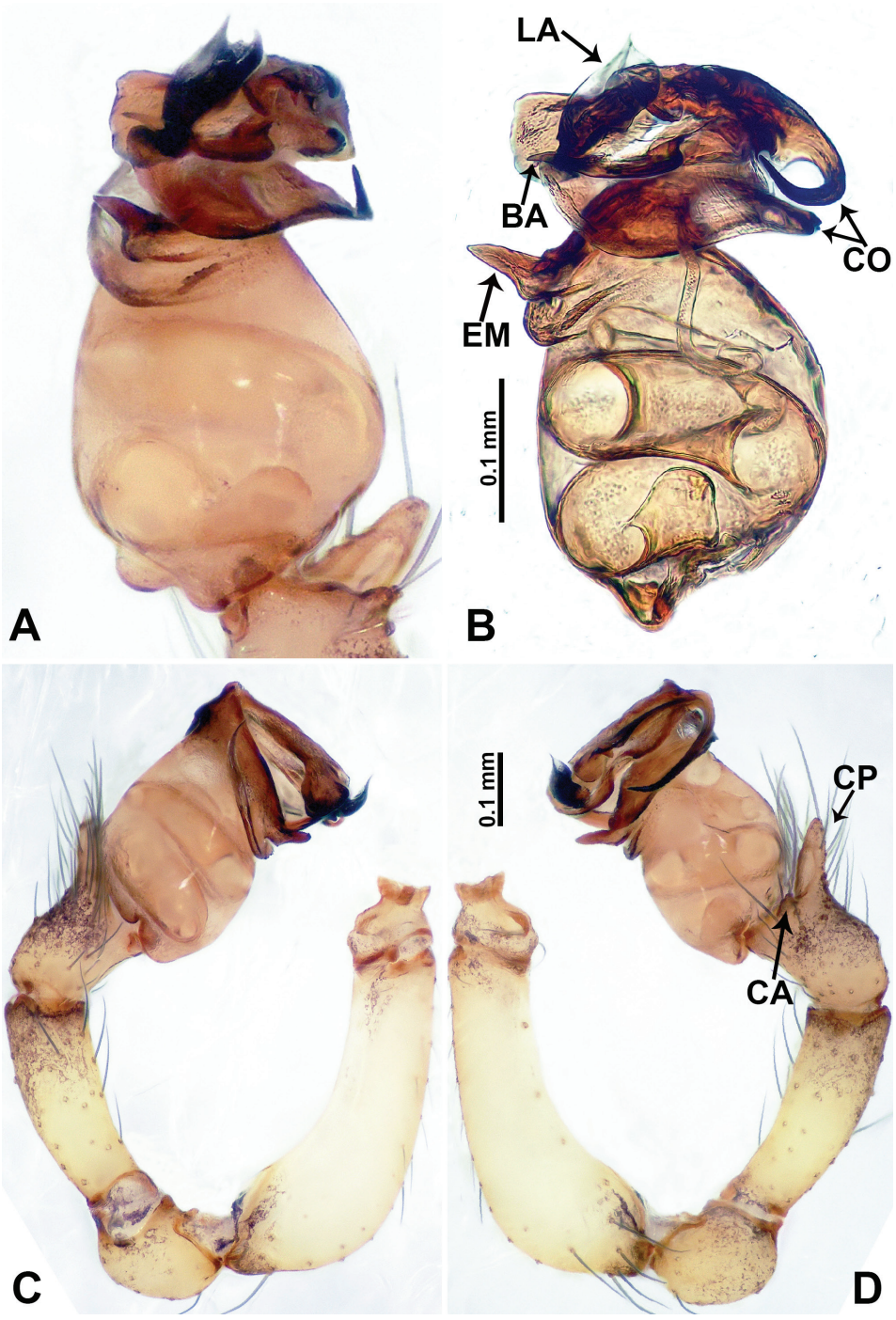

Figure 4. *Flexicrurum yangjiao* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palpal bulb, ventral view **C** palp, prolateral view **D** palp, retrolateral view. Abbreviations: BA = bulbal apophysis, CA = cymbial apophysis, CO = conductor, CP = cymbial protrusion, EM = embolus, LA = laminal apophysis. **A** and **B** share the scale bar as well as **C** and **D**.

ME–ME 0.16, PLE–PLE 0.33, ALE–ME 0.13, PLE–ME 0.19, ALE–PLE 0.13. Clypeus 0.35 high. Leg measurements: I 7.34 (2.00, 0.25, 2.25, 1.75, 1.09), II missing, III 5.10 (1.28, 0.25, 1.75, 1.20, 0.62), IV 6.82 (1.71, 0.31, 2.00, 2.00, 0.80). Internal genitalia: a pair of ovoid ring-shaped spermathecae connected to bow-tie-shaped ducts divided by a pair of distinct vertical ducts, bearing a pair of droplet-shaped ducts laterally (Fig. 3A).

Distribution. Known only from the type locality (Fig. 9).

***Flexicrurum qishi* Li & Li, sp. nov.**

http://zoobank.org/15FA5BD3-172D-4A38-8456-B21BB623D53F

Figs 5–6, 8C, 9

Types. Holotype: ♂ (IZCAS), China, Hainan Island, Tunchang County, Datong Village, Mountain Wolong, 19°27.5450'N, 110°7.3150'E, 248 m, 06.VII.2014, Li F. and Wang X. leg.; **Paratype:** 1♀ (IZCAS), same data as holotype.

Etymology. The species name is a noun in apposition derived from the Chinese pinyin "qíshì" (knight) and refers to the ventral view of the bulb which resembles a piece in international chess game representing a knight (Fig. 6A).

Diagnosis. The species is similar to *Flexicrurum wuzhishanense* sp. nov. Diagnostic features are discussed under *F. wuzhishanense* sp. nov.

Description. Male (Holotype). Total length 2.45; carapace 1.25 long, 0.75 wide; abdomen 1.20 long, 0.68 wide. Carapace round and brown, with three longitudinal dark brown bands, the middle band is 2 times wider than the lateral bands (Fig. 5C). Fovea shallow and dark brown. Anterior part of thoracic region distinctly elevated. Eye sizes and interdistances: ALE 0.08, ME 0.06, PLE 0.05; ALE–ALE 0.28, ME–ME 0.15, PLE–PLE 0.30, ALE–ME 0.16, PLE–ME 0.18, ALE–PLE 0.13. Chelicerae brown. Cheliceral promargin with lamina of three triangular extensions and no teeth, retromargin with two small teeth (Fig. 8C). Clypeus slanting 0.20 high, medially dark brown and two pale areas laterally. Endites dark brown. Labium slanting and dark brown. Sternum circular with brown complex pattern delimiting a 1/3 medial small pale spot anteriorly and bottom margin. Abdomen elongated, dorsum anterior 2/3 with random dark brown spots, posterior 1/3 with horizontal dark brown striated pattern medially, ventrum anterior half with pair of circular pale areas and ovoid epigastric area, posterior half with random irregular dark brown spots. Legs uniformly brown; measurements: missing (detached from specimens, sequence of legs cannot be differentiated). Palp (Fig. 6A–D): femur slender, swollen at the base, patella swollen and angled ventrally (Figs 5C, 6C), tibia swollen and darker distally, cymbium pale, darker distally, with strong lateral protrusion darker distally, bearing posterolateral cymbial apophysis with two bulges (Fig. 6D); bulb pale brown and pyriform, bearing a pointed laminar apophysis, a slender bulbal apophysis adjacent to embolus which is located further away from conductor; conductor comprising two parts (two slender conductors circling inwards) resembling a broken ring; embolus hook-shaped, curving distally (Fig. 6B).

Female (Paratype). General features and coloration similar to male (Fig. 5D–E). Measurements: total length 2.15; carapace 0.75 long, 0.78 wide; abdomen 1.40 long,

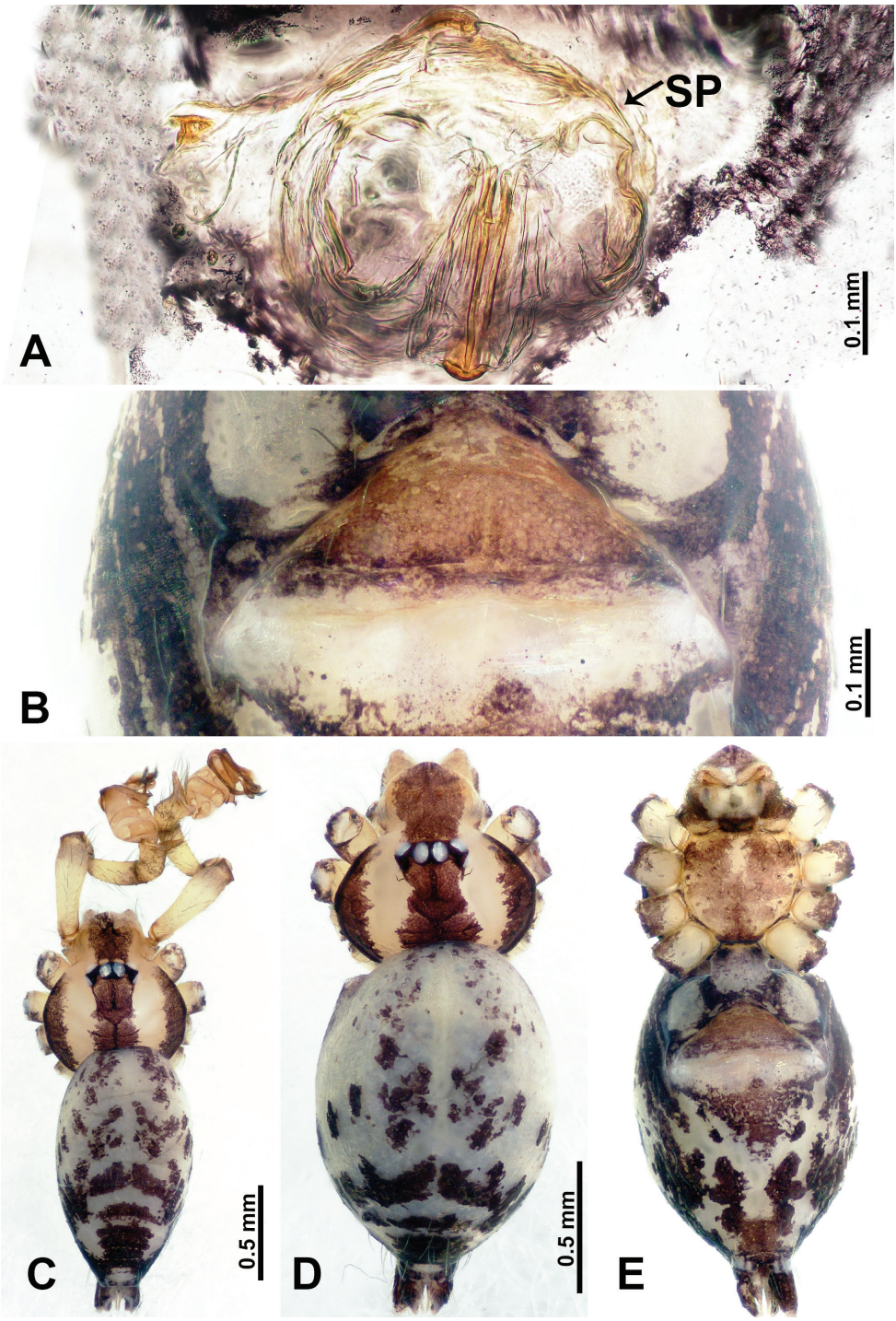

Figure 5. *Flexicrurum qishi* Li & Li, sp. nov., male holotype and female paratype **A** internal genitalia, dorsal view **B** female epigastric area, ventral view **C** male habitus, dorsal view **D** female habitus, dorsal view **E** female habitus, ventral view. Abbreviation: SP = spermathecae. **D** and **E** share the scale bar.

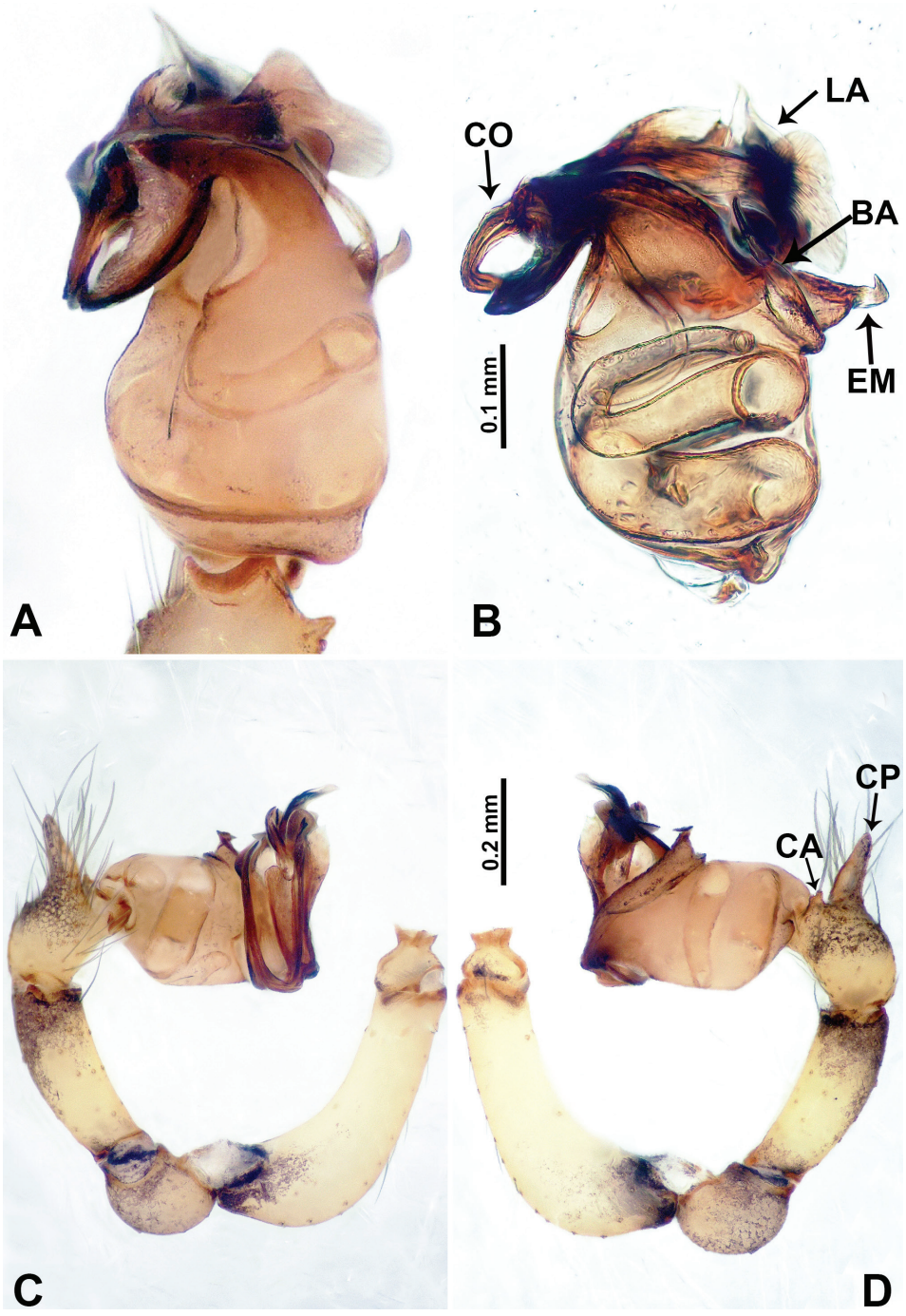

Figure 6. *Flexicrurum qishi* Li & Li, sp. nov., male holotype **A** palp, ventral view **B** palpal bulb, ventral view **C** palp, prolateral view **D** palp, retrolateral view. Abbreviations: BA = bulbal apophysis, CA = cymbial apophysis, CO = conductor, CP = cymbial protrusion, EM = embolus, LA = laminal apophysis. **A** and **B** share the scale bar as well as **C** and **D**.

0.93 wide. Eye sizes and interdistances: ALE 0.09, ME 0.06, PLE 0.05; ALE–ALE 0.29, ME–ME 0.13, PLE–PLE 0.31, ALE–ME 0.16, PLE–ME 0.18, ALE–PLE 0.14. Clypeus 0.23 high. Leg measurements: I missing, II missing, III missing, IV 6.65 (1.80, 0.25, 1.80, 1.87, 0.93). Internal genitalia: a pair of spermathecae resembling the structure of human uterus (distinct pair of lobe-shaped ducts hanging directed posteriorly, medially with a pair of vertical ducts bearing a curvy, flat duct posteriorly) (Fig. 5A).

Distribution. Known only from the type locality (Fig. 9).

Flexicrurum minutum Tong & Li, 2007

Figs 7, 9

Flexicrurum minutum Tong and Li, 2007: 65, figs 1I–L, 4A–E; Tong, 2013: 20, figs 16I–L, 35A–E

Type examined. Holotype: ♂ (IZCAS), China, Hainan Island, Changjiang County, Bawangling National Natural Reserve, 22.III.2005.

Other material. ♀ (IZCAS), China, Hainan Island, Dongfang City, Donghe Town, Nanlang Village, foot of Mountain E-Xian, 19°0.3800'N, 109°5.0300'E, 214 m, 16.XII.2014, Zhao Q. and Shao L. leg.

Description. Female. Total length 2.34; carapace 0.78 long, 0.75 wide; abdomen 1.56 long, 0.87 wide. Carapace round and brown, with three longitudinal dark brown bands, the middle band is 2 times wider than the lateral bands (Fig. 7C). Fovea shallow and dark brown. Anterior part of thoracic region distinctly elevated. Eye sizes and interdistances: ALE 0.08, ME 0.06, PLE 0.05; ALE–ALE 0.31, ME–ME 0.15, PLE–PLE 0.33, ALE–ME 0.14, PLE–ME 0.18, ALE–PLE 0.15. Chelicerae brown. Cheliceral promargin with lamina of three triangular extensions and no teeth, retromargin with two small teeth (Tong and Li 2007). Clypeus slanting 0.24 high, dark brown. Endites dark brown. Labium slanting and dark brown. Sternum circular with brown complex pattern delimiting a medial ovoid pale spot anteriorly. Abdomen elongated, dorsum anterior 2/3 with dark brown striated spacing delimiting a pale area medially, posterior 1/3 with horizontal dark brown striated pattern medially, ventrum with brown pattern at margin and anterior half medially pale with an ovoid epigastric area, posterior half with random irregular dark brown pattern (Fig. 7D). Legs uniformly brown; measurements: I 7.85 (2.24, 0.25, 2.40, 1.87, 1.09), II 5.76 (1.60, 0.25, 1.60, 1.56, 0.75), III 5.02 (1.75, 0.20, 1.20, 1.25, 0.62), IV 7.11 (1.87, 0.25, 2.12, 2.00, 0.87). Internal genitalia: a pair of umbrella-shaped spermathecae (a pair of vertical ducts posteriorly connected with pair of ovoid vesicle and covered by a dome anteriorly) (Fig. 7A).

Distribution. Hainan Island, China (Fig. 9).

Remarks. The female was matched with the holotype male on the basis of proximity of its collection location to the type locality (only about 30 km away), similarities in somatic morphology with the holotype male, and from DNA barcoding data.

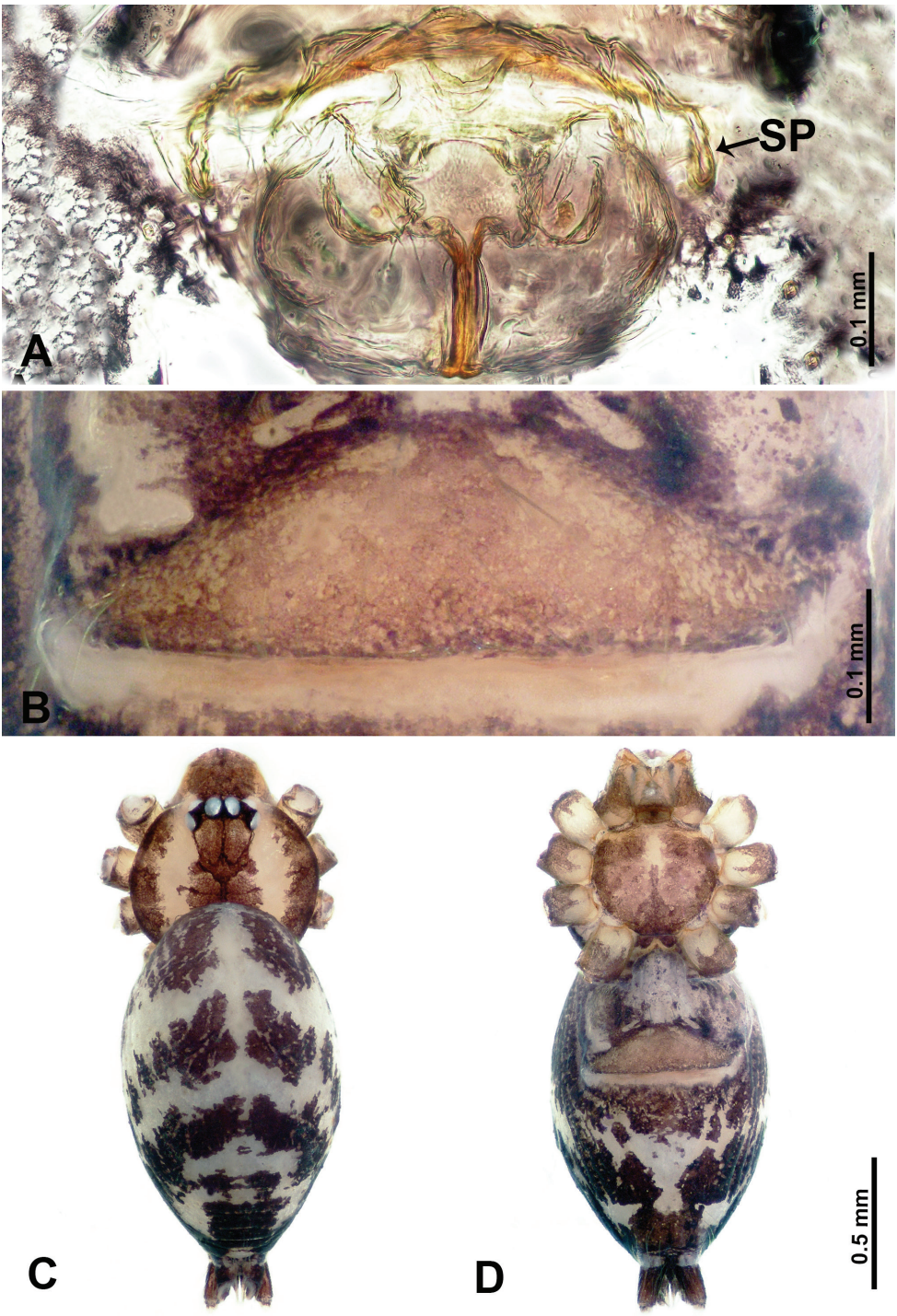

Figure 7. *Flexicrurum minutum* Tong & Li, 2007, female **A** internal genitalia, dorsal view **B** female epigastric area, ventral view **C** female habitus, dorsal view **D** female habitus, ventral view. Abbreviation: SP = spermathecae. **C** and **D** share the scale bar.

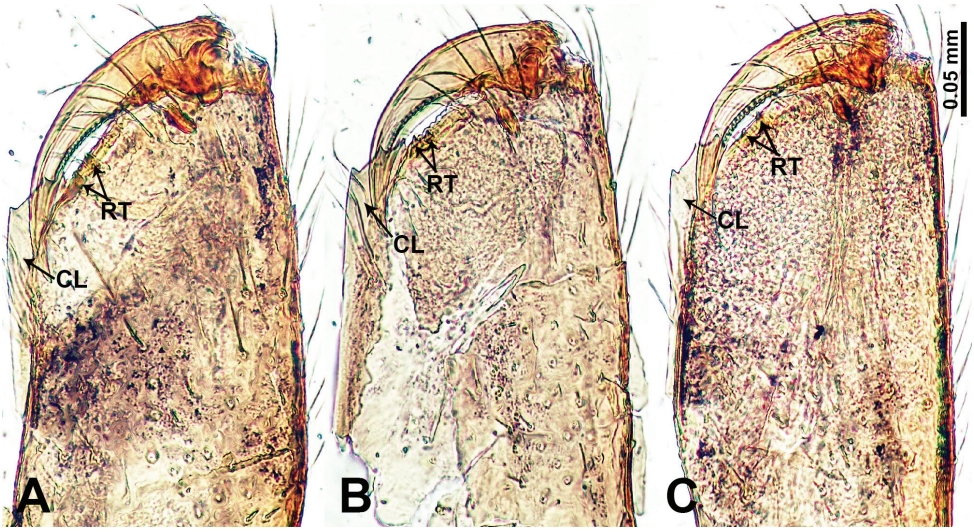

Figure 8. Cheliceral retromargin **A** *Flexicrurum wuzhishanense* Li & Li, sp. nov. **B** *F. yangjiao* Li & Li, sp. nov. **C** *F. qishi* Li & Li, sp. nov. Abbreviations: CL = cheliceral laminal, RT = retromargin teeth. **A, B** and **C** share the scale bar.

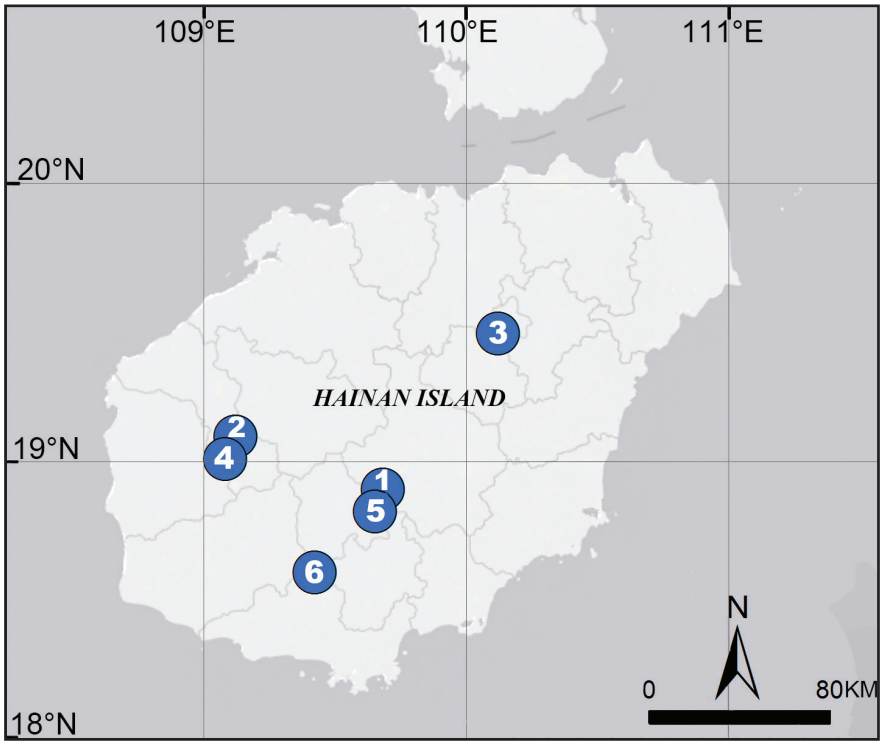

Figure 9. Distribution of *Flexicrurum* species in Hainan Island, China. 1. *F. wuzhishanense* Li & Li, sp. nov., 2. *F. yangjiao* Li & Li, sp. nov., 3. *F. qishi* Li & Li, sp. nov., 4. *F. minutum* Tong & Li, 2007, 5. *F. flexicrurum* Tong & Li, 2007, 6. *F. longispina* Tong & Li, 2007.

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RESEARCH ARTICLE

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Isotomidae of Japan and Asiatic part of Russia. II. The genus *Tetracanthella* of the Far East

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Abstract

The paper considers new and little-known species of the genus *Tetracanthella* distributed in the Far East of Russia and in Japan. Sensillar chaetotaxy and labial palp, two less known morphological characters for the genus, are discussed. Two new species *T. annulata* **sp. nov.** and *T. tardoki* **sp. nov.** are described; *T. manschurica* Kutyreva, 1980 and *T czernovae* Kutyreva, 1980 are redescribed. For the latter species a lectotype and paralectotypes are designated. Remarks are provided for *T. sylvatica* Yosii, 1939. A second undescribed species is recorded for Japan. New records for *T. orientalis* Martynova, 1977 and *T. sibirica* Deharveng, 1987 are listed.

Keywords

α-taxonomy, Collembola, the Far East of Russia, Japan

Introduction

Tetracanthella is a typically Holarctic genus and is one of largest in the family (Deharveng 1987). The maximal diversity is located in Europe where 80 species are known. The Asiatic fauna is less understood but is obviously not so rich. So far only 17 species are recorded in Asia. Our study is a result of examination of large collections coming from the Far East of Russia. In the area under study, the species of the genus is a rather rare and unpredictable component of Collembolan communities. Ecological

niche of the genus is more limited here than in Europe: corticolous species absent, high mountain forms are very rare (*T. tardoki* sp. nov.). Most east-Asiatic species of *Tetracanthella* are damp litter dwellers. Taxonomically, the species belong to Asiatic or American groups ('*sylvatica*', '*stebaevae*', and '*ethelae*' groups). Few species (*T. martynovae* and *T. sibirica*) occurs only in the arctic zone of the Far East and belong to generally European '*wahlgreni*' group. We list below all the species of the region, redescribe little-known species, and describe two new ones. This paper is our second special contribution to taxonomy of Asiatic species of Isotomidae of Russia and Japan (Potapov et al. 2018). Following our results, the fauna of *Tetracanthella* of the Far East of Russia and Japan is represented by eight and two species, respectively, including still undescribed forms.

Abbreviation used

A, B, C, D, E	papillae of labial palp following notation of Fjellberg (1999)
A.B.	A. Brinev
A.F.	A. Fjellberg
A.G	A. Geras'kina
A.K.	A. Kuprin
a1	medial mesochaetae on Abd.V
a2	medial macrochaetae on Abd.V
Abd.	abdominal segments
Alt	altitude
Ant.	antennal segments
Ap	unpaired chaetae in anterior part of head
B5, X	chaetae on tibiotarsus 3 following notation of Deharveng (1983)
dA, dH	diameter of ocellus A and H
eAS	external pair of anal spines
M.P.	M. Potapov
Md, Mdl, Ml	macrochaetae in dorsal, dorso-lateral and lateral position
ms	micro s-chaeta(e) or ms-chaeta(e)
MSPU	Moscow State Pedagogical University
PAO	postantennal organ
N.K.	N. Kuznetsova
p1, p3	chaetae of p-row on tergites
PAO	postantennal organ
pc3	chaetae of p-row on head following notation of Deharveng (1987)
pp	chaetae of pp-row on head following notation of Deharveng (1987)
s	in the text and figures, macro s-chaeta(e) or s-chaeta(e)
s'	male s-chaeta on Ant.3 in lateral position
Th.	thoracic segments.

Towards the knowledge of the taxonomic characters regarding the species of the Far East of Russia

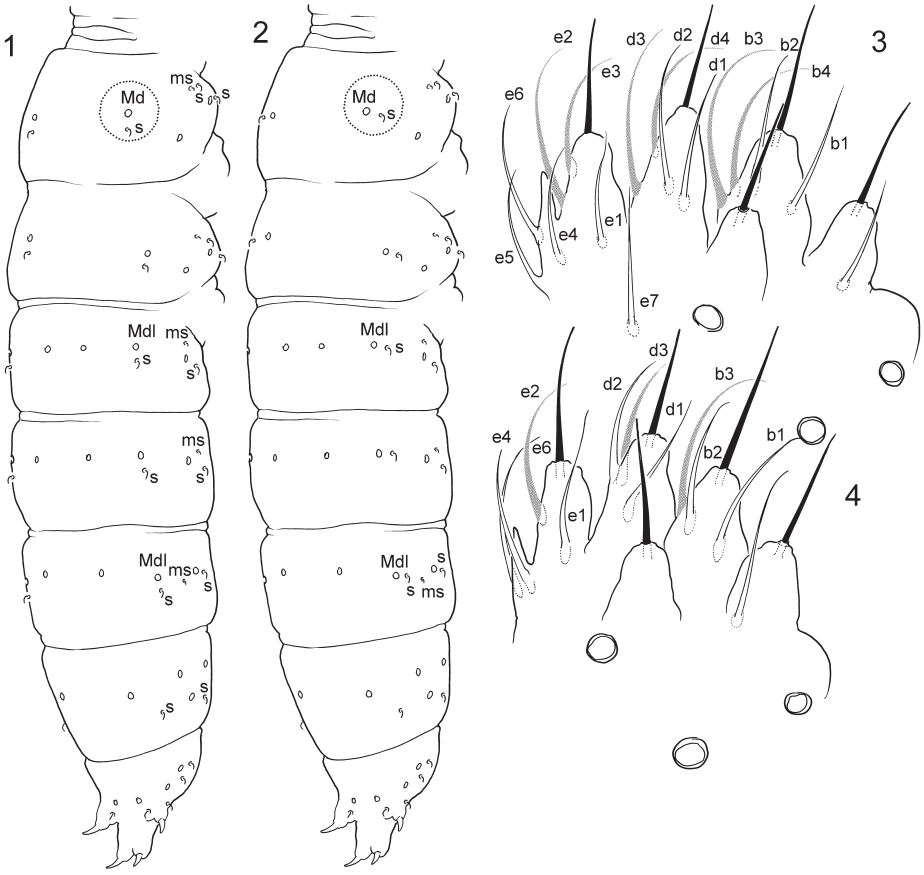
S-chaetae on tergites. In his monograph Deharveng (1987) referred this character to be not of great value to identify the species of the genus. Number of s-chaetae is very conservative in the genus indeed, and probably all species obviously possess 3,3/2,2,2,2,4 s-chaetae, that should be confirmed since this is unknown for several species. The invariable set of s-chaetae is an additional confirmation of the monophyly of the genus. The only key taxonomic character of the genus is four anal spines on Abd.V that is not very safe if considering the independent appearance of spines in the evolution of the family (Deharveng 1978, Potapov et al. 2017). Concerning ms-chaetae, complete set (1,1/1,1,1, Figs 21, 22) is probably shared by almost all species, while, in Far East, *T. orientalis* and *T. tardoki* sp. nov. lost three ms-chaetae resulting 1,0/1,0,0 formula (Figs 46, 47) that is unique for the genus so far. Unlike number, the position of s-chaetae is more variable: the relative position of medial s-chaetae and macrochaetae can differentiate groups of species (Potapov 2001). Medial s-chaetae are situated either behind Mdl macrochaetae ('*alpina*', '*ethelae*', '*cassagnaui*', and '*wahlgreni*' groups: Fig. 1) or between Mdl and Ml macrochaetae ('*grinbergsi*', '*stebaevae*', and '*sylvatica*' groups: Fig. 2). The former type is a characteristic of European and American groups while the latter one relates to Asiatic ones. This character was not indicated in the descriptions of all species of the genus and exceptions are possible. The European '*pilosa*' group shows rather the "European-American" s-pattern although a few its members show considerable shift of medial s to lateral position. According to figures, at least, in *T. doftana* Fiera, Konikiewicz, Skarżyński, 2013, *T. strenzkei* Gisin, 1949, and *T. gallica* Deharveng, 1987, these s-chaetae are situated behind and lateral to Mdl on abdominal tergites (Deharveng 1987, Fiera et al. 2013).

Labial palp. The character is poorly studied for the genus but appears to be promising at least at level of species group. After Fjellberg (1999, Fig. 51) and Smolis and Skarżyński (2006, Figs 12, 32) six *Tetracanthella* species ('*wahlgreni*', '*alpina*', and '*pilosa*' groups) from Scandinavia and Poland show reduced A(1)B(3)C(0)D(3)E(5) set in which four guards are lost. In East Asia the species of '*stebaevae*' and '*sylvatica*' groups have complete set [A(1)B(4)C(0)D(4)E(7)], and two young "afurcated" species of '*ethelae*' group lost five guards giving A(1)B(3)C(0)D(3)E(4) formula (Figs 3 and 4, respectively).

List of the species of *Tetracanthella* of the Far East of Russia (R) and Japan (J)

'*sylvatica*' group
Tetracanthella annulata sp. nov. (R)
Tetracanthella manschurica Kutyreva, 1980 (R)
Tetracanthella sylvatica Yosii, 1939 (J)
Tetracanthella sp. 1 (R)

'*stebaevae*' group
Tetracanthella czernovae Kutyreva, 1980 (R)
Tetracanthella sp. 2 (J)
'*ethelae*' group
Tetracanthella orientalis Martynova in Martynova et al. 1977 (R)
Tetracanthella tardoki sp. nov. (R)
'*wahlgreni*' group
Tetracanthella martynovae Potapov, 1997 (R)
Tetracanthella sibirica Deharveng, 1987 (R)



Figures 1–4. *Tetracanthella* spp. **1–2** typical sensillar patterns of western (**1**) and eastern (**2**) groups of species **3–4** labial palp in *T. sylvatica* (**3**) and *T. tardoki* sp. nov. (**4**) Abbreviations: Md, Mdl-dorsal and dorso-lateral macrochaetae.

Species of the '*sylvatica*' group

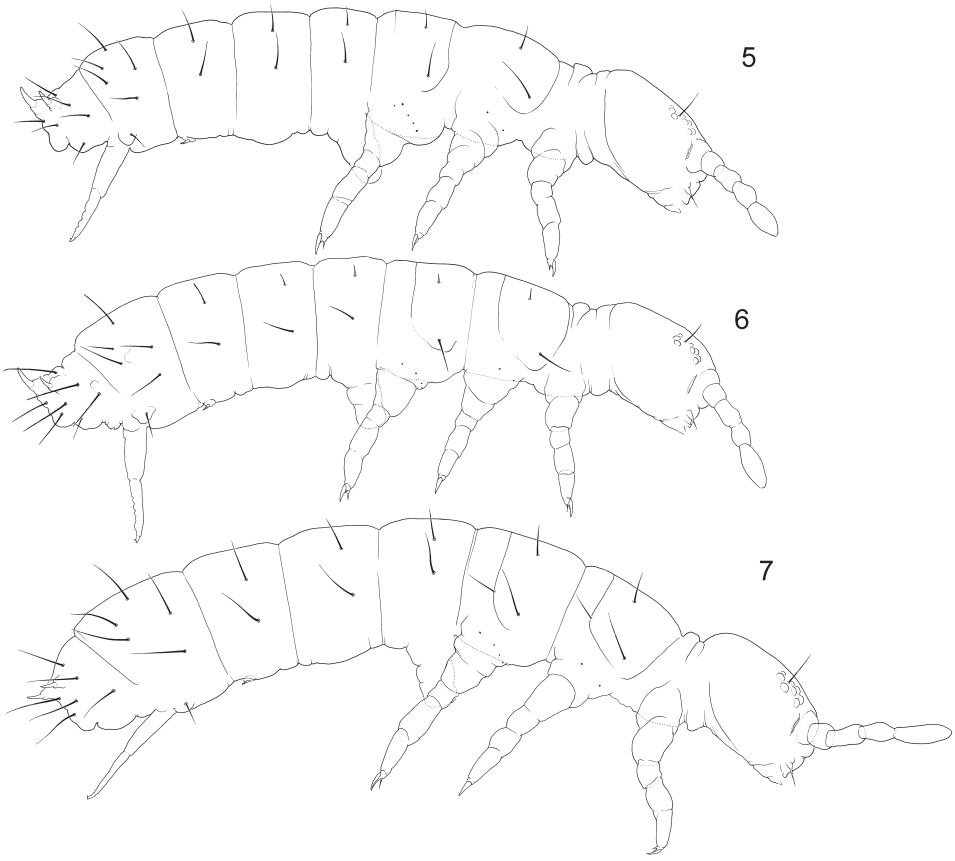
***Tetracanthella annulata* sp. nov.**
http://zoobank.org/5ABA38DC-0298-4CB7-BC5F-00CDA6CDE57B
Figs 6, 8–20, 51, 58

Type material. Holotype: subadult female, Russia, Far East, Primorye, Terneyski District, Sikhote-Alinski Reserve, Kabani station, 900 m alt., 45.14122°N, 135.87759°E, coniferous forest with *Rhododendron fauriei*, rotten wood, 8.08.2017, leg. N.K., A.G., A.K. Three paratypes: nearly the same place, 932 m alt., 45.13840°N, 135.88702°E, leg. N.K., A.G., A.K.; seven paratypes: Sikhote-Alinski Reserve, Blagodatny station, 95 m alt., 44.96670°N, 136.53410°E, oak forest, rotten wood, 7.08.2017, leg. N.K., A.G., A.K.

Other material (all from the Far East of Russia): **Primorski Krai: Shkotovski district**, Livadiysky Range, Pidan Mt., rotten wood, ~800 m alt., 20.09.2004, leg. M.Potapov; ibidem, trail to Falaza Mt., ~600 m alt., mosses on rotten wood, 08.09.2018, leg. M.P., A.K.; **Primorski Krai, Khasanski district**, "Kedrovaya Pad " Reserve, valley of Kedrovaya River, cedar litter of mixed forest, 29.09.2004, leg. M.P.; ibidem, 5 km of trail to Central shelter, valley mixed forest, rotten wood, 29.07.2016, leg. N.K., M.P.; ibidem, right bank of Kedrovaya River, 2nd Zolotisti Spring, coniferous litter, 14.07.2013, leg. S. Spiridonov; **Primorski Krai, Lazovsky district**, in mountains nearby Preobrazheniye, Sredni stream (tributary of Maralovaya (valley of Sokolovka River), mixed forest, rotten wood, 21.09.2011, leg. M.P.; **Primorski Krai, Terneyski district**, Ostraya Mt., litter, 02.06–04.06.2018, leg. A.K.; Sikhote-Alinski Reserve, Kabani station, 900 m alt., 45.14122°N, 135.87759°E, coniferous wood with *Rhododendron fauriei*, rotten wood, 8.08.2017, leg. N.K., A.G., A.K.; ibidem, 932 m alt., 45.13840°N, 135.88702°E; Sikhote-Alinski Reserve, Blagodatny station, oak wood, rotten wood, 7.08.2017. 95m alt., 44.96670°N, 136.53410°E; leg. N.K., A.G., A.K. **Primorski Krai, Partyzanski district**, Olkhovaya Mt., 540 m alt., 43.3058°N, 133.6679°E, rotten wood in mixed forest, 20.08.2018, leg. M.P., A.K.

Khabarovski Krai, Nanaiski District, Anyuiski National Park, Tormasu River, mixed forest, rotten wood, 204 m alt., 49.30332°N, 137.57004°E, 07.08.2018, leg. N.K., A.G., A.K.; ibidem, Anyuiski National Park, Anyui River, mixed forest, rotten wood, 205 m alt., 49.36350°N, 137.70227°E; Komsomolsk-Khabarovsk road, 270 km, cedarn-large-leaved valley forest, litter, 42 m alt., 048.93659°N, 136.33167°E, leg. N.K., A.G., A.K.; **Khabarovski Krai, Komsomolski District**, Komsomolski Reserve, foothills of Sergol Mt., aspen-oak forest, rotten wood, 259 m alt., 50.73823°N, 137.40182°E, 11.08.2018, leg. N.K., A.G., A.K.; ibidem, Komsomolski Reserve, Sergol Mt., mixed forest with cedar, rotten wood, 228 m alt., 50.73710°N, 137.39772°E, 11.08.2018, leg. N.K., A.G., A.K.; Komsomolski District, Komsomolsk–Khabarovsk road, 85 km, 1,5 km from Gorely Klyuch Stream, mixed forest, rotten wood, 50.21810°N, 137.33202°E, 12.08.2018, leg. N.K., A.G., A.K.

Amurskaya Region, Arkharinski district, Khinganski Reserve, 10 km E Uril, coniferous forest, litter, 07.10.2009, leg M.Babykina.

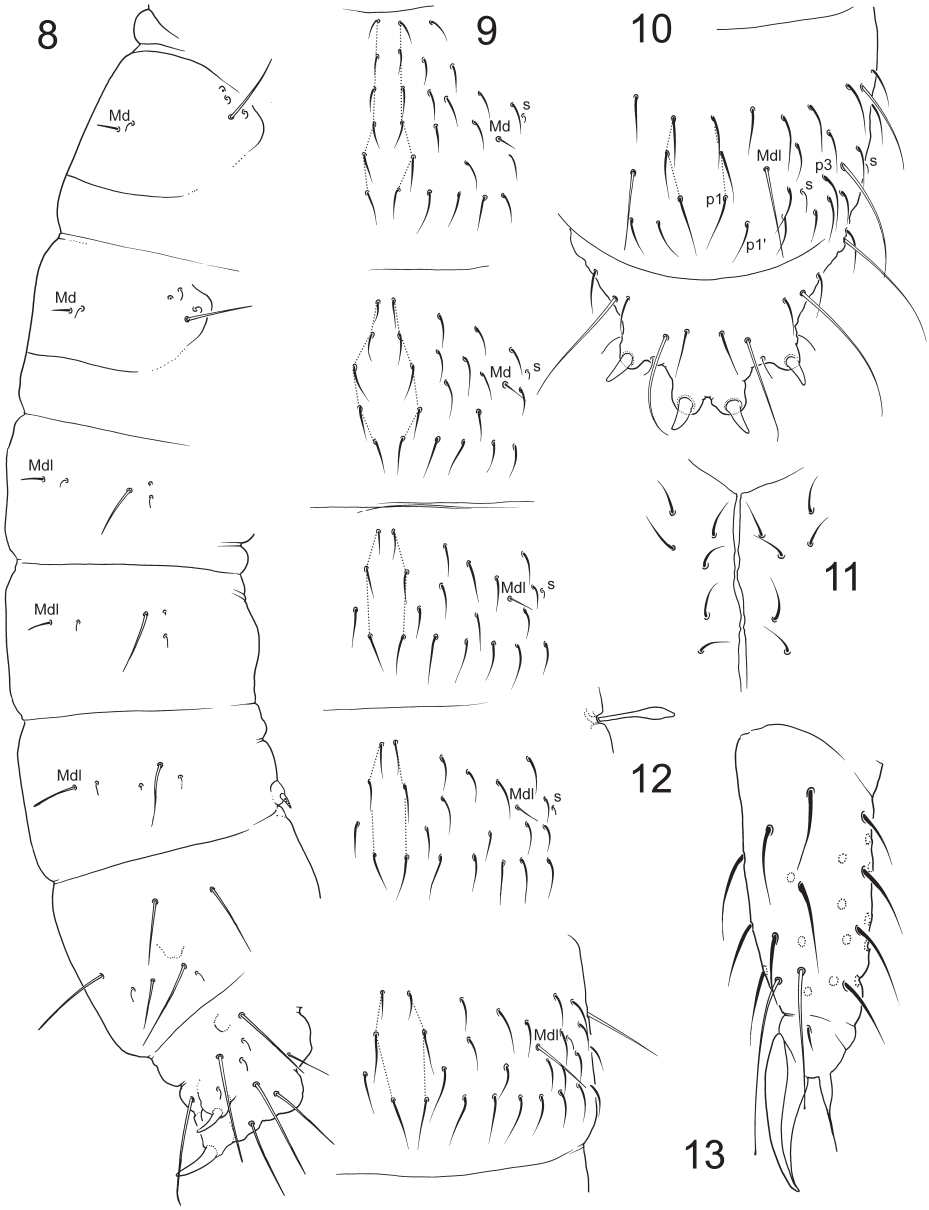


Figures 5–7. Appearance and macrochaetotaxy of *Tetracanthella* '*sylvatica*' group **5** *T. sylvatica* **6** *T. annulata* sp. nov. **7** *T. manschurica*.

Diagnosis. Coloration spotty, from dark to light grey. Coxa I without an external chaeta. Macrochaetotaxy: 2,2/2,2,2. Dens long, with clear crenulations, without anterior and normally with seven posterior chaetae.

Description. Body length 0.9–1.5 mm. Body cylindrical, not narrowing (Fig. 6). Coloration spotty, from dark to light grey, ventral side of corpus paler, often not pigmented. Pigmentation of antennae vary, paler than other parts of the body, sometimes colorless. Largest polygons much larger than mesochaeta sockets, canals between polygons broad, clearly marked (Fig. 51). No smooth fields. Dorsal mesochaetae long, not shortened in axial part of tergites, in posterior row of Abd. IV not longer than on other parts of body (Md : p1 = 1.8–2.5). Abd. IV with p3 longer than p1 (p3 : p1 = 1.2–1.8) (Fig. 10). Macrochaetae usually blunt and plain at tip.

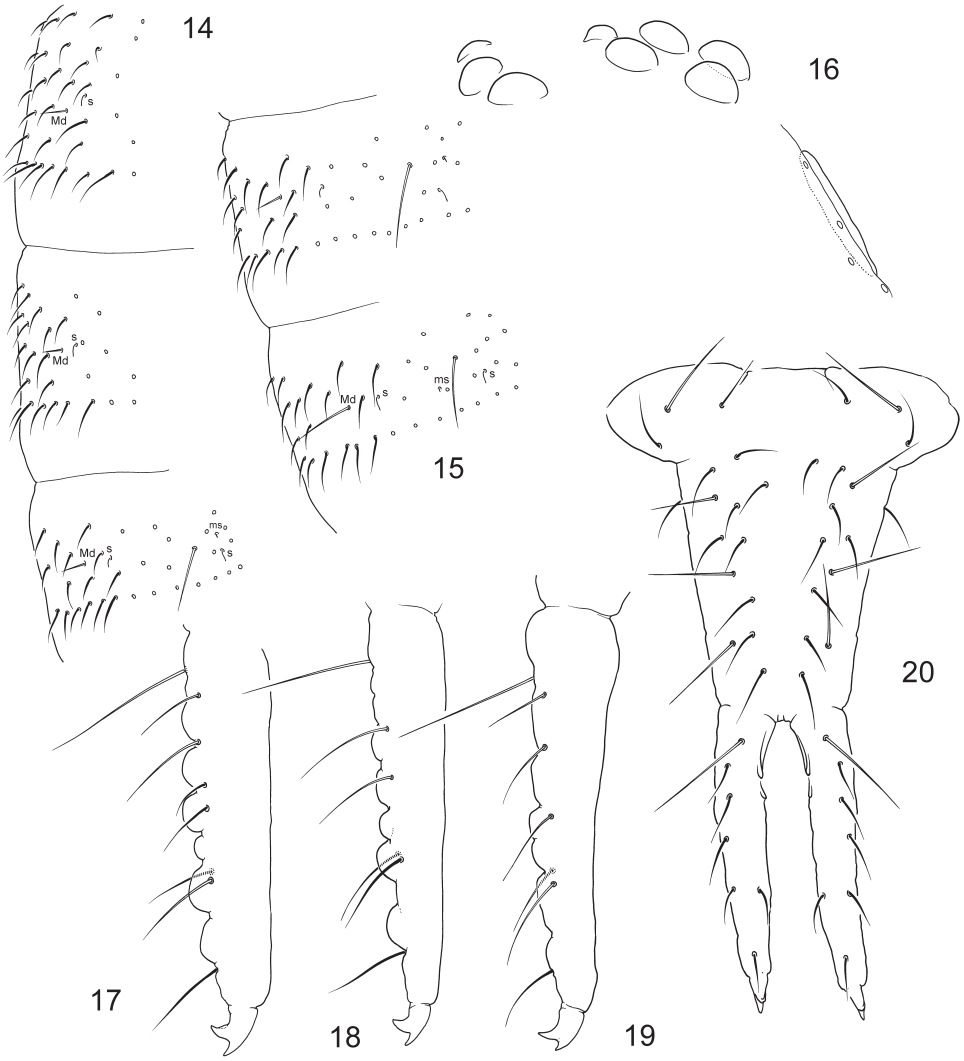
8+8 ocelli, G and H reduced (dA : dH = 1.5–2.0). PAO 1.9–2.7 times as long as the diameter of ocellus A (Fig. 16). Chaeta s' of Ant.III in males absent. Four prelabral chaetae. Outer maxillary lobe with four sublobal hairs and simple maxillary palp. Labium with with complete set of guards [A(1)B(4)C(0)D(4)E(7)], three proximal



Figures 8–13. *Tetracanthella annulata* sp. nov. **8** position of macrochaetae and s-chaetae on corpus **9–10** dorsal chaetotaxy of Th.II–Abd.III (**9**) and Abd.IV (**10**), dorsal view **11** postlabial area **12** spur of Leg 3 in adult male **13** distal part of leg 3.

and four basomedian chaetae. Postlabial chaetae 4+4 (Fig. 11). Five chaetae between medial line and pc3 on head. Frontal chaeta ap present.

Axial chaetotaxy: 12–14,10/6,6,6,6 (without chaetae in Md-position on Abd.I–III and p1' chaetae on Abd.IV) (Figs 9, 10). Macrochaetotaxy: 2,2/2,2,2. Md macrochae-



Figures 14–20. *Tetracanthella annulata* sp. nov. **14–15** dorsal chaetotaxy of Th.II–Abd.I (**14**) and Abd.II–III (**15**) lateral view **16** PAO and ommatidia **17–19** variation of dens, lateral view **20** furca, posterior view.

tae on Th.II and III and Mdl macrochaetae on Abd.I and II short (Figs 8, 14, 15). Corner mesochaetae on Th. II and III not stronger than other mesochaetae of p-row. Number of s-chaetae: 3,3/2,2,2,2,4 (s), 1,1/1,1,1 (ms) (Fig. 8). S-chaetae of medium size, medial ones on Abd. I–III arranged lateral to Mdl macrochaetae. Sternite of Th. III without chaeta.

Coxa I without an external chaeta. Tibiotarsi with 1,2,2 clavate dorsal tenent hairs (Fig. 13) and 1,1,0 ventral pointed long hairs. Males with chaeta B5 and X on tibiotarsi III expanded, spatula-like (Fig. 12), these chaetae thin in females. Tibiotarsi I, II, III with 21, 21, 25 chaetae. Claw untoothed, empodial appendage long, 0.6–0.8 as

long as inner edge of claw, with long apical filament (Fig. 13). Ventral tube with 3+3 latero-distal and four posterior chaetae.

Retinaculum with a chaeta and 4+4 teeth, basal tooth smaller. Anterior furcal subcoxa with 8–9 (rarely seven or ten) chaetae, posterior one with 5–6 (rarely four or seven) chaetae. Dorsal side of manubrium with 3+3 laterobasal chaetae and 11+11 (sometimes ten or 12 on one side) chaetae on main part (14+14 at whole), besides with a chaeta on each lateral side (Fig. 20). Mucro bidentate, small. Dens long, always with clear crenulations, without anterior and with 6–8 (normally 7, rarely 9) posterior chaetae (Figs 17–19). Dens : claw III = 3.5–4.3. Manubrium : dens : mucro = 8–12 : 8–12 : 1.

Anal spines parallel, large, on moderate papillae. Medial mesochaetae (a1) of Abd. V slightly in front of medial macrochaetae (a2). Arrangement of chaetae and spines on dorsum of Abd V as a2-a2/a1-a1 =2.1–2.3; a2-a2/a2-eAS = 1.7–1.8 (Fig. 10). Males present.

Etymology. The species is characterized by annulated posterior side of dens.

Distribution and ecology. The species is widely distributed in southern areas of the Far East of Russia (Primorsky Krai, Khabarovsky Krai and Amurskaya District), both in flatland and in the mountains (Fig. 58). It prefers rotten wood although occurs in forest litter.

Discussion. The new species belongs to '*sylvatica*' group and differs from all species of the group by absence of chaetae on anterior side of dens. The disproportion of anterior and posterior number of chaetae on dens (0 vs. ~7), clear humps on posterior side of dens and grey coloration make *T. annulata* sp. nov. unmistakable in the area of its distribution.

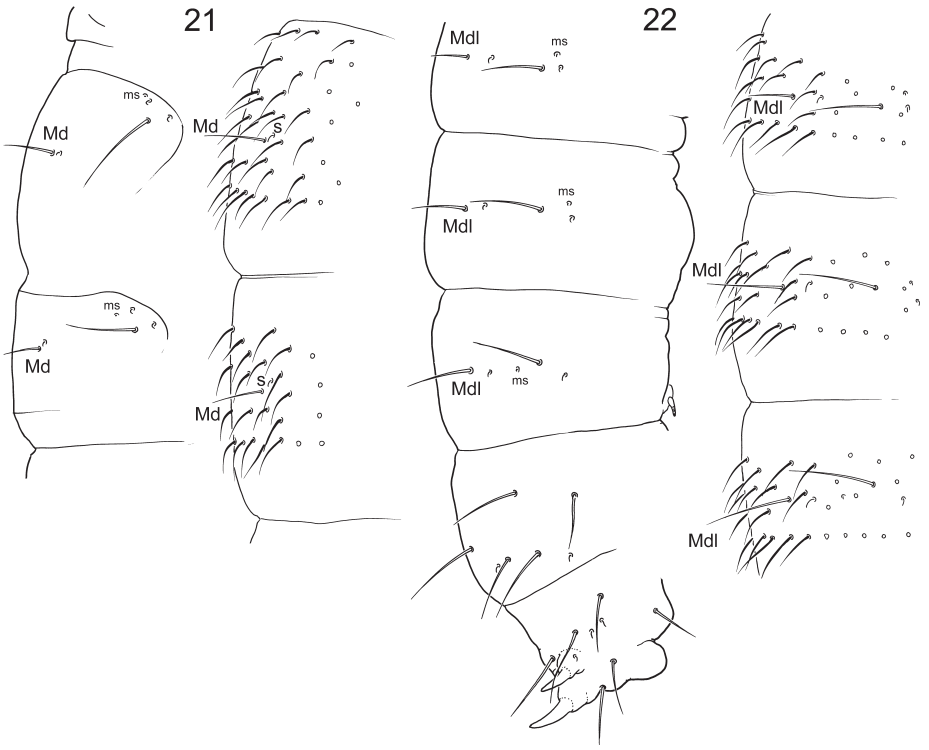
Tetracanthella sylvatica Yosii, 1939

Figs 3, 5, 21, 22, 52, 58

Material. Japan, Honshu, Kyoto, Kamigamo experimental forest in Kyoto University, 2011, leg. S. Fujii.

Distribution. *Tetracanthella sylvatica* was described from Osaka (central Honshu) and was numerously recorded around here afterwards, particularly from Kamigamo Experimental Forest of Kyoto University (e.g., Takeda 1973, Deharveng 1987, Fujii et al. 2014). A few records are known from Shikoku and more northern areas of Honshu (Yosii 1969, Tamura and Chiba 1977, Yamauchi and Suma 1999, 2009, Nakamura et al. 2006, Niijima 1976) (Fig. 58). The species was recorded once from Hokkaido (Suma 1990).

Discussion. The remarks to chaetotaxy of the species were given by Yosii (1961), the complete redescription was provided by Deharveng (1987). After our materials, the species has complete set of guards in labial palp (Fig. 3) that is common for the species of eastern groups ('*sylvatica*', '*stebaevae*', '*grinbergsi*'). *Tetracanthella sylvatica*, *T. annulata* sp. nov., and *T. dorsoduplex* Xie, Potapov, Sun, 2019 combine a natural group of species distributed in East Asia. They share long furca with annulated dorsal side of dens, well developed reticulation with broad canals between polygons (Figs 51–52), and few macrochaetae on body tergites. *Tetracanthella sylvatica* differs from other two species by better develop-



Figures 21–22. *Tetracanthella sylvatica*, position of macrochaetae and *s*-chaetae on thorax (**21**) and abdomen (**22**).

ment of medial macrochaetae on body (Figs 5, 21, 22), from *T. annulata* sp. nov. by the presence of anterior chaeta on dens, from *T. dorsoduplex* by common position of lateral s on Abd.IV. The specimens from Kamigamo have 3+3 postlabial chaetae that could be an additional differentiated character of the species if confirmed by wider Japanese materials.

In the alpine zone of Ezop Range (western part of Khabarovski Krai, leg. A.B.) we discovered a form which shares many essential characters with typical *T. sylvatica* from which it differs by larger body (~2 mm), 4+4 postlabial chaetae and absence of annulations on posterior side of dens.

Tetracanthella manschurica Kutyreva, 1980

Figs 7, 23–35, 53, 58

Material (all from the Far East of Russia): Khabarovski Krai, Imeni Lazo district, upper flux of Katen River, Ko Mt., upper part of Ko Stream, ~970 м alt., 29.06.2018, soil in coniferous forest, A.B.; Khabarovski Krai, Vaninski district, ~14 km N Vysokogorny, upper flux of Mulinka River, closed spruce forest at pass, ~900 m alt., 29.09.2011, leg. M.P.; Primorski Krai, Partyzanski district, Olkhovaya Mt., 1380 m

alt., 43.3375°N, 133.6615°E, spruce litter, 20.08.2018, leg. M.P., A.K.; Primorski Krai, Chuguevski district, Oblachnaya Mt., 1230 m alt., 43.6483°N, 134.1978°E, spruce litter, 19–20.09.2018, leg. A.K.; Primorski Krai, Chuguevski district (unprecise locality), spruce forest, 8.09.1973, leg. L. Kutyreva.

Description based on the aforementioned specimens. Body length 1.6–1.9 mm. Body thick, tubular, not narrowed (Fig. 7). Coloration dark blue, distal half of antennae white. Reticulation very thin, polygons much smaller than mesochaeta socket (Fig. 53). No smooth fields. Size of dorsal mesochaetae variable (see the Remarks part), not shortened in axial part of tergites (Md : p1 = 1.3–1,5). Abd. IV with p3 subequal to p1. Macrochaetae acuminate.

8+8 ocelli, G and H smaller. PAO short, 1.1–1.6 as long as the diameter of ocellus A (Fig. 28). Chaeta s' of Ant.III in males absent. Four prelabral chaetae. Outer maxillary lobe with four sublobal hairs and simple maxillary palp. Labium with complete set of guards [A(1)B(4)C(0)D(4)E(7)], three proximal and four basomedian chaetae. Postlabial chaetae 4–5+4–5. With 8–10 chaetae between medial line and pc3 on head. Frontal chaeta ap present.

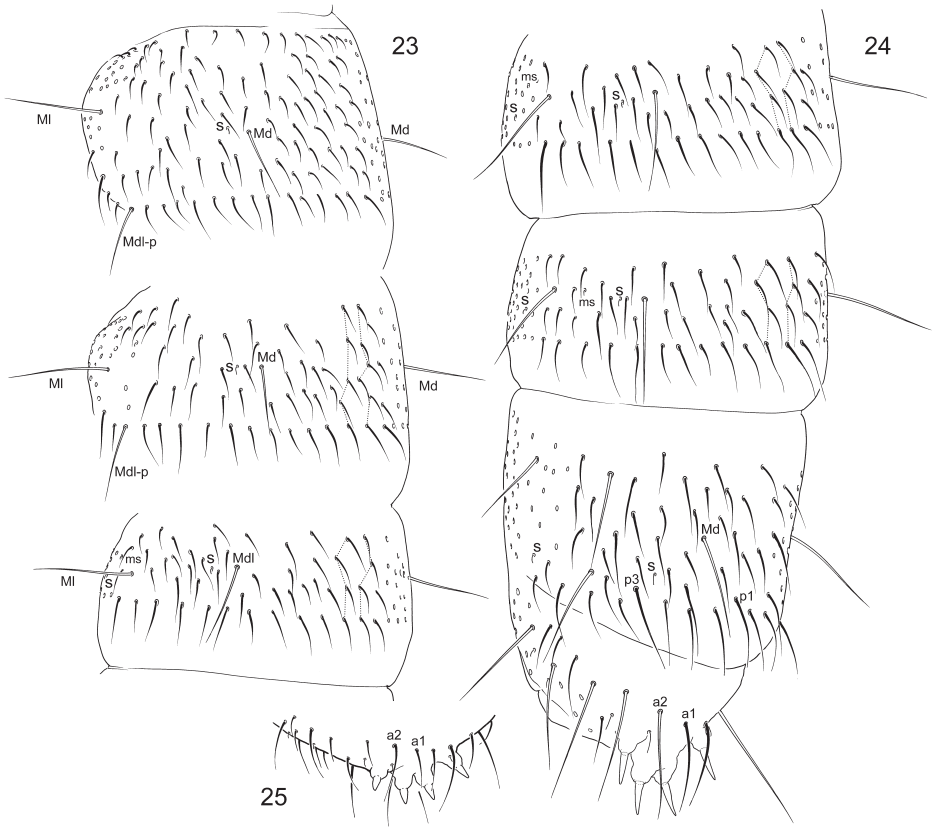
Chaetotaxy abundant (Figs 23, 24). Axial chaetotaxy often asymmetrical 12–14,8/8,8,8,8–10 Macrochaetotaxy: 3(W),3(W)/2,2,2 (Fig. 27). Mdl macrochaetae in p-row on Th. II and III. Number of s-chaetae: 3,3/2,2,2,2,4 (s), 1,1/1,1,1 (ms) (Fig. 27). S-chaetae short, medial ones on Abd. I–III arranged lateral to Mdl macrochaetae. Sternite of Th. III without chaetae.

Coxa I without an external chaeta. Tibiotarsi with 1,2,2 long and clavate dorsal tenent hairs and without well developed ventral tenent hairs. Tibiotarsi with many additional chaetae on all legs, tibiotarsi I and II with 26–28 chaetae each, III with more than 30 chaetae (Fig. 34). Empodial appendage 0.7–0.8 as long as inner edge of claw, with apical filament.

Ventral tube with 3+3 laterodistal and four posterior chaetae. Retinaculum with 4+4 teeth and a chaeta. Anterior furcal subcoxa with 10–17 chaetae, posterior one with 3–4 chaetae (Fig. 33). Posterior side of manubrium with 6(7)+6(7) chaetae on main part and 3+3 on basolateral parts (9+9 at whole) (Figs 26, 32). Mucro indistinctly bidentate, with two teeth and some lamellae which make illusion of tridentate or quadridentate mucro (Figs 26, 29–32, 35). Anterior side of dens with three anterior chaetae, one larger and in more distal position and two (rarely one) smaller on both its sides. Posterior side with six (rarely five) chaetae, arranged as 1+1+(1)+2+1 (Figs 29–31). Dens:claw III = 3.1–4.8 (see the Remarks part). Manubrium : dens : mucro = 6.8–9.3 : 4.6–7.1 : 1. Inner and outer anal spines parallel, relatively small, on unsclerotised high papillae. Medial mesochaetae (a1) of Abd. V at level or slightly posterior to medial macrochaetae (a2) (Figs 24, 25). Arrangement of chaetae and spines on dorsum of Abd V as a2-a2/a1-a1 ~3.0; a2-a2/a2-eAS ~1.7. Males present.

Distribution and ecology. *Tetracanthella manschurica* occurs in the mountains of Sikhote-Alin Range (Fig. 58). It is a rare species preferring coniferous litter.

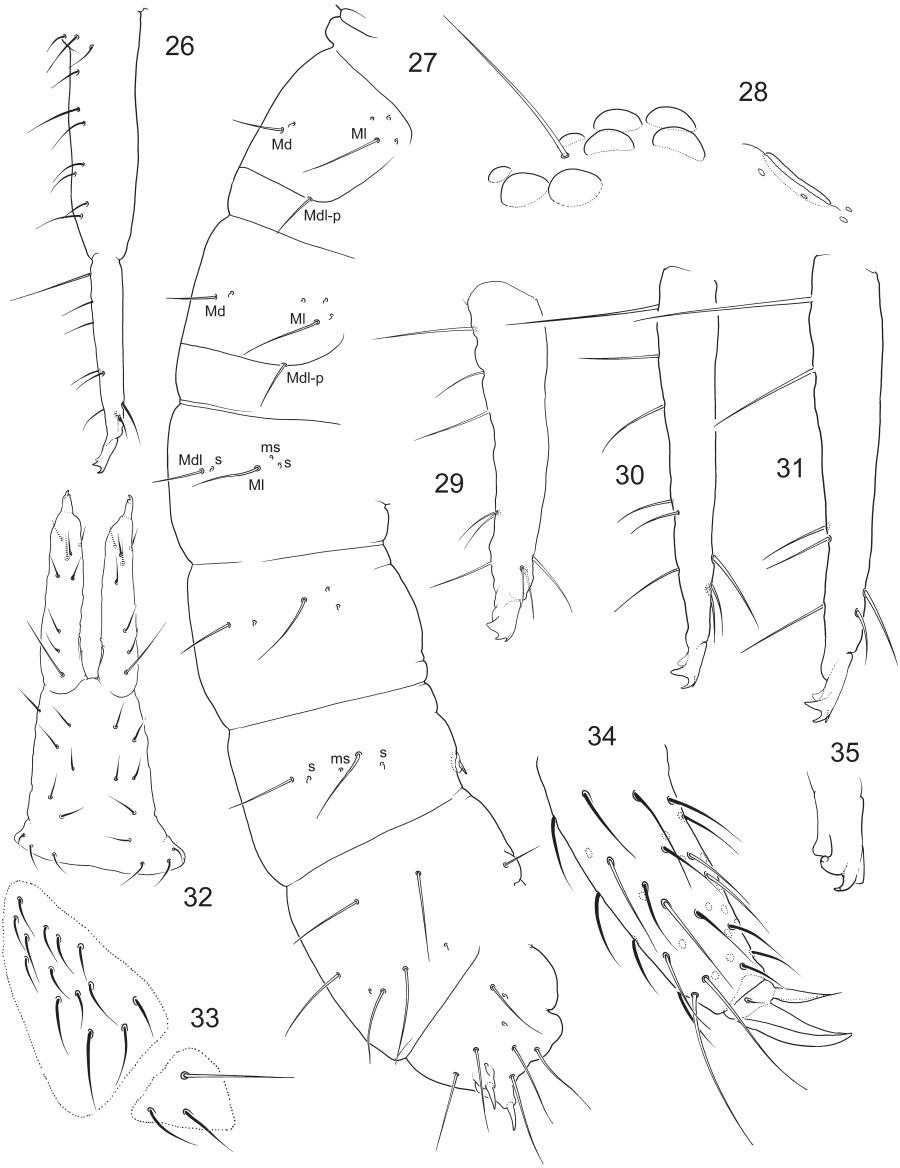
Discussion. *Tetracanthella manschurica* was described from Lazovski district of Primorski Krai. Afterwards, it was recorded once with few morphological remarks



Figures 23–25. *Tetracanthella manschurica* **23–24** dorsal chaetotaxy, dorsal view (Vaninski district) **25** anal spines (Chuguevski district).

by Potapov (2001). The only known type individual of the species is probably lost and our redescription is based on 15 specimens from three different districts of the same region. These specimens share several peculiar features and generally fit to the original description. Some discrepancy between the text of the first description and our observations is probably due to the juvenile condition of the holotype (Kutyreva 1980). *Tetracanthella manschurica* belongs to the '*sylvatica*' group and differs from other species of the group (*T. sylvatica*, *T. annulata* sp. nov., and *T. dorsoduplex* by three chaetae on anterior side of dens, absence of crenulation on posterior side of dens, thin reticulation of cuticle, dark blue colouration and few chaetae on posterior side of manubrium and posterior furcal subcoxa. *Tettracanthella manschurica* additionally has very peculiar mucro which appears to have three or four teeth due to one or two lamellae. Regardless the lamellae, mucro of this species keeps the general bidentate pattern known in the genus.

Population from the northern part of Sikhote-Alin Range (Vaninski district) show longer meso- and macrochaetae (Fig. 24), clearly clavate tenent hairs on legs, longer



Figures 26–35. *Tetracanthella manschurica* **26** furca, lateral view (Vaninski district) **27** position of macrochaetae and s-chaetae on corpus **28** PAO and ommatidia **29–31** dens, lateral view in specimen from Imeni Lazo district (**29**) and Vaninski district (**30, 31**) **32** furca, posterior view, juvenile specimen **33** furcal subcoxae **34** distal part of leg 3 **35** mucro.

claws (dens:claw III = 3.1–3.6) and mucro (dens : mucro = 4.6–5.1 : 1) (Figs 30, 31). More southern populations (Fig. 58) (correspond better to the type specimens morphology because of shorter meso- and macrochaetae (Fig. 25), slightly (vs. clearly) clavate tenent hairs, short claws (dens : claw III = 4.1–4.8) and short mucro (dens :

mucro = 6.7–7.1 : 1) (Fig. 29). We include both forms to the diagnosis of *T. manschurica* in view of the possible ecomorphic nature of the differences. One individual of unclear status from Kunashir Island (Alekhino, leg. I. Volonikhina) differs from continental populations by much shorter dens.

Species of the '*stebaevae*' group

Tetracanthella czernovae **Kutyreva, 1980**
Figs 36–39, 54

Type material. Lectotype and one paralectotype (females) designated and labeled as: Primorski Krai: Shkotovski district, NE part of Livadiysky Range, Krinichnaya (= Falaza) Mt., coniferous forest belt with *Picea* and *Abies*, litter under *Abies nephrolepis*, 12.10.1977, leg. L. Kutyreva

Redescription. Body length 2.0 mm (for subadult female). Body thick, tubular. Coloration dark, antennae white. Reticulation thin, polygons smaller than mesochaeta socket (Fig. 54). No smooth fields. Dorsal mesochaetae long, not shortened in axial part of tergites, (Md : p1 = 1.2–1,4). Abd. IV with p3 subequal to p1. Macrochaetae acuminate.

8+8 ocelli, G and H smaller. Four prelabral chaetae. Outer maxillary lobe with four sublobal hairs and simple maxillary palp. Labium with complete set of guards [A(1)B(4) C(0)D(4)E(7)], three proximal and four basomedian chaetae. Postlabial chaetae 4+4. With 7–8 chaetae between medial line and pc3 on head (Fig. 37). Frontal chaeta ap present.

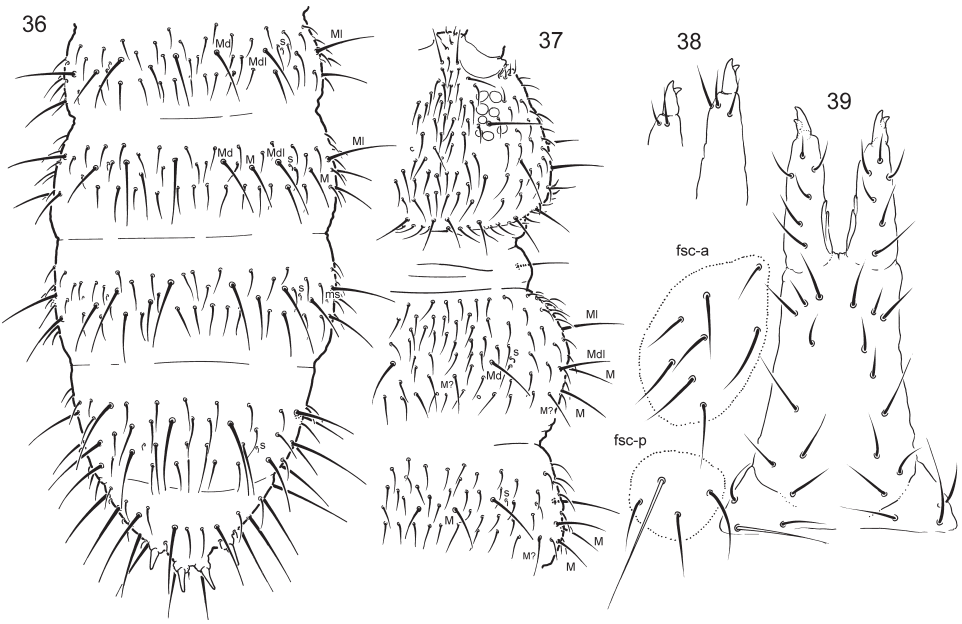
Chaetotaxy abundant (Figs 36, 37). Axial chaetotaxy 12–14,8/6,6,6,6. Basic set of macrochaetae complete: 3(A),3(A)/3,3,3. Besides, additional macrochaetae present posterior to basic macrochaetae resulting full formula 3+'4',3+'4'/3+'3',3+'3',3+'3'. Some chaetae of p-row also macrochaeta-like. Number of s-chaetae: 3,3/2,2,2,2,4 (s), 1,1/1,1,1 (ms). S-chaetae short, medial ones on Abd. I–III arranged lateral to Mdl macrochaetae. Sternite of Th. III without chaetae.

Coxa I without an external chaeta. Tibiotarsi with 1,2,2 long and clavate dorsal tenent hairs. Ventral tenent hairs weakly developed. Tibiotarsi I, II, III with 21, 21, 25 chaetae, respectively. Empodial appendage 0.7–0.8 as long as inner edge of claw, with apical filament.

Ventral tube with 3+3 laterodistal and four posterior chaetae. Retinaculum with 4+4 teeth and a chaeta. Anterior furcal subcoxa with 8–9 chaetae, posterior one with four chaetae (Fig. 39). Posterior side of manubrium with 8–9+8–9 chaetae on main part and 3+3 on basolateral parts (Fig. 39). Mucro bidentate, short. Anterior side of dens with two or three chaetae (differing in lectotype and paralectotype) (Fig. 38). Posterior side with six chaetae. Dens : claw III = 1.4–1.6. Manubrium : dens : mucro = 9–12 : 4–5 : 1. Inner and outer anal spines parallel, on high unsclerotised papillae. Medial mesochaetae (a1) of Abd. V slightly posterior to medial macrochaetae (a2). Arrangement of chaetae and spines on dorsum of Abd V as a2-a2/a1-a1 ~2.8; a2-a2/a2-eAS ~1.7. Males unknown.

Distribution. The species is known only from type locality, by two specimens.

Discussion. *Tetracanthella czernovae* belongs to the '*stebaevae*' group due to chaeta on coxa I missing and complete set of macrochaetae on tergites. The species how-



Figures 36–39. *Tetracanthella czernovae* **36–37** dorsal chaetotaxy of thorax (**36**) and abdomen (**37**), dorsal view **38** anterior side of dens, paralectotype (left) and lectotype (right) **39** furcal area, lectotype. Abbreviations: fsc-a and fsc-p, anterior and posterior furcal subcoxae.

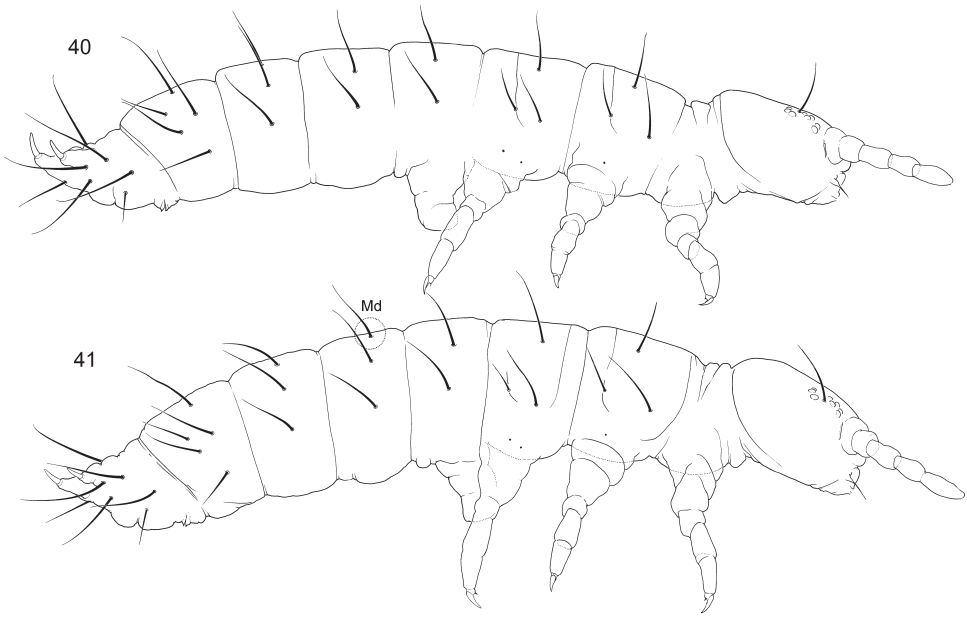
ever shares many essential characters, incl. appearance, with *T. manschurica* ('*sylvatica*' group). *Tetracanthella czernovae* was briefly redescribed by Potapov (2001) from two specimens supposed to be syntypes. These two specimens from the collection of E. Kutyreva did not have labels indicating type status. We designate two specimens collected by L. Kutyreva as lectotype and paralectotype. *Tetracanthella czernovae* resembles *T. wui* Xie, Potapov, Sun, 2019 but differs by having more setae on the dens (2–3/6 vs. 1/5).

One individual from central Honshu (Japan, Nagano Prefecture: Chino, leg. M.P. and N.K.) is close to *T. czernovae* but obviously represents a new species differing by absence of additional macrochaetae on body and presence of additional chaetae on Tibiotarsi I and II. It is the second species of the genus *Tetracanthella* occurring in Japan.

Species of the '*ethelae*' group

***Tetracanthella tardoki* sp. nov.**
http://zoobank.org/034F2534-C6F0-4F1B-B83E-AE022A1496C3
Figs 4, 41, 42–45, 46, 55–56, 58

Type material. Holotype: female, Russia, Far East, Khabarovsky Krai, Nanaisky district, ~40 km S road Khabarovsk-Sov.Gavan, Tardoki-Yani Mt., ~2050 m alt., tundra on top, 16–26.06.2017, leg. A.B. 19 paratypes from the same place and nearby, 1800–1900 m alt.



Figures 40–41. Appearance and macrochaetotaxy of *T. orientalis* (**40**) and *T. tardoki* sp. nov. (**41**).

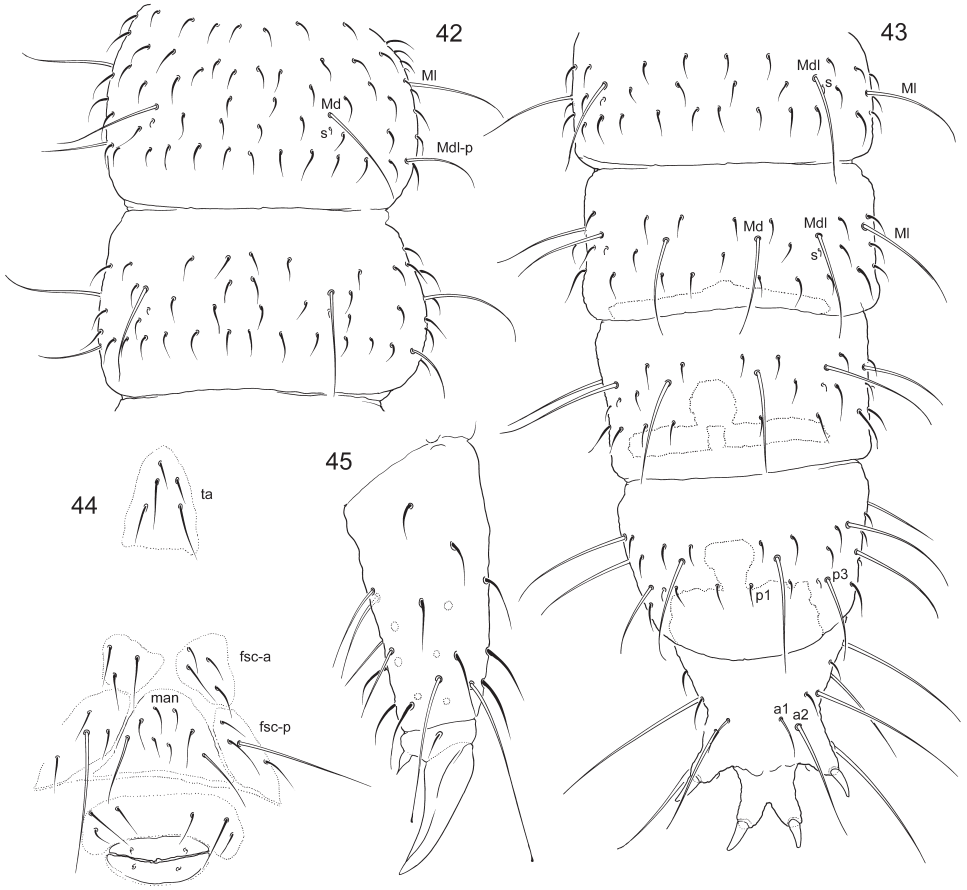
Other material (all from Tardoki-Yani Mt.): different open sites nearby type locality (moss and lichen on talus, mountain tundra, and mosses on rocks), 16–26.06.2017, leg. A.B.

Diagnosis. Coxa I without an external chaeta. Macrochaetotaxy: 3(W),3(W)/2,3,3. Retinaculum and furca absent.

Description. Body length 1.2–1.7 mm. Body slender, continuously narrowing (Fig. 41). Coloration dark, including antennae. Polygons large, canals between polygons well-marked. Smooth fields present on Abd.II–IV (Fig. 56), often on Abd.I. Head (Fig. 55), Th.II and III sometimes with narrow smooth belts at posterior edge. Area between ASi sometimes with small field. Dorsal mesochaetae rather short, slightly shortened in axial part of tergites (Fig. 43), in posterior row of Abd. IV not longer than on other parts of body (Md : p1 = 5.7–7.8). Abd. IV with p3 much longer than p1 (p3 : p1 = 3.4–4.5). Macrochaetae long and thick.

8+8 ocelli, G and H reduced. PAO 2.5–3.3 as long as the diameter of ocellus A. Chaeta s' of ant.III in males present. Two prelabral chaetae. Outer maxillary lobe with three sublobal hairs and simple maxillary palp. Labium with three proximal and four basomedian chaetae, labial palp with reduced set of guards [A(1)B(3)C(0)D(3)E(4)] (Fig. 4): papillae B and D each lost one dorsal guard (b4 and d4, respectively), papilla E lost three guards (e7 and probably e5 and e3). Postlabial chaetae 3+3. With 4–5 (rarely three in smaller and juvenile individuals) chaetae between medial line and pc3 on head. Frontal chaeta ap absent.

Chaetotaxy scarce (Figs 42, 43). Axial chaetotaxy 10,8/4,4,4,4. Macrochaetotaxy: 3(W),3(W)/2,3,3. Mdl macrochaetae in p-row on Th. II and III. Number of s-chaetae:



Figures 42–45. *Tetracanthella tardoki* sp. nov. **42–43** dorsal chaetotaxy of thorax (**42**) and abdomen (**43**), dorsal view **44** tenacular, furcal and genital areas of female **45** distal part of leg 3. Abbreviations: fsc-a and fsc-p–anterior and posterior furcal subcoxae, man manubrial field, ta tenacular area.

3,3/2,2,2,2,4 (s), 1,0/1,0,0 (ms) (Fig. 46). S-chaetae short, medial ones on Abd. I–III arranged behind Mdl macrochaetae. Sternite of Th. III without chaeta.

Coxa I without an external chaeta. Tibiotarsi with 1,2,2 long and clavate dorsal tenent hairs and 3,3,1 enlarged ventral tenent hair (Fig. 45). Males with chaeta B5 and X on tibiotarsi III stick-like, thickened. Tibiotarsi I and II with 21 chaetae each, III with 22 chaetae. Claw without teeth. Empodial appendage very short, 0.15–0.20 as long as inner edge of claw (Fig. 45).

Ventral tube with 3+3 lateral and four posterior chaetae.

Retinaculum and furca absent. Retinacular field with 3–5 chaetae. Anterior furcal subcoxa with three (rarely two or four) chaetae, posterior one with four chaetae. Manubrial field normally with eight chaetae (Fig. 44). Anal spines parallel, large, on high papillae. Papillae of inner pair sclerotised. Medial mesochaetae (a1) of Abd. V anterior

to medial macrochaetae (a2) (Fig. 43). Arrangement of chaetae and spines on dorsum of Abd V as a2-a2/a1-a1 = 1.6–1.8; a2-a2/a2-eAS = 1.5–2.0 (Fig. 43). Males present.

Etymology. The species is named after the type locality.

Distribution and ecology. It is known only from the Tardoki-Yany mountain massive (central part of Sikhote-Alin Range) where it occurs in all samples from alpine sites which we have examined (Fig. 58).

Discussion. The new species belongs to the '*ethelae*' group by absence of chaeta on coxa I, three sublobal hairs, two prelabral chaetae and other characters. Together with *T. orientalis* they are the only representatives of this Nearctic group in Palearctic. The two species share several apomorphic characteristics unknown in North American species: absence of furca, presence of the third macrochaetae in p-position on thorax, low number of axial chaetae, short empodium. *Tetracanthella tardoki* sp. nov. differs from *T. orientalis* by the presence of Md macrochaetae on Abd.II resulting in formula 2,3,3 (vs. 2,2,3) on abdomen.

Tetracanthella orientalis Martynova, 1977 in Martynova et al. 1977

Figs 40, 47–50, 57, 58

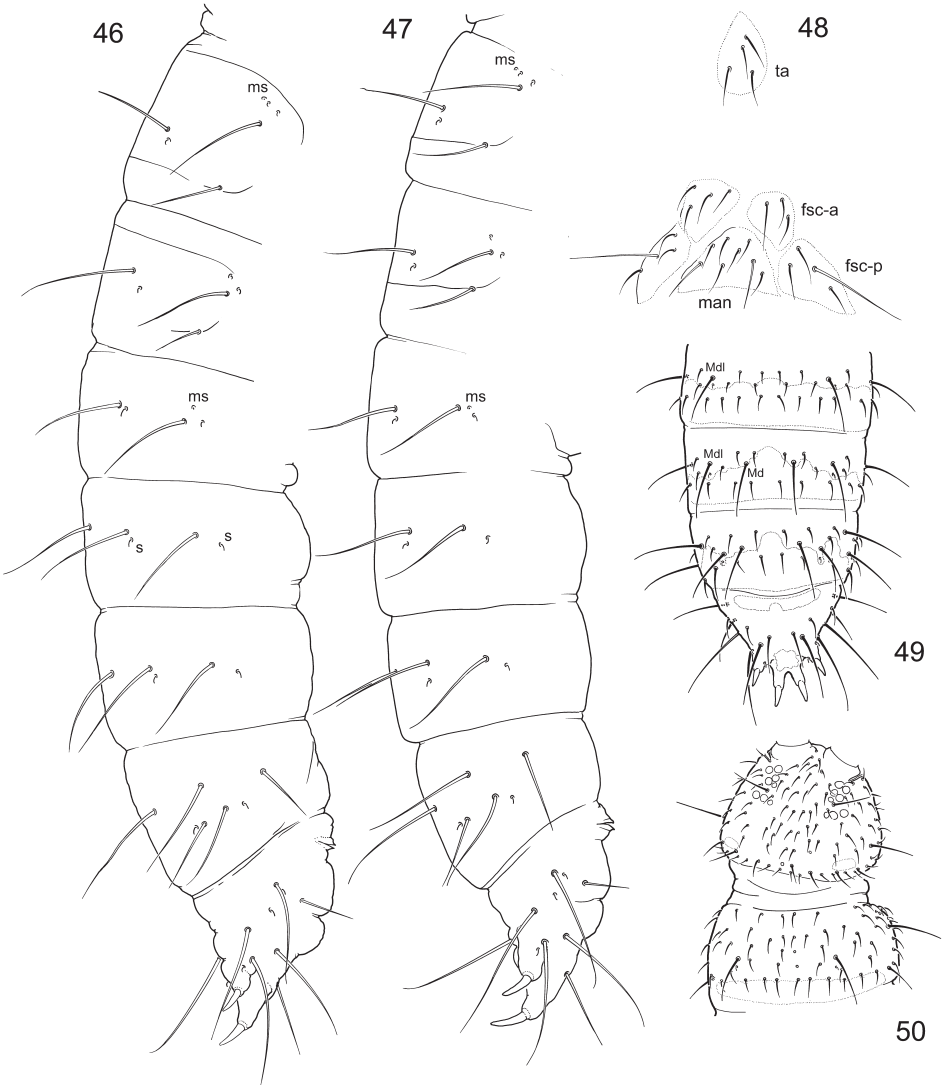
Material. Magadanskaya region: vicinities of Magadan, Snow Valley, 18.09.1974. It is the type locality of the species although the type specimens were not seen by us and are probably lost.

Chukotski AO: Anadyrski district, vicinities of Anadyr, Observatsii Cape, tundra, 27.06.1974, leg. E. Bondarenko, Anadyrski district, Ugolnaya Bay, tundra, leg. M. Chernyakhovski.

Kamchatka: Yuzhno-Kamchatski Reserve, Elizovski district (south), Kambalnoye Lake, pine elfin wood, 14.09.2005, leg. L. Lobkova; Elizovski district (north), Kronotski reserve, caldera of Uzon, moss-lichen tundra, 20.08.2005, leg. L. Lobkova; Kronotski reserve, Vachkazhets Volcano, 1000 ma lt., tundra, gopher burrow, leg. L. Lobkova; Bystrinski district, vicinities of Anavgai and Esso, 3–5.07.2012, tundra at lake (*Ledum, Empetrum*), leg. M.P.

Description. Body length 1.2–1.6 mm. Body slender, continuously narrowing (Fig. 40). Coloration dark, including antennae. Polygons large, canals between polygons well marked. Smooth fields usually present on all tergites of body (Fig. 49, 50). Posterior edge of head with smooth fields in lateral position (Fig. 50) or two groups of larger polygons (Fig. 57) in associated places. Area between ASi often with small smooth field. Dorsal mesochaetae short, slightly shortened in axial part of tergites (Fig. 49), in posterior row of Abd. IV not longer than on other parts of body (Md:p1 = 3.7–5.7). Abd. IV with p3 much longer than p1 (p3 : p1 = 2.3–4.4). Macrochaetae long.

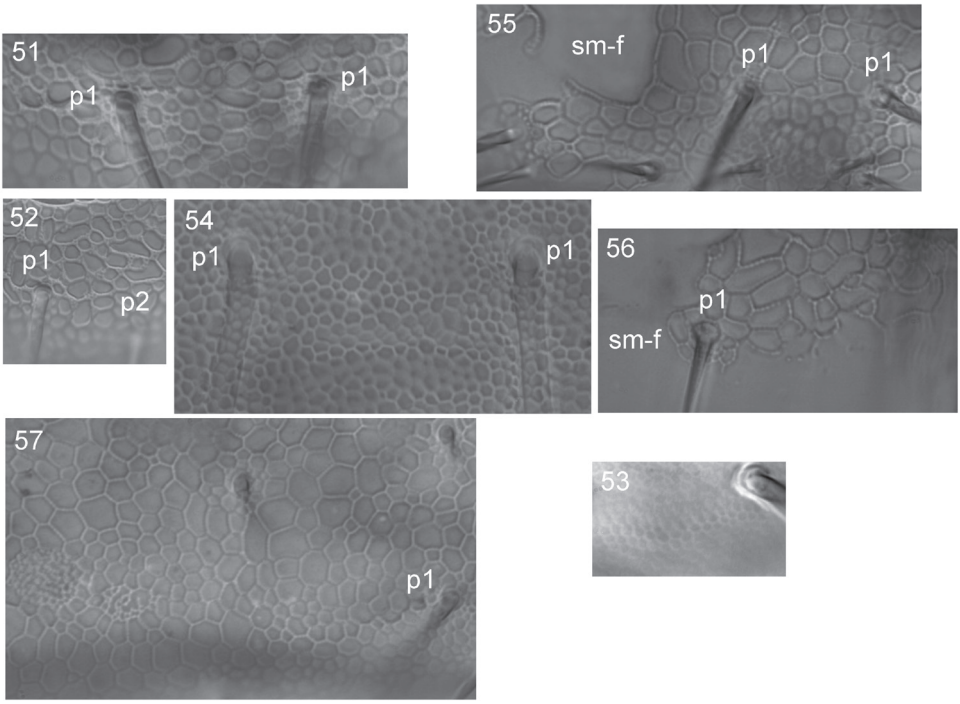
8+8 ocelli, G and H reduced (dA : dH = ~1.5). PAO 2.5–4.0 as long as the diameter of ocellus A. Chaeta s' of ant.III in males present. Two prelabral chaetae. Outer maxillary lobe with three sublobal hairs and simple maxillary palp. Labium with three proximal and four basomedian chaetae, labial palp with reduced set of guards [A(1)



Figures 46–50. *Tetracanthella tardoki* sp. nov. (**46**) and *T. orientalis* (**47–50**) **46–47** position of macrochaetae and s-chaetae on corpus **48** tenacular and furcal areas **49–50** dorsal chaetotaxy of Abd.II–V (**49**), head and Th.II (**50**), dorsal view. Abbreviations: fsc-a and fsc-p anterior and posterior furcal subcoxae, man manubrial field, ta tentacular area.

B(3)C(0)D(3)E(4)] (as in Fig. 2). Postlabial chaetae 3+3. With 4–5 chaetae between medial line and pc3 on head. Frontal chaeta ap absent.

Chaetotaxy scarce (Figs 49, 50). Axial chaetotaxy 12–10,8/4,4,4,4. Macrochaetotaxy: 3(W),3(W)/2,2,3. Mdl macrochaetae in p-row on Th. II and III, sometimes weakly developed. Number of s-chaetae: 3,3/2,2,2,2,4 (s), 1,0/1,0,0 (ms) (Fig. 47). S-



Figures 51–57. Reticulation of cuticle in *Tetracanthella* of East Asia **51** *T. annulata* sp. nov., posterior edge of Abd.IV **52** *T. sylvatica,* ibidem **53** *T. manschurica*, posterior edge of Abd.IV, lateral part **54** *T. czernovae*, posterior edge of Abd.IV **55–56** *T. tardoki* sp. nov., posterior edge of head (**55**) and posterior edge of Abd.IV (**56**) **57** *T. orientalis*, posterior edge of head. Abbreviations: p1 and p2, chaetae of p-row, sm-f smooth field.

chaetae short, medial ones on Abd. I–III arranged behind Mdl macrochaetae. Sternite of Th. III without chaeta.

Legs as in *T. tardoki* sp. nov. Tibiotarsi I, II, III with 21, 21, 22 chaetae. Claw without teeth. Empodial appendage short, 0.2–0.3 as long as inner edge of claw. Ventral tube with 3+3 lateral and four posterior chaetae.

Retinaculum and furca absent. Retinacular field with 3–5 chaetae. Anterior furcal subcoxa with three (rarely four) chaetae, posterior one with four chaetae. Manubrial field with eight (rarely seven) chaetae (Fig. 48). Anal spines parallel, large, on high papillae. Papillae of inner pair sclerotised. Medial mesochaetae (a1) of Abd. V anterior to medial macrochaetae (a2) (Fig. 49). Arrangement of chaetae and spines on dorsum of Abd V as a2-a2/a1-a1 = 1.7–1.8; a2-a2/a2-eAS = 1.3–1.7. Males present.

Distribution. *Tetracanthella orientalis* is widely distributed in northern part of the Far East of Russia (Fig. 58). In Magadanskaya region and Kamchatka it is the only known species of the genus. In Chukotka, *T. orientalis* can be recorded together with *T. sibirica* which has the similar appearance but belongs to another group of species.

Discussion. See the remarks to *T. tardoki* sp. nov.

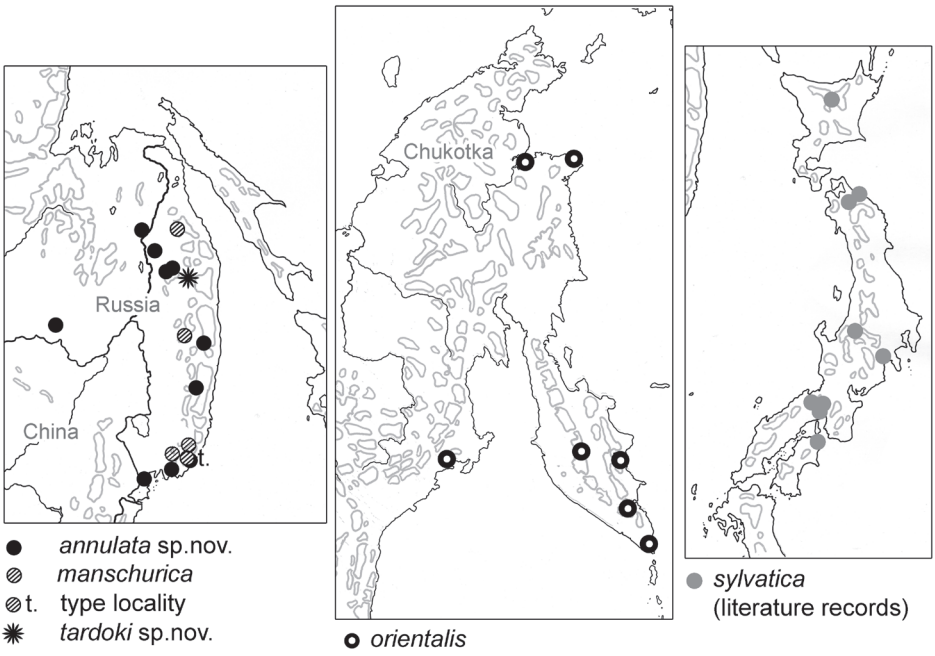


Figure 58. Records of five species of *Tetracanthella* in the Far East of Russia and Japan.

Species of the '*wahlgreni*' group

Tetracanthella sibirica Deharveng, 1987

Tetracanthella arctica auct.
Tetracanthella cf. *arctica* auct.

Material from the Far East of Russia. Chukotski AO: Anadyrski district, vicinities of Anadyr (holotype and paratype), leg. E. Bondarenko; ibidem, Anadyrski district, vicinities of Shakhterski, Volchikha River, leg. E. Bondarenko; ibidem, Iul'tinski district, Shmidta Cape, leg. K. Gorodkov; ibidem, Iul'tinski district, Wrangel Island, Somnitel'naya Bay, leg. K. Gorodkov.

Material from the Palearctic. Yakutia, Bulunski Ulus, Bol'shoi Lyakhovski Isl. (Novosibirskiye Islands), mouth of Bol'shoi Etirikan River; ibidem, Bol'shoi Lyakhovski Isl., Shalourova Cape, leg. V. Bulavintsev.

Material from the Nearctic. USA, Alaska, Kotzebue, 66.90°N, 162.59°W, 04.IX.1976, trough, moss & *Carex* litter, leg. R. Greenberg; Alaska, North Slope, 10 ml NW Franklin Bruffs, moss in active polygon, 70.26°N, 161.89°W, 17.VIII.1976, leg.A.F.; Alaska, North Slope, Icy Cape, trough between polygons, moss and *Carex* sp., 28.VIII.1976, leg. P. Connors; Alaska, North Slope, Canning River Delta, 70.05°N, 145.50°W, 23.VII.1980, several sites with *Dryas* sp., moss and *Carex* sp., leg. S. Ma-

cLean; Alaska, Norton Bay, Inglutalik River, moist tundra, leg. A.F.; Alaska, Nunivak Island, Duchikthluk Bay, 59.86°N, 166.07°W, 19.IX.1976 tundra with *Empetrum* sp., *Carex* sp., *Vaccinium* sp., lichens, leg. P. Michelson; Alaska, Point Barrow, 71.31°N, 156.66°W, 30.VIII.1976, thick moss, some algae and lichens; ibidem, moss , *Saxifraga* sp., *Cochlearia* sp. on sandy stream bank, leg. A.F.; Alaska, Cape Thompson, Ogoturuk Creek Basin, 68.16°N, 165.35°W, 11.VIII.1980, moss in tussock tundra, leg. D. & B. Murrey; Alaska, Chevak in Yukon, Kuskokwin Delta, 61.51°N, 165.26°W, 09.VII.1976, mesic upland, moss and *Betula nana,* leg. T. Seasted; Alaska, Cape Krusenstern, rather dry site, lichens, 67.25°N, 163.50°W, 03.IX.1976, *Vaccinium* sp., leg. R. Greenberg.

Distribution. Common in Asiatic and American parts of Arctic. In the Far East of Russia was recorded from Chukotka, in Wrangel Island, Anadyrskij, Uil'tinskij, Chaunskij and Chukotskij districts, as *T. arctica* Cassagnau, 1959 or *T.* cf. *arctica* in older publications (Bondarenko 1975, Deharveng 1987, Babenko 2010, 2017, Martynova 1971, MacLean et al. 1978, and others). All Arctic records from the literature were summarized by Babenko and Fjellberg (2006).

Discussion. The status of species is somewhat doubtful because morphological intergrading to *T. arctica* (Fjellberg 2007, 2015) which is distributed in Atlantic sector of Arctic. Specimens of *T. sibirica* from Asia fit to the first description (Deharveng 1987).

Tetracanthella martynovae Potapov, 1997

Distribution. The species is distributed in central part of Russian sector of Arctic. From the Far East it is known only in Chaunski district (Chaun Bay) of Chukotka, as "cf. *britannica*" by MacLean et al. (1978), which is the most eastern record of the species so far.

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RESEARCH ARTICLE

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Two new species of the genus *Tsauria* Koçak & Kemal (Hemiptera, Fulgoromorpha, Cixiidae) from China, with descriptions of female genitalia of three species

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Abstract

Two new species of cixiid planthoppers genus *Tsauria* Koçak & Kemal, *Tsauria brevispina* Zhi & Chen, **sp. nov.** and *T. longispina* Zhi & Chen, **sp. nov.**, are described and illustrated from China and *T. transspinus* (Zhang & Chen, 2011) was removed to give the genus four species in total. The female genitalia of three species are described and illustrated for the first time. A key to all known species of *Tsauria* based on male genitalia, and a key to three species (except for *T. major*) based on female genitalia, are provided.

Keywords

Female genitalia, Fulgoroidea, morphology, Oriental region, taxonomy

Introduction

Tsaur et al. (1991) established the cixiid planthopper genus *Discophorellus* with the type species *Discophorellus major* Tsaur & Hsu, 1991 from China (Taiwan), and placed this genus in the tribe Cixiini of the subfamily Cixiinae (Hemiptera: Fulgoromorpha: Cixiidae). Later, Koçak and Kemal (2009) proposed a new replacement name *Tsauria* for *Discophorellus* Tsaur & Hsu, 1991 because the latter is a junior homonym of

Discophorellus Wibmer & O'Brien, 1986 (Coleoptera). But, Zhang and Chen (2011) did not recognize the homonym of *Discophorellus* and described two new species from China: *D. cehengensis* and *D. transspinus*. Subsequently, Xing and Chen (2014) transferred the two species described by Zhang and Chen (2011) to *Tsauria*. However, the taxonomic status of *T. transspinus* (Zhang & Chen, 2011) is reviewed in this study and, based on a few diagnostic characters, removed from *Tsauria* (see Discussion). So far, *Tsauria* includes two species: *T. cehengensis* (Zhang & Chen, 2011) and *T. major* (Tsaur & Hsu, 1991).

Herein, two new species: *Tsauria brevispina* Zhi & Chen, sp. nov. and *T. longispina* Zhi & Chen, sp. nov. are described and illustrated from China. Female genitalia of three Chinese species are described and illustrated for the first time. The genus now includes four species, and all from China. A key to all known species of *Tsauria* based on male genitalia, and a key to three species (except for *T. major*) based on female genitalia, are provided.

Materials and methods

The morphological terminology and measurements follow Bourgoin (1987) and Bourgoin et al. (2015). The morphological terminology of female genitalia follows Bourgoin (1993). Body length was measured from apex of vertex to tip of forewing; vertex length was measured the median length of vertex (from apical transverse carina to tip of basal emargination). Fuchsin staining was used to highlight the female genitalia structures studied. Ten to fifteen female specimens per species were dissected. External morphology and drawings were done with the aid of a Leica MZ 12.5 stereomicroscope. Photographs were taken with KEYENCE VHX-1000 system. Illustrations were scanned with CanoScan LiDE 200 and imported into Adobe Photoshop CS7 for labeling and plate composition. The dissected male and female genitalia are preserved in glycerin in small plastic tubes pinned together with the specimens.

The type specimens examined are deposited in the Institute of Entomology, Guizhou University, Guiyang, Guizhou Province, China (GUGC).

Taxonomy

Tsauria Koçak & Kemal, 2009

Discophorellus Tsaur & Hsu, 1991: 21; Zhang and Chen 2011: 60.
Tsauria Koçak & Kemal, 2009: 6 for *Discophorellus* Tsaur & Hsu, 1991, nec Wibmer & O'Brien, 1986; Xing and Chen 2014: 149.

Type species. *Discophorellus major* Tsaur & Hsu, 1991, by original designation. For the relationship and diagnosis of *Tsauria* see Tsaur et al. (1991: 21) and Zhang and Chen (2011: 60).

Distribution. Oriental region (China).

Key to species (males) of *Tsauria* (revised from Zhang and Chen 2011)

1 Ventral margin of aedeagal periandrium with an extremely long spinose process, which is the longest of all spinose processes of periandrium (Figs 46–49) ..... ***T. longispina* sp. nov.**

– Spinose process on ventral margin of aedeagal periandrium not the longest of periandrium **2**

2 Ventral margin of aedeagal periandrium with an extremely short spinose process, which is the shortest of all spinose processes of periandrium (Figs 13–16) ..... ***T. brevispina* sp. nov.**

– Spinose process on ventral margin of aedeagal periandrium not the shortest of periandrium **3**

3 Forewings with r-m cross-vein and apical cells yellowish brown (Zhang and Chen 2011: Fig. 36); medioventral process of pygofer papillary in ventral view, with bristles at apex (Zhang and Chen 2011: Fig. 5) ..... ***T. cehengensis***

– Forewings with r-m cross-vein and apical cells black; medioventral process of pygofer sub-triangular in ventral view, rounded and smooth at apex (Tsaur et al. 1991: Fig. 10E) ..... ***T. major***

Key to species (females) of *Tsauria* (except for *T. major*)

1 Wax plate divided by median keel (Fig. 53)..... ***T. longispina* sp. nov.**

– Wax plate widened laterally and without median keel **2**

2 The length of posterior vagina (Figs 34–35) equal to the width. Sclerites in ventral view mainly concentrated in the middle area and the ones in dorsal view mainly concentrated on left side. Gonapophysis IX (Fig. 32) with two middle teeth, denticulate portion with one small rounded odontoid ..... ***T. cehengensis***

– Posterior vagina (Figs 24–25) elongate, with sclerites dispersed both in ventral and dorsal view. Gonapophysis IX (Fig. 22) with one middle tooth, denticulate portion degenerated..... ***T. brevispina* sp. nov.**

***Tsauria brevispina* Zhi & Chen, sp. nov.**
http://zoobank.org/30979941-88CE-413C-9E3F-E4C2C1B1BDD1
Figs 1–2; 5–26

Type material. Holotype: ♂, **China**: Hubei, Luotian County, Dabieshan, 15 July 2010, Jun-qiang Ni; paratypes: 3♀♀, Hubei, Luotian County, Dabieshan, 15–17 July 2010, Jun-qiang Ni; 2♂♂5♀♀, Hubei, Luotian County, Dabieshan, Qingtaiguan, 2–3 July 2014, Mei-na Guo, Jian-kun Long, Zheng-xiang Zhou; 1♂2♀♀, Hubei, Luotian County, Dabieshan, Taohuachong, 23–28 June 2014, Mei-na Guo, Hai-yan

Figures 1–4. 1–2 *Tsauria brevispina* sp. nov., male **1** dorsal view **2** lateral view **3–4** *Tsauria longispina* sp. nov., male **3** dorsal view **4** lateral view.

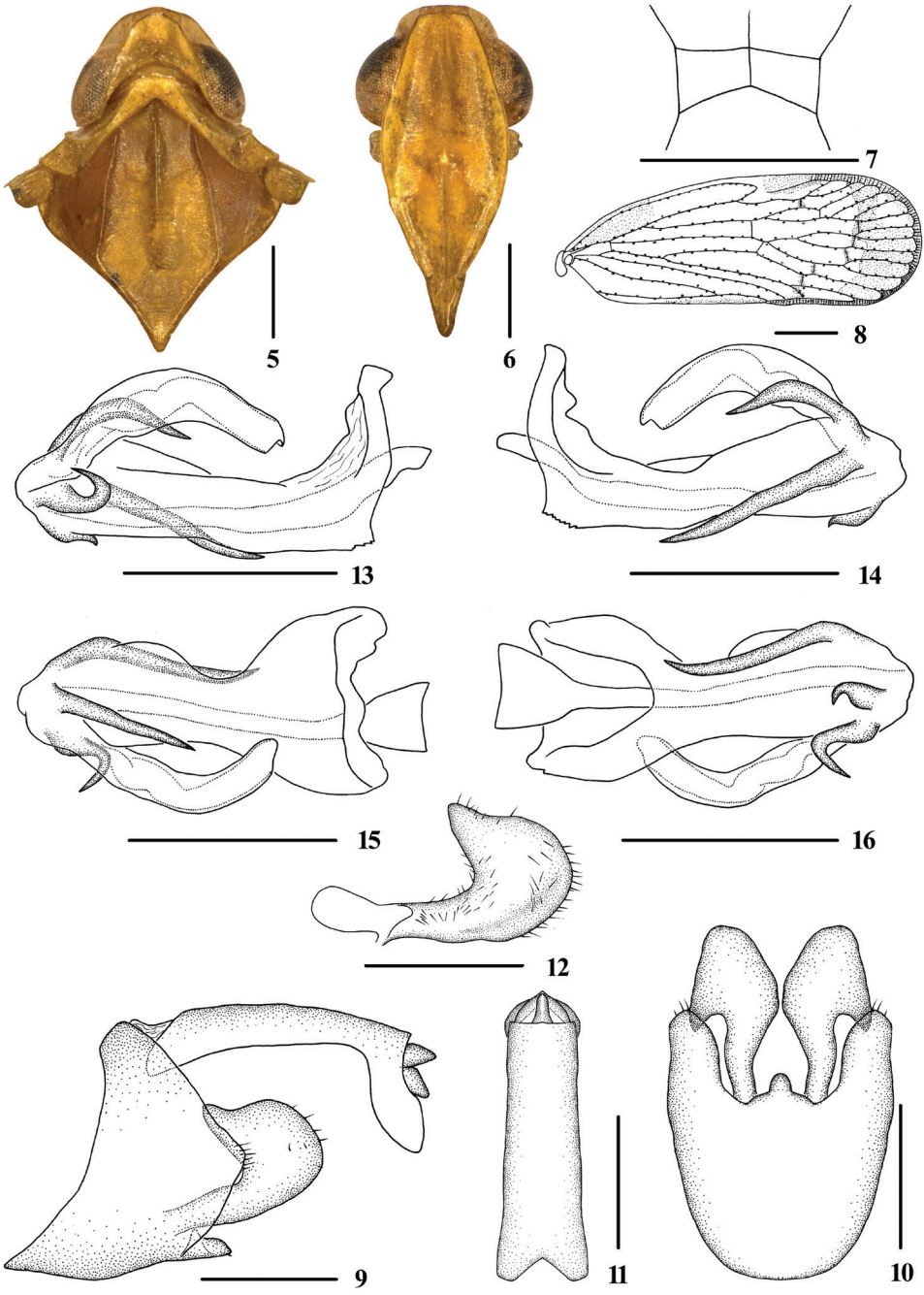
Sun; 1♂1♀, Hubei, Luotian County, Dabieshan, Wujiashan, 27–29 June 2014, Meina Guo, Zheng-xiang Zhou; 5♂♂5♀♀, Guizhou, Tongren, Fanjingshan, Heihewan, 18 May 2013, Wei-cheng Yang, Yu-bo Zhang, Jian-kun Long; 1♂, Guizhou, Guiyang, Huaxi, Qingyan, 20 July 2012, Zhi-hua Fan.

Description. Body length: male 6.9–7.5 mm (*n* = 11), female 7.0–8.8 mm (*n* = 16).

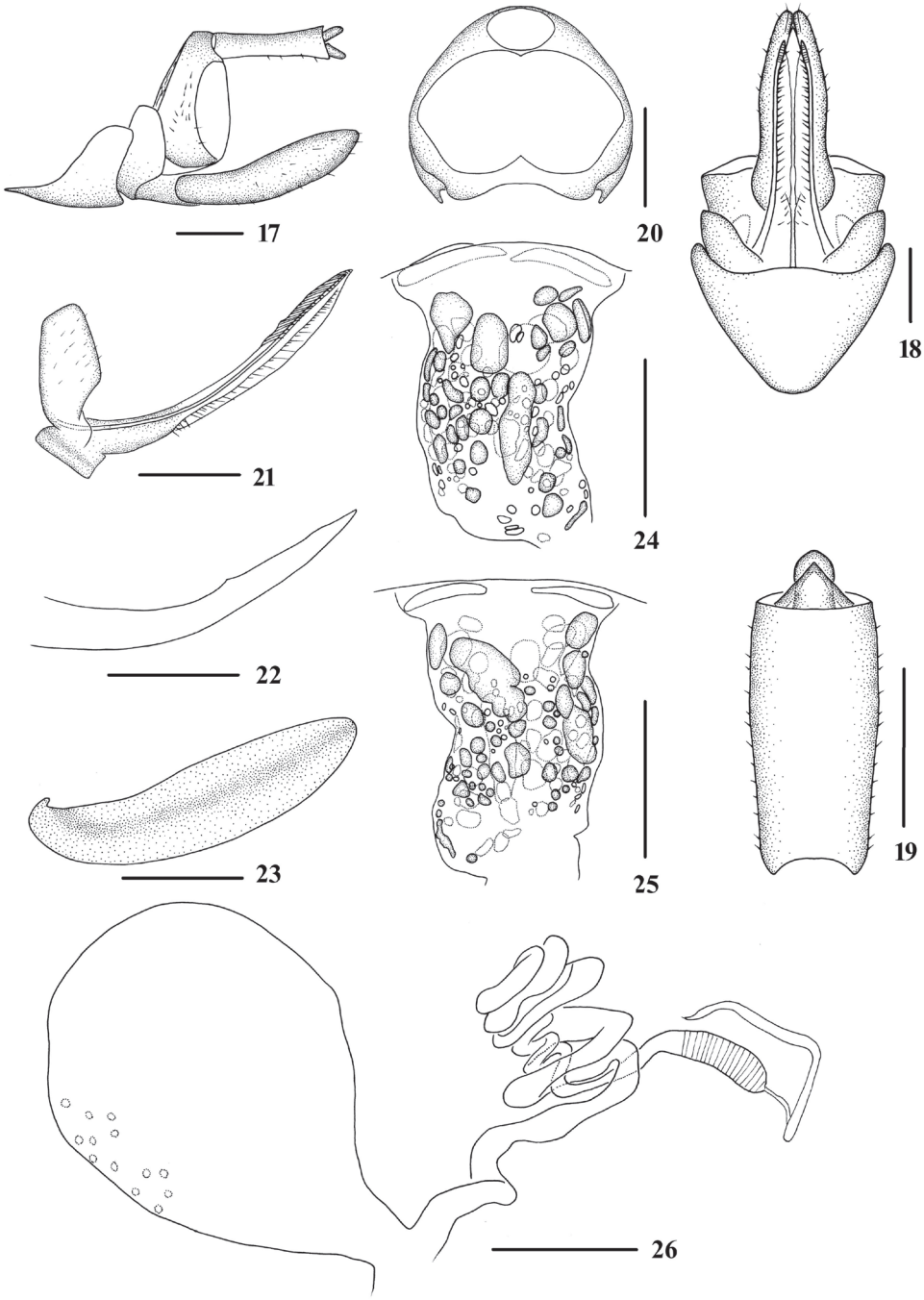
Coloration. General color yellowish brown (Figs 1, 2, 5, 6). Eyes yellowish brown, ocelli yellow. Vertex, face, rostrum and pronotum yellowish brown, mesonotum brown. Forewing semi-translucent, yellowish brown, stigma yellowish brown, termination of forewing blackish brown. Hind tibiae and abdominal sternites yellowish brown.

Head and thorax. Vertex (Figs 1, 5, 7) broad, 1.5 times wider than long; subapical carina with middle prominent into obtuse angle, median carina interrupted by subapical carina, with anterior portion complete, posterior portion only discernible at basal half. Frons (Fig. 6) 1.2 times as long as wide. Clypeus with median carina distinct and elevated throughout. Pronotum (Figs 1, 5) 1.9 times longer than vertex. Mesonotum 1.6 times longer than pronotum and vertex combined. Forewing (Fig. 8) 2.7 times longer than wide, with 13 apical and 7 subapical cells; RP 4 branches, MP with 5 terminals: MP_{11}, MP_{12}, MP_2, MP_3, and MP_4, fork MP_1+MP_2 basad of fork MP_3+MP_4. Hind tibia with 3−5 lateral spines; chaetotaxy of hind tarsi: 8–9/10–11, second segment of hind tarsus with 7 platellae.

Male genitalia. Pygofer (Figs 9, 10) symmetrical, dorsal margin concave and U-shaped ventrally, widened towards apex; in lateral view, lateral lobes triangularly extended caudally. Medioventral process mastoid ventrally. Anal segment (Figs 9, 11) long tubular, symmetrical, 2.5 times longer than wide in dorsal view; anal style



Figures 5–16. *Tsauria brevispina* sp. nov., male **5** head and thorax, dorsal view **6** face, ventral view **7** head, top view **8** forewing **9** genitalia, lateral view **10** pygofer and gonostyli, ventral view **11** anal segment, dorsal view **12** gonostyli, inner lateral view **13** aedeagus, right side **14** aedeagus, left side **15** aedeagus, dorsal view **16** aedeagus, ventral view. Scale bars: 0.5 mm (**5–7, 9–16**); 1.0 mm (**8**).



Figures 17–26. *Tsauria brevispina* sp. nov., female **17** genitalia, lateral view **18** genitalia, ventral view **19** anal segment, dorsal view **20** tergite IX, caudal view **21** gonapophysis VIII and gonocoxa VIII, dorsal view **22** gonapophysis IX, lateral view **23** gonoplac, inner lateral view **24** posterior vagina, ventral view **25** posterior vagina, dorsal view **26** internal genitalia. Scale bars: 0.5 mm.

finger-like, not beyond anal segment. Gonostyli (Figs 9, 10, 12) in ventral view, symmetrical, widening towards apex, apical part extended, apical margin rounded; in lateral view, "L-shaped". Aedeagus (Figs 13–16) in total with four processes. Spinose process on left side near apex of periandrium being the longest, straight, directed ventrocephalically; right side of periandrium with a medium-sized spinose process, strongly curved, directed dorsocaudally at apex; periandrium with a medium-sized spinose process positioning slightly to left side of its dorsal margin, directed right-ventrocephalically; ventral margin of aedeagal periandrium with an extremely short spinose process, which is the shortest of all spinose processes of periandrium, hooked, curved towards right side. Endosoma moderately sclerotized, simple, generally curving left.

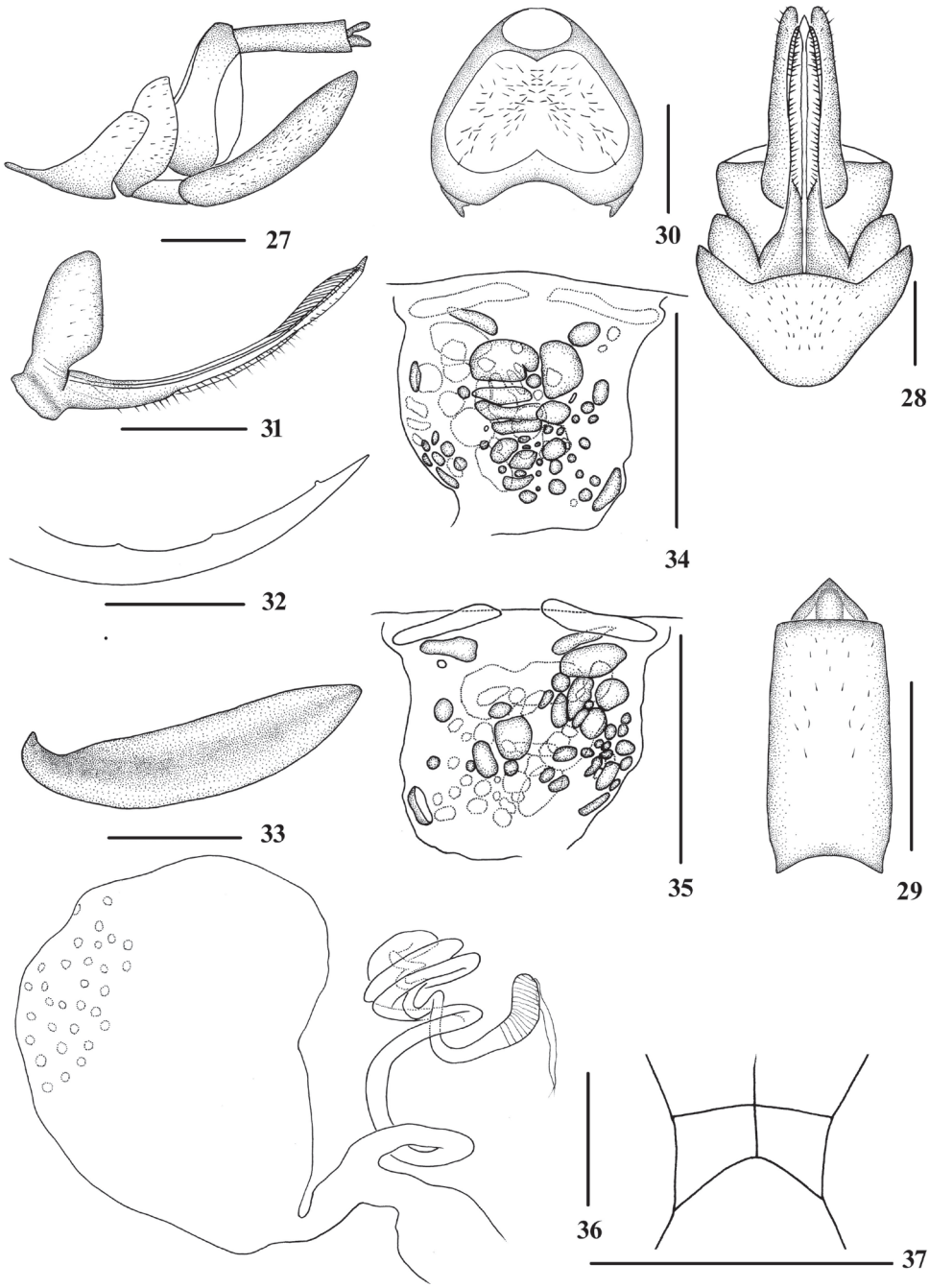
Female genitalia. Tergite IX (Figs 17, 18, 20) moderately sclerotized, with a large nearly elliptical wax plate. Anal segment (Figs 17, 19) rectangle, 2.2 times longer than wide in dorsal view. Gonapophysis VIII (Fig. 21) elongate, and slightly curved upwards. Gonapophysis IX (Fig. 22) with one middle tooth, denticulate portion degenerated. Gonoplac (Fig. 23) rod-like, 3.7 times longer than wide in lateral view. Posterior vagina (Figs 24, 25) elongate, with many small round, oval and oblong sclerites both in ventral and dorsal view, dispersed. Base with several relatively large sclerites, and the middle area with a longitudinally oblong sclerite in ventral view; at basal each lateral side with several relatively large sclerites respectively in dorsal view. Internal genitalia as shown in Fig. 26.

Distributions. China (Guizhou, Hubei).

Etymology. The specific name is derived from the Latin prefixes "*brevi*" and noun "*spina*", referring to the ventral margin of aedeagal periandrium with an extremely short spinose process, which is the shortest of all spinose processes of the periandrium.

Remarks. Male genitalia of *T. brevispina* sp. nov. is similar to *T. cehengensis* (Zhang & Chen), but differs in: (1) spinose process on ventral margin of periandrium being the shortest of all spinose processes of periandrium (in *T. cehengensis*, not the shortest one); (2) spinose process on left side near apex of periandrium being the longest, straight (in *T. cehengensis*, spinose process in the same position being the shortest, basal two-thirds stout and apical third arc-shaped curved); (3) medioventral process without bristles at apex (the latter with bristles); (4) forewing with 13 apical cells (the latter with 12 apical cells).

Female genitalia of *T. brevispina* sp. nov. is similar to *T. cehengensis* (Zhang & Chen), but differs in: (1) posterior vagina elongate (in *T. cehengensis*, the length of posterior vagina equal to the width); (2) sclerites dispersed both in ventral and dorsal view (in *T. cehengensis*, sclerites in ventral view mainly concentrated in the middle area and the ones in dorsal view mainly concentrated in left side); (3) Gonapophysis IX with one middle tooth, denticulate portion degenerated (in *T. cehengensis*, Gonapophysis IX with two middle teeth, denticulate portion with one small rounded odontoid).



Figures 27–37. *Tsauria cehengensis* (Zhang & Chen, 2011) **27–36**, female **27** genitalia, lateral view **28** genitalia, ventral view **29** anal segment, dorsal view **30** tergite IX, caudal view **31** gonapophysis VIII and gonocoxa VIII, dorsal view **32** gonapophysis IX, lateral view **33** gonoplac, inner lateral view **34** posterior vagina, ventral view **35** posterior vagina, dorsal view **36** internal genitalia **37** head, top view, male. Scale bars: 0.5 mm.

***Tsauria cehengensis* (Zhang & Chen, 2011)**
Figs 27–37

Discophorellus cehengensis Zhang & Chen, 2011: 61, figs 1–11, 36–37.
Tsauria cehengensis (Zhang & Chen, 2011): Xing and Chen 2014: 149.

Material examined. China: 1♂, Guizhou, Ceheng County (900 m), 29 June–1 July 2006, Qiong-zhang Song (holotype); 9♂♂3♀♀, same data as holotype, Qiong-zhang Song, Pei Zhang (paratypes); 4♀♀, Guizhou, Ziyun County, Getuhe, Dahemiaozhai (930 m), 24–27 June 2006, Pei Zhang (paratypes); 2♂♂, Guizhou, Libo County, Maolan, Banzhai, 4–6 July 2010, Pei Zhang, Xiao-hui Hou; 1♂1♀, Guizhou, Libo County, Maolan, Wengang, 4 July 2010, Pei Zhang; 1♂, Guizhou, Huishui County, Duanshan, Guangrong, 9 May 2013, Jian-kun Long; 1♂2♀♀, Guizhou, Guiyang, Forest Park, 25 June 2010, Yan-li Zheng; 1♂1♀, Jiangsu, Longnan County, Jiulianshan, Daqiutian, 24 July 2009, Ze-hong Meng; 3♂♂3♀♀, Anhui, Huangshan City, Tangkou (500 m), 20 May 2008, Zheng-guang Zhang; 17♂♂19♀♀, Guangxi, Shangsi County, Shiwandashan National Forest Park, 2 May 2011, Rong Huang, Xiao-fei Yu; 1♀, Guangxi, Shangsi County, Shiwandashan National Forest Park, 9 June 2012, Jian-kun Long; 1♂1♀, Guangxi, Shangsi County, Shiwandashan National Forest Park, 30 May 2012, Nan-nan Yang; 1♂1♀, Guizhou, Leishan County, Leigongshan, Xiaodanjiang, 6–8 July 2011, Jian-kun Long, Wei-bin Zheng; 1♂2♀♀, Guizhou, Wangmo County, Xintun, 28-June 2013, Jian-kun Long, Yang-yang Liu; 1♂, Guizhou, Congjiang County, Guanghui, 20 July 2016, Zheng-xue Zhao.

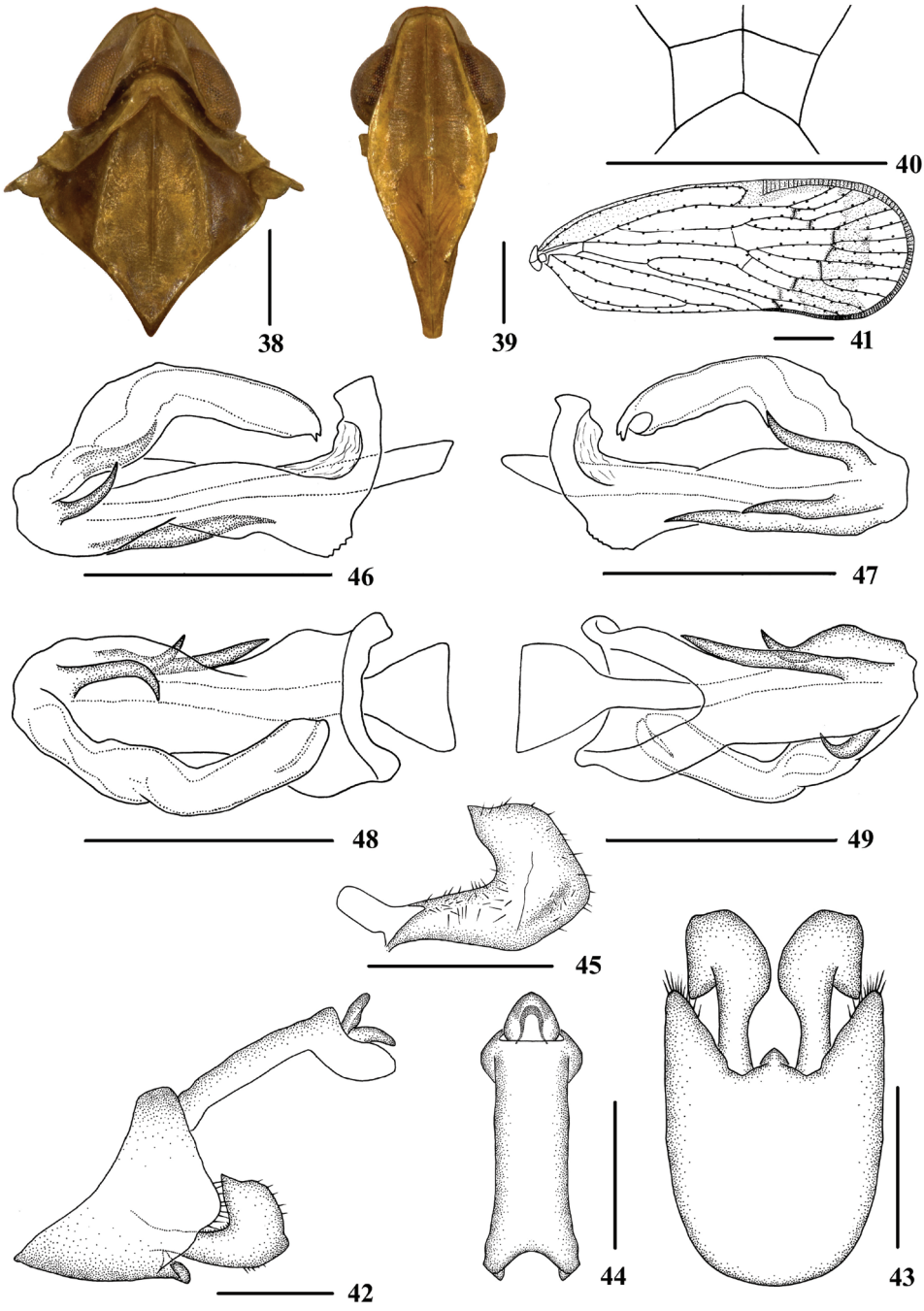
Supplementary description. Female genitalia. Tergite IX (Figs 27, 28, 30) moderately sclerotized, with a large nearly trapezoidal wax plate. Anal segment (Figs 27, 29) rectangle, 2.1 times longer than wide in dorsal view. Gonapophysis VIII (Fig. 31) elongate, and slightly curved upwards. Gonapophysis IX (Fig. 32) with two middle teeth, denticulate portion with only one small rounded odontoid. Gonoplac (Fig. 33) rod-like, 3.9 times longer than wide in lateral view. The length of posterior vagina (Figs 34, 35) equal to the width. Posterior vagina with many small round, oval and oblong sclerites both in ventral and dorsal view. Sclerites in ventral view mainly concentrated in the middle area and the ones in dorsal view mainly concentrated in left side. Internal genitalia as shown in Fig. 36.

Distributions. China (Anhui, Jiangsu, Guangxi, Guizhou).

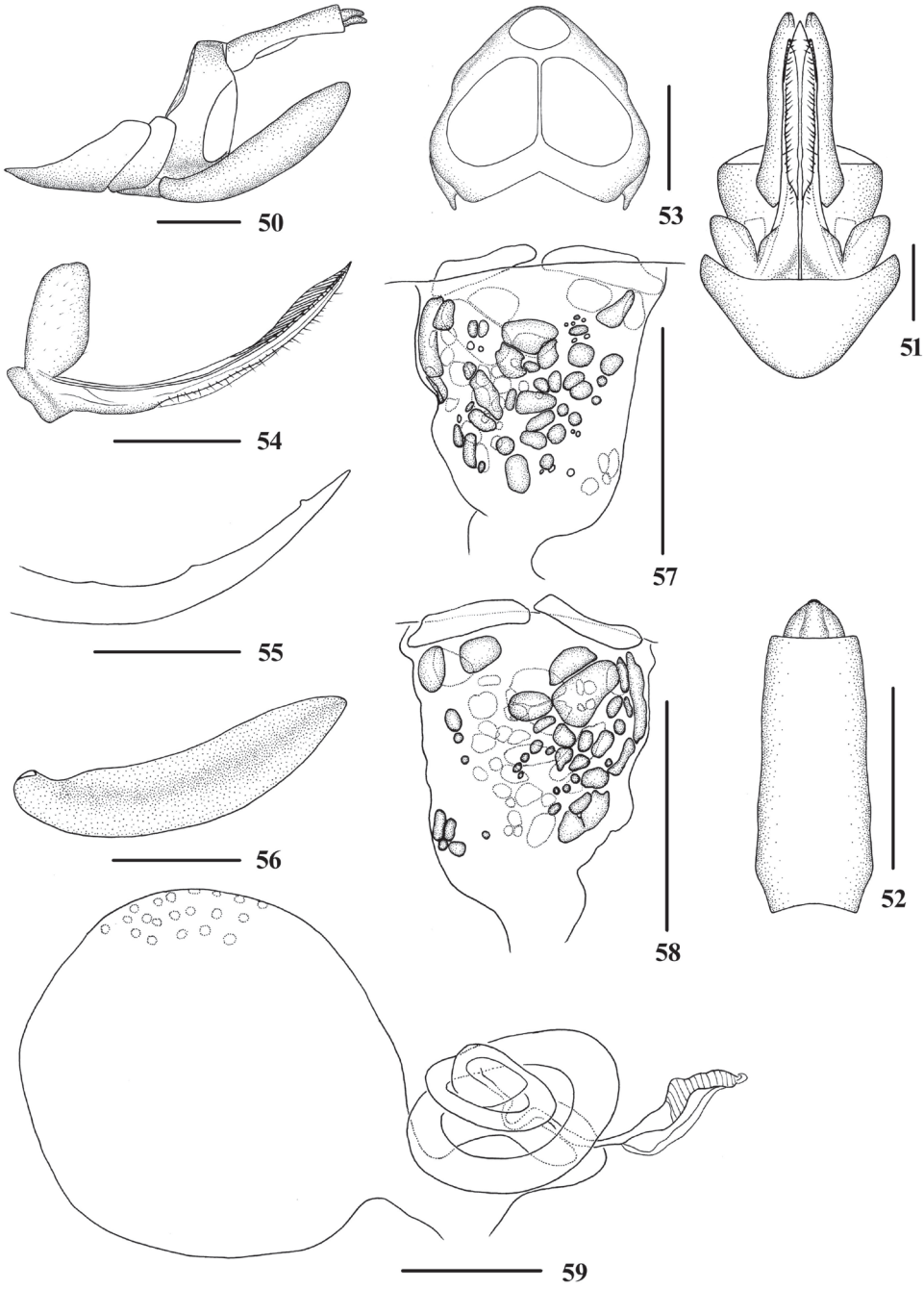
Note. The female genitalia of this species are described and illustrated for the first time.

***Tsauria longispina* Zhi & Chen, sp. nov.**
http://zoobank.org/A394C767-D2ED-4689-89DB-5B16D0CF4232
Figs 3, 4; 38–59

Type material. Holotype: ♂, **China**: Zhejiang, Hangzhou City, Tianmushan, 22 July 2009, Ting-ting He; paratypes: 24♂♂33♀♀, Zhejiang, Hangzhou City, Tianmushan,



Figures 38–49. *Tsauria longispina* sp. nov., male **38** head and thorax, dorsal view **39** face, ventral view **40** head, top view **41** forewing **42** genitalia, lateral view **43** pygofer and gonostyli, ventral view **44** anal segment, dorsal view **45** gonostyli, inner lateral view **46** aedeagus, right side **47** aedeagus, left side **48** aedeagus, dorsal view **49** aedeagus, ventral view. Scale bars: 0.5 mm (**38–40, 42–49**); 1.0 mm (**41**).



Figures 50–59. *Tsauria longispina* sp. nov., female **50** genitalia, lateral view **51** genitalia, ventral view **52** anal segment, dorsal view **53** tergite IX, caudal view **54** gonapophysis VIII and gonocoxa VIII, dorsal view **55** gonapophysis IX, lateral view **56** gonoplac, inner lateral view **57** posterior vagina, ventral view **58** posterior vagina, dorsal view **59** internal genitalia. Scale bars: 0.5 mm.

20–22 July 2009, Yong Chen, Ting-ting He; 1♂, Zhejiang, Longquan City, Fengyangshan, 28–29 July 2009, Ting-ting He; 2♂♂, Guizhou, Liping County, Taipingshan (520–859 m), 15–23 July 2006, Zheng-Guang Zhang; 1♂4♀♀, Guizhou, Liping County, Deshun, 14 July 2016, Yan-li Zheng, Nian Gong, Zheng-xue Zhao, Ying-jian Wang; 1♂, Hainan, Wuzhishan (650 m), 14 July 2007, Ji-chun Xing; 3♂♂, Fujian, Jianou City, Wanmulin, 8–10 August 2009, Pei Zhang, Jun-qiang Ni; 2♂♂4♀♀, Fujian, Jianou City, Wanmulin, 20 May 2012, Jian-kun Long, Wei-cheng Yang; 1♂1♀, Fujian, Dehua county, Guobao, Yunlonggu, 11 May 2012, Jian-kun Long, Wei-cheng Yang; 1♂, Fujian, Datian County, Forest Park, 14 May 2012, Wei-cheng Yang.

Description. Body length: male 6.8–7.6 mm (*n* = 37), female 7.0–8.3 mm (*n* = 42).

Coloration. General color yellowish brown (Figs 3, 4, 38–39). Eyes yellowish brown, ocelli pale yellow. Vertex, face, rostrum, pronotum and mesonotum brown. Forewing semi-translucent, yellowish brown, apical 1/5 with a wide blackish brown stripe, stigma yellowish brown. Hind tibiae yellowish brown and abdominal sternites dark brown.

Head and thorax. Vertex (Figs 3, 38, 40) broad, 1.3 times wider than long; subapical carina with middle prominent into obtuse angle, median carina interrupted by subapical carina, with anterior portion complete, posterior portion only discernible at basal half. Frons (Fig. 39) 1.2 times as long as wide. Clypeus with median carina distinct and elevated throughout. Pronotum (Figs 3, 38) 1.8 times longer than vertex; mesonotum 1.5 times longer than pronotum and vertex combined. Forewing (Fig. 41) 2.7 times longer than wide, with 12 apical and 7 subapical cells; RP 3 branches, MP with 5 terminals: MP_{11}, MP_{12}, MP_2, MP_3, and MP_4, fork MP_1+MP_2 basad of fork MP_3+MP_4. Hind tibia with 3−4 lateral spines; chaetotaxy of hind tarsi: 9/10−12, second segment of hind tarsus with 6−9 platellae.

Male genitalia. Pygofer (Figs 42, 43) symmetrical, dorsal margin concave and U-shaped ventrally; in lateral view, lateral lobes triangularly extended caudally, apex round. Medioventral process mastoid ventrally. Anal segment (Figs 42, 44) long tubular, symmetrical, 2.9 times longer than wide in dorsal view; anal style finger-like, slightly beyond anal segment. Gonostyli (Figs 42, 43, 45) in ventral view, symmetrical, widening towards apex, apical part extended, apical margin rounded; in lateral view, "L-shaped". Aedeagus (Figs 46–49) in total with four processes. Left side of periandrium with a medium-sized spinose process, slightly curved, directed left-ventrocephalically at apex; right side near apex of periandrium with a short spinose process, directed left-dorsocephalically; periandrium with a medium-sized spinose process positioning slightly to left side of its dorsal margin, slightly curved upward and directed right-dorsally at apex; ventral margin of aedeagal periandrium with an extremely long spinose process, which is the longest of all spinose processes of periandrium, straight, generally directed towards left side, apex directed cephalically. Endosoma moderately sclerotized, structure simple, generally curving left.

Female genitalia. Tergite IX (Figs 50, 51, 53) subtriangular, moderately sclerotized, divided by median keel. Anal segment (Figs 50, 53) rectangle, 2.3 times longer than wide in dorsal view. Gonapophysis VIII (Fig. 54) elongate, and slightly curved upwards. Gonapophysis IX (Fig. 55) with two middle teeth, denticulate portion with

only one small rounded odontoid. Gonoplac (Fig. 56) rod-like, 3.7 times longer than wide in lateral view. Posterior vagina (Figs 57, 58) elongate. Posterior vagina with many small round, oval and oblong sclerites both in ventral and dorsal view. Sclerites in ventral view dispersed and the ones in dorsal view mainly concentrated in left side. Internal genitalia as shown in Fig. 59.

Distributions. China (Fujian, Guizhou, Hainan, Zhejiang).

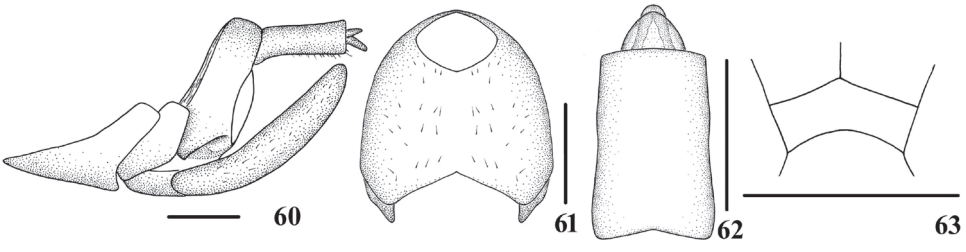
Etymology. The specific name is derived from the Latin prefixes "*longi*" and noun "*spina*", referring to the ventral margin of aedeagal periandrium with an extremely long spinose process, which is the longest of all spinose processes of the periandrium.

Remarks. Male genitalia of *T. longispina* sp. nov. is similar to *T. brevispina* sp. nov., but differs in: (1) spinose process on ventral margin of periandrium being the longest of all spinose processes of periandrium, straight (in *T. brevispina*, spinose process on ventral margin of periandrium being the shortest of all spinose processes of periandrium, hooked at apex); (2) spinose process on right side near apex of periandrium slightly curved, directed left-dorsocephalically at apex (the latter strongly curved, directed dorsocaudally at apex).

Female genitalia of *T. longispina* sp. nov. is similar to *T. cehengensis* (Zhang & Chen), but differs in: (1) wax plate divided by median keel (the latter widened laterally and without median keel; (2) posterior vagina elongate (in *T. cehengensis*, the length of posterior vagina equal to the width).

Discussion

Holzinger (2002) emphasized the importance of the morphological characters of the female abdomen wax plate and its conformation in Cixiini. The conformation of the wax-plate area below the anal tube in females has great taxonomic value in Cixiidae. Therefore, following Holzinger's taxonomic practice, we confirmed that the species *Tsauria transspinus* (Zhang & Chen, 2011) had been incorrectly placed in this genus, for its females lacked the wax plate (Fig. 61), whereas the existence of this structure was critical in *Tsauria*. Some other characters, such as "vertex with median carina before subapical carina vanished (Fig. 63) and abdomen with shorter anal tube in females



Figures 60–63. *Tsauria transspinus* (Zhang & Chen, 2011) incertae sedis, female **60** genitalia, lateral view **61** tergite IX, caudal view **62** anal segment, dorsal view **63** head, top view, male. Scale bars: 0.5 mm.

(Figs 61–62)" were also distinctly inconsistent with the other members of *Tsauria*. For the above reasons, in this study we removed *Tsauria transspinus* from *Tsauria* and left it as incertae sedis provisionally, as determining its taxonomic position was out of the main purpose of this paper, and it probably should be dealt with elsewhere.

Tsauria cehengensis (Zhang & Chen, 2011) and *T. major* (Tsaur & Hsu, 1991) were distinguished mainly on the characters of the male genitalia; only the anal segment of *T. major* was illustrated for the female (Tsaur et al. 1991; Zhang and Chen 2011). Zhi et al. (2017, 2018) found the characters of the sclerites on the posterior vagina could be considered as key diagnostic characters for female identification in the genera *Neocarpia* (Eucarpiini) and *Oecleopsis* (Pentastirini). The authors also discussed the external and the internal structures of the female genitalia in cixiid planthoppers. In this study, the sclerites of the vagina are studied in detail in *Tsauria brevispina* (Figs 24, 25), *T. cehengensis* (Figs 34, 35) and *T. longispina* (Figs 57, 58). As a result, the characters of the posterior vagina have been shown to be fairly effective when used to distinguish among species of *Tsauria*.

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The authors are grateful to the specimen collectors for their hard work in the field collections. This work was supported by the National Natural Science Foundation of China (No. 31472033), the Program of Excellent Innovation Talents, Guizhou Province (No. 20154021), the Program of Science and Technology Innovation Talents Team, Guizhou Province (No. 20144001), the International Cooperation Base for Insect Evolutionary Biology and Pest Control (No. 20165802) and the Science and Technology Project of Guiyang (No. [2017]5-25).

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Zhi Y, Yang L, Zhang P, Chen XS (2018) Two new species of genus *Oecleopsis* Emeljanov from China, with descriptions of female genitalia of five species (Hemiptera, Fulgoromorpha, Cixiidae). ZooKeys 768: 1–17. https://doi.org/10.3897/zookeys.768.24796

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RESEARCH ARTICLE

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Review of the leafhopper subgenus *Pediopsoides* (*Sispocnis*) (Hemiptera, Cicadellidae, Eurymelinae, Macropsini) with description of two new species from China

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Abstract

The leafhopper subgenus *Pediopsoides* (*Sispocnis*) Anufriev, 1967 is reviewed and the type species is fixed as *Bythoscopus kogotensis* Matsumura, 1912. Six valid species of the subgenus are recognized including two new species described and illustrated here, *Pediopsoides* (*Sispocnis*) *rectus* Li, Li & Dai, **sp. nov.** and *P.* (*S.*) *triangulus* Li, Li & Dai, **sp. nov.** from Sichuan Province of Southwestern China. Additionally *P.* (*S.*) *heterodigitatus* Dai & Zhang, 2009 is proposed as a junior synonym of *P.* (*S.*) *aomians* (Kuoh, 1981) based on examination of many specimens. A key to species of the subgenus is also provided for identification.

Keywords

Auchenorrhyncha, morphology, new type, taxonomy

Introduction

The leafhopper genus *Pediopsoides* belonging to the subfamily Eurymelinae, tribe Macropsini (Dietrich and Thomas 2018) of Cicadellidae (Hemiptera: Auchenorrhyncha) was originally established by Matsumura (1912) with *Pediopsoides formosanus*

Matsumura, 1912 as its type species, and divided into four subgenera based on the features of the facial and tegminal proportions, and the male genitalia by Hamilton (1980). *Sispocnis* is just one of the four subgenera of *Pediopsoides* as proposed by Hamilton (1980), and was originally placed in the genus *Oncopsis*, erected by Anufriev (1967) for *Bythoscopus juglans* Matsumura, 1912 (misidentified type species). Later, Viraktamath (1981) added a new species, *Pediopsoides* (*Sispocnis*) *sharmai* from India; Dai and Zhang (2009) described two new species, *P.* (*S.*) *dilatus* and *P.* (*S.*) *heterodigitatus* from China, proposed a new combination, *P.* (*S.*) *aomians* from the genus *Oncopsis*, and revealed two new synonyms: *Digitalis* Liu & Zhang, 2002 as a synonym of *Pediopsoides* and *Digitalis striolatus* Liu & Zhang, 2002 as a junior synonym of *P.* (*S.*) *aomians* (Kuoh, 1981). So far, five species of *Pediopsoides* (*Sispocnis*) are known from the world including four species recorded in China.

In our marcopsine collection from Sichuan Province of China, two new species of *Pediopsoides* (*Sispocnis*) are recognized, and their illustrated descriptions are provided in the present paper. Based on the examination of the specimens, the subgenus *Pediopsoides* (*Sispocnis*) is simultaneously reviewed and a key is given for identification. It is revealed that *P.* (*S.*) *heterodigitatus* Dai & Zhang, 2009 is a junior synonym of *P.* (*S.*) *aomians*. To date, six species of the subgenus *Pediopsoides* (*Sispocnis*) are known, five of which occur in China.

Materials and methods

Adult specimens collected by sweep net were used for examination, description, illustration and imaging. The habitus images of adults were obtained with an Olympus SZX7 microscope mounted with a Canon EOS 550D camera.

The morphological terminologies and the higher classification system follow Hamilton (1980). The body length is measured from the apex of the head to the end of the forewings and is given in millimeters (mm).

The type materials of the new species are deposited in the Museum of Zoology and Botany, Shaanxi University of Technology, Hanzhong, China (SUHC). Other examined specimens are deposited in the Institute of Entomology, Guizhou University, Guiyang, China (GUGC).

Systematics

Genus *Pediopsoides* Matsumura, 1912

Pediopsoides Matsumura, 1912: 305

Type species. *Pediopsoides formosanus* Matsumura, 1912

Subgenus *Pediopsoides* (*Sispocnis*) Anufriev, 1967

Oncopsis (*Sispocnis*) Anufriev, 1967: 174
Pediopsoides (*Sispocnis*) Hamilton, 1980: 897

Type species. *Bythoscopus kogotensis* Matsumura, 1912, new designation.

The type species is fixed here under Article 70.3 of the ICZN as *Bythoscopus kogotensis* Matsumura, 1912, misidentified as *Bythoscopus juglans* Matsumura, 1912 in the original designation of *Sispocnis* by Anufriev (1967).

Distribution. Palaearctic and Oriental Regions.

Diagnosis. *Pediopsoides* (*Sispocnis*) is well known by the following features: face including eyes is clearly wider than long; the stripes on pronotum are usually transverse and weakly obscure, forewing has anteapical cells of variable number (2 or 3), male pygofer ventral processes generally bifid to multifid and twisted inward; and the dorsal connective usually carries a strongly developed process from its inner ventral margin.

Remarks. *Sispocnis* was originally established as a subgenus under the genus *Oncopsis* by Anufriev (1967) for *Bythoscopus juglans* Matsumura, 1912 which was designated as the type species. Hamilton (1980) revised the status of *Sispocnis* and proposed it as a subgenus within *Pediopsoides*. Hamilton (1980) also recognized Anufriev's (1967) identification of *B. juglans* Matsumura as a misidentification, and provisionally considered *Oncopsis* (*Sispocnis*) *kurentsovi* Anufriev as the type of the subgenus. Based on examination of the type specimens of Matsumura (1912) and Anufriev (1977), Okudera (2014) considered *O.* (*S.*) *kurentsovi* Anufriev as a junior synonym of *B. kogotensis* Matsumura, and recognized misidentifications of this species as *B. juglans* by Anufriev (1967) and Anufriev and Emeljanov (1988). Additionally, Okudera (2014) considered *B. juglans* Matsumura as a junior synonym of *Oncopsis nitobei* (Matsumura, 1912).

Herein, it is necessary to clarify the type species for the subgenus. Following the provisions of Article 70.3.2 of the International Code of Zoological Nomenclature (ICZN, 1999), the type species is fixed here as *Bythoscopus kogotensis* Matsumura, 1912, misidentified as *Bythoscopus juglans* Matsumura, 1912 in the original designation by Anufriev (1967). Thus, *Pediopsoides* (*Sispocnis*) remains as a valid subgenus.

***Pediopsoides* (*Sispocnis*) *aomians* (Kuoh, 1981)**
Figs 1–26

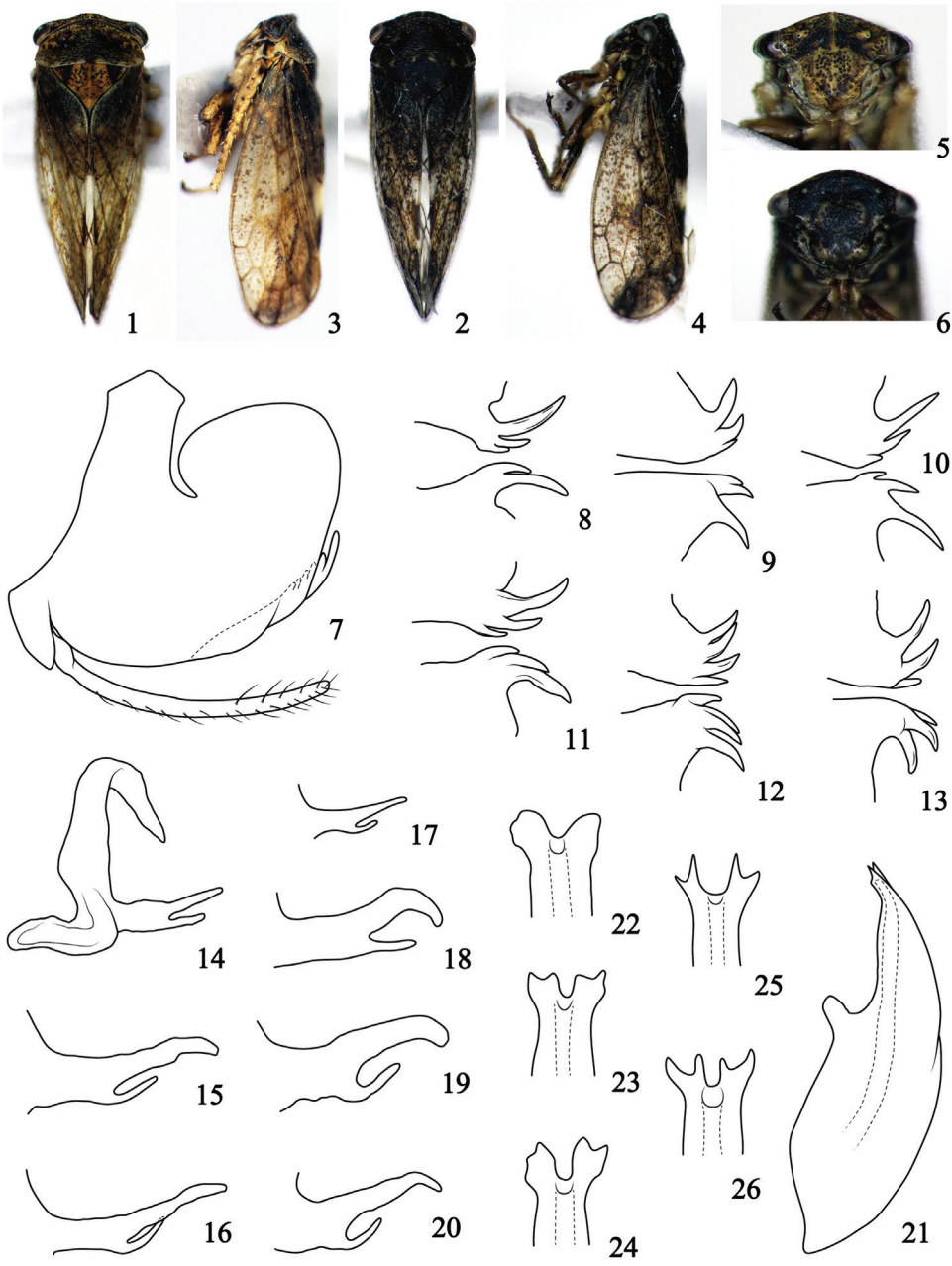
Oncopsis aomians Kuoh, 1981: 201
Digitalis striolatus Liu & Zhang, 2002: 175 (synonym by Dai and Zhang 2009)
Pediopsoides (*Sispocnis*) *aomians*, Dai & Zhang 2009: 28
Pediopsoides (*Sispocnis*) *heterodigitatus* Dai & Zhang, 2009: 31. syn. n.

Material examined. GUGC: 1 ♂, CHINA: Shaanxi Province, Mei County, Taibaishan National Natural Reserve, 17.vii.2012, collected by Fan Zhi-Hua; 1 ♀, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Kangding County, 31.vii.2012, collected by Fan Zhi-Hua; 2 ♀♀, CHINA: Yunnan Province, Diqing Tibetan Autonomous Prefecture, Shangri-la, 08.viii.2012, collected by Fan Zhi-Hua; 1 ♂, CHINA: Qinghai Province, Tu Autonomous County of Huzhu, Beishan Forest Farm, 2685 m, 17.viii.2008, collected by Song Qiong-Zhang; 2 ♂♂, CHINA: Qinghai Province, Datong Hui & Tu Autonomous County, Black Spring Reservoir, 3000 m, 09.vii.2007, collected by Chen Xiang-Sheng; 1 ♂ 7 ♀♀, CHINA: Sichuan Province, Tibetan Qiang Autonomous Prefecture of Ngawa, Songpan County, Huanglong Temple, 22.viii.1994, collected by Du Yu-Zhou; 5 ♀♀, CHINA: Yunnan Province, Nujiang of the Lisu Autonomous Prefecture, Lushui City, PianMa Town, 17.viii.2001, collected by Yang Mao-Fa; 2 ♂♂ 4 ♀♀, CHINA: Shanxi Province, Xinzhou City, Ningwu County, Luyashan National Natural Reserve, 18.viii.2011, collected by Li Hu, Fan Zhi-Hua & Yu Xiao-Fei. SUHC: 4 ♂♂ 4 ♀♀, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Luding County, Moxi Town, Hailuogou, 3600 m above sea level, 12.viii.2015, collected by Zhan Hong-Ping; 1 ♂ 1 ♀, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Daocheng County, Sangdui Town, 4100 m above sea level, 15.viii.2015, collected by Zhan Hong-Ping; 1 ♂ 1 ♀, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Luding County, Minya Konka, Yajiageng, 3800 m above sea level, 13.viii.2015, collected by Zhan Hong-Ping; 1 ♂, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Luding County, Xindianzi, 2845 m above sea level, 13.viii.2015, collected by Zhan Hong-Ping.

Description. *Body color* (Figs 1–6). Yellow brown to dark brown or black, usually densely marked with darker maculae. Pronotum (Figs 1, 2) generally with 4–6 shallow yellowish or brown spots on posterior margin. Scutellum (Figs 1, 2) with black triangular spots on lateral corners, or evenly black.

Body appearance (Figs 1–6). Stout and wedge-shaped. Head (Figs 1, 2) with frontal margin sinuated slightly. Face (Figs 5, 6) with stripes and punctures; frons clearly with longitudinal carina in middle, and oblique striations from carina to lateral margins; lower parts of postclypeus tumid. Pronotum (Figs 1, 2) 2.5 times wider than long, scutellum 1.2 times longer than that of pronotum. Forewing (Figs 3, 4) with three anteapical and four apical cells, and occasionally with additional cross-vien(s).

Male genitalia. Pygofer (Figs 7–13) basally broad, ventrocaudal margin with multifid and inturned process usually with 2–4 figure-like or spine-like branches of different size. Dorsal connective (Figs 14–20) strongly developed, S-shaped, with bifurcate various process from inner ventral margin with dorsal branch usually larger, longer and twisted ventrad and ventral branch small, short and dorsally bent. Aedeagus (Figs 21–26) broad basally, shaft margins parallel or slightly sinuate at ventral aspect, apical dorsal margin of shaft elongate to two lobes (Fig. 22) and usually bifid at varying levels (Figs 23–26) with each lobe.



Figures 1–26. *Pediopsoides* (*Sispocnis*) *aomians* (Kuoh) **1, 2** male habitus, dorsal view **3, 4** male habitus, lateral view **5, 6** face **7** male pygofer and subgenital plate, lateral view **8–13** pygofer ventral processes (from several specimens), ventrocaudal view **14** dorsal connective, lateral view **15–20** process of dorsal connective from inner ventral margin, lateral view **21** aedeagus, lateral view **22–26** apex of aedeagus, ventral view.

Distribution. China (Shaanxi, Sichuan, Qinghai, Shanxi, Gansu and Yunnan).

Remarks. After examination of many specimens, the morphological diversity of *P.* (*S.*) *aomians* in body color and male genital structures is now better understood. *Pediopsoides* (*S.*) *aomians* can be distinguished from other members of *Pediopsoides* (*Sispocnis*) largely by the multifid (2–4) figure-like or spine-like process on distal caudoventral margin of male pygofer, the bifurcate process from inner ventral margin of the dorsal connective, and the unique structure of the aedeagus. The original description of *P.* (*S.*) *heterodigitatus* was based on only one male from Yunnan Province of China and the shape of male genitalia according to the description of that species falls well within the variation of *P.* (*S.*) *aomians* as interpreted here. It is proposed herein as a junior synonym of *P.* (*S.*) *aomians*.

Pediopsoides (*Sispocnis*) *dilatus* Dai & Zhang, 2009

Pediopsoides (*Sispocnis*) *dilatus* Dai & Zhang, 2009: 31

Material examined. 2 ♂♂, CHINA: Qinghai Province, Datong Hui & Tu Autonomous County, Black Spring Reservoir, 3000 m, 09.vii.2007, collected by Chen Xiang-Sheng; 1 ♀, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Kangding County, Scenic Spot of Kangding Love Song (= Mugecuo), 3600–3800 m, 30.viii.2008, collected by Yang Mao-Fa; 14 ♀♀, CHINA: Guizhou Province, Zunyi City, Suiyang County, Kuankuoshui National Natural Reserve, Chachang/Shuiku, 03-09.vi.2010, collected by Li Hu, Dai Ren-Huai & Xing Ji-Chun; 2 ♀♀, CHINA: Guizhou Province, Qiandongnan Miao & Dong Autonomous Prefecture, Leishan County, Leigongshan National Natural Reserve, 05.vii.2011, collected by Zheng Wei-Bin; 1 ♀, CHINA: Shandong Province, Qingdao City, Laoshan Mountain, 17.viii.2011, collected by Chang Zhi-Min.

Distribution. China (Sichuan, Qinghai, Guizhou, Shandong and Xizang).

Remarks. This species can be easily recognized by the teeth on the caudoventral margin of the male pygofer, the aedeagal shaft broadened gradually from the base to the end, the lateral triangular expansions on shaft apex, and the dorsal connective with the process from the inner ventral margin weakly sclerotized, slender, short and unbranched.

Pediopsoides (*Sispocnis*) *kogotensis* (Matsumura, 1912)

Bythoscopus kogotensis Matsumura, 1912: 305
Oncopsis juglans, Ishihara 1953: 21, misidentified (nec Matsumura 1912)
Oncopsis (*Sispocnis*) *juglans*, Anufriev 1967: 174, misidentified (nec Matsumura 1912)
Oncopsis (*Sispocnis*) *kurentsovi* Anufriev, 1977: 12 (synonym by Okudera 2014)

Pediopsoides (*Sispocnis*) *juglans*, Anufriev and Emeljanov 1988: 78, misidentified (nec Matsumura 1912)

Material examined. 28 ♂♂ 29 ♀♀, CHINA: Shanxi Province, Lishan National Natural Reserve, 23–26.vii.2012, collected by Song Qiong-Zhang, Zhang Pei & Xing Dong-Liang; 1 ♀, CHINA: Shanxi Province, Xinzhou City, Ningwu County, Luyashan National Natural Reserve, 19.viii.2011, collected by Yu Xiao-Fei; 2 ♂♂ 1 ♀, CHINA: Sichuan Province, Ya'an City, Tianquan County, Erlang Mountain, Labahe, 25.vii.2012, collected by Fan Zhi-Hua & Li Hu; 2 ♀♀, CHINA: Sichuan Province, Ya'an City, Fengtongzhai National Natural Reserve, 1500 m, 01.viii.2005, collected by Zhou Zhong-Hui & Xu Fang-Ling; 1 ♀, CHINA: Sichuan Province, Erlang Mountain, 04.viii.2005, collected by Yang Zai-Hua; 1 ♂, CHINA: Shaanxi Province, Ankang City, Ningshan County, Huoditang, Linchang, 12.vii.2012, collected by Li Hu; 2 ♀♀, CHINA: Shaanxi Province, Mei County, Taibaishan National Natural Reserve, Haopingsi, 12.vii.2012, collected by Xu Shi-Yan; 1 ♀, CHINA: Shaanxi Province, Qingmuchuan National Natural Reserve, 18.viii.2010, collected by Li Hu & Fan Zhi-Hua; 1 ♂, CHINA: Anhui Province, Liuan City, Tiantangzhai National Natural Reserve, 950 m, 01.viii.2013, collected by Li Bin, Jiao Meng & Yu Xiao-Fei; 1 ♀, CHINA: Hubei Province, Shiyan City, Wudang Mountains, 13.vii.2013, collected by Li Hu; 1 ♀, CHINA: Hubei Province, Shennongjia National Natural Reserve, Guanmenshan, 19.vii.2013, collected by Xing Dong-Liang; 1 ♂, CHINA: Hubei Province, Shennongjia National Natural Reserve, Yazikou, 1850 m, 11.viii.1997, collected by Yang Mao-Fa; 1 ♂, CHINA: Hubei Province, Wufeng Tujia Autonomous County, Houhe National Natural Reserve, 22.vii.2013, collected by Chang Zhi-Min; 1 ♀, CHINA: Guizhou Province, Leigongshan National Natural Reserve, 10.vii.2010, collected by Long Jian-Kun; 1 ♂ 3 ♀♀, CHINA: Guizhou Province, Leigongshan National Natural Reserve, Light traping, 04–06.vii.2011, collected by Chang Zhi-Min & Zheng Wei-Bin; 2 ♀♀, CHINA: Jilin Province, Changbaishan National Natural Reserve, 24.vii.2011, collected by Jiao Meng; 2 ♂♂ 1 ♀, CHINA: Henan Province, Xinxiang City, Huixian City, 800 m, 12.vii.2002, collected by Chen Xiang-Sheng; 2 ♂♂, CHINA: Henan Province, Baiyunshan National Natural Reserve, 14–17.viii.2008, collected by Li Jian-Da; 2 ♀♀, CHINA: Ningxia Hui Autonomous Region, Liupan Mountains, 2050 m, 28–29.vii.2008, collected by Song Qiong-Zhang; 1 ♀, CHINA: Jilin Province, Changbaishan National Natural Reserve, Baihe, 13.viii.1996, collected by Li Zi-Zhong; 1 ♀, CHINA: Liaoning Province, Benxi City, Laotudingzi National Natural Reserve, 19–20.vii.2011, collected by Fan Zhi-Hua; 10 ♂♂ 7 ♀♀, CHINA: Hebei Province, Chengde City, Wulingshan National Natural Reserve, 09.viii.2011, collected by Li Hu, Jiao Meng, Fan Zhi-Hua, Yu Xiao-Fei, Liang Wen-Qin & Zhang Xin-Feng.

Distribution. Widespread in China (Jilin, Liaoning, Zhejiang, Hebei, Henan, Shanxi, Shaanxi, Ningxia, Anhui, Hubei, Guizhou and Sichuan), Korea, southern part of Primorsky Krai of Russia and Japan.

Remarks. The combined features of the shape of the pygofer articulated lobe and ventral process, the relatively simple dorsal connective, and the structure of the aedeagus separate *P.* (*S.*) *kogotensis* from other species.

Pediopsoides (*Sispocnis*) *rectus* Li, Li & Dai, sp. nov.

http://zoobank.org/5BA796B9-A9DB-4027-A391-401A8D1A24BA
Figs 27–37

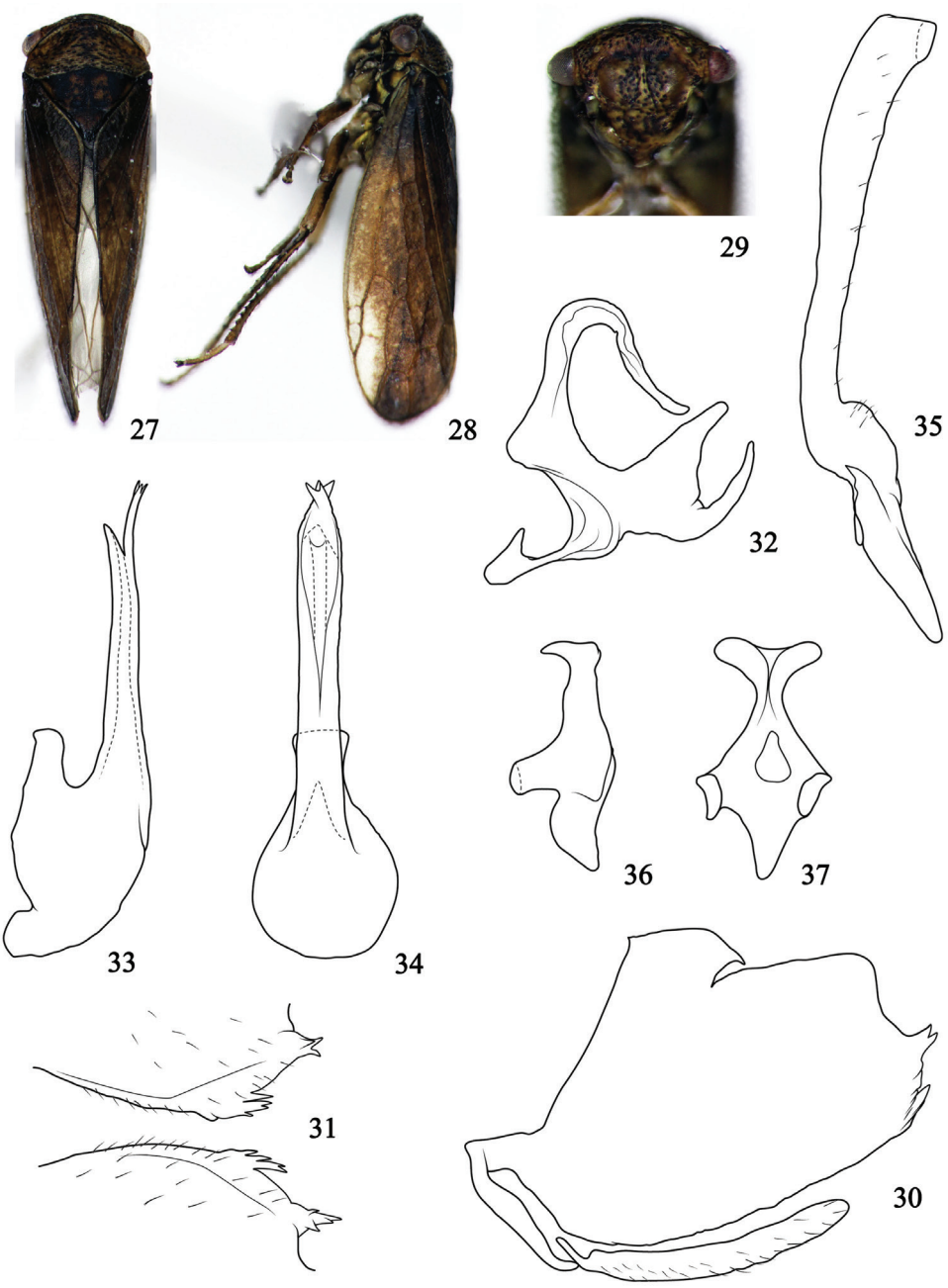
Type material. HOLOTYPE: ♂, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Luding County, Minya Konka, Yajiageng, 3800 m above sea level, 13.viii.2015, collected by Zhan Hong-Ping. PARATYPE: 1 ♂, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Xiangcheng County, Shagong Town, Dagen, 3500–3900 m above sea level, 15.viii.2015, collected by Zhan Hong-Ping.

Etymology. The new specific epithet was derived from the Latin words "*rectus*" indicating that the aedeagal shaft is straight relatively.

Description. *Body color*. Body background color (Figs 27, 28) chocolate, punctures on surface of head, face, pronotum and scutellum darker brown. Face (Fig. 29) brownish, eyes reddish brown on facial view and pale brown on dorsal view (Fig. 27). Scutellum (Fig. 27) darker brown, both lateral corners with black triangular spots. Forewing (Figs 27, 28) evenly brown except area around outer apical cell, venation darker.

Body appearance. Head (Fig. 27) short, and prominent forward, anterior margin slightly depressed near eyes, including eyes as wide as pronotum. Face (Fig. 29) covered distinct punctures; frons with weak carina and oblique striations, central part with two smooth inflated regions without any stripes or maculae; distance between ocelli nearly 4 times of that from ocellus to adjacent eye. Pronotum (Fig. 27) with obvious, intensively transverse striations and punctures, anterior margin round, and prominent frontally, posterior margin depressed in middle, 2.6 times broader than long. Scutellum (Fig. 27) surface granulose, mid-length 1.5 times that of pronotum. Forewing (Figs 27, 28) opaque, with three anteapical cells, veins prominent.

Male genitalia. Pygofer (Fig. 30) broad basally, dorsal margin incised and straight, distal part of ventral and caudal margins carries irregular small spine-like processes, and scattered setae. Subgenital plate (Fig. 30) slender, approximatively 0.65 times ventral margin of pygofer, marginated with setae. Aedeagus (Figs 33, 34) basally broad, dorsal apodeme well developed, shaft slender, and almost straight in lateral view, lateral margins parallel in ventral view, apex of ventral margin strongly expanded, and produced to bifid process which bifurcates again; gonopore apical. Dorsal connective (Fig. 32) in lateral aspect S-shaped, carries large bifurcate process from its inner ventral margin with both branches of equal length. Style (Fig. 35), stem stout and widened gradually to truncate apex, with marginal setae.



Figures 27–37. *Pediopsoides* (*Sispocnis*) *rectus* sp. nov. **27** male habitus, dorsal view **28** male habitus, lateral view **29** face **30** male pygofer and subgenital plate, lateral view **31** pygofer ventral processes, ventrocaudal view **32** dorsal connective, lateral view **33** aedeagus, later view **34** aedeagus, ventral view **35** style, dorsal view **36** connective, lateral view **37** connective, dorsal view.

Measurement. Body length (including tegmen): 4.8–4.9 mm.

Distribution. China (Sichuan).

Remarks. This new species somewhat resembles *P.* (*S.*) *aomians* with both sharing approximate color pattern and external body form more or less, but it can be distinguished from the latter and other known species of *Pediopsoides* (*Sispocnis*) by the different structures of the pygofer ventral processes, aedeagus and the dorsal connective.

Pediopsoides (*Sispocnis*) *sharmai* Viraktamath, 1981

Pediopsoides (*Sispocnis*) *sharmai* Viraktamath, 1981: 308

Material examined. None.

Distribution. India.

Remarks. Based on the original description by Viraktamath (1981), this species can be separated from other members of the subgenus mostly by the following features: the pygofer ventral margin has two spine-like processes distally, the tapered aedeagal shaft has an excavated distal margin in middle formed into a U-shaped in caudal view, and the dorsal connective has a bifid apex and caudally-directed triangular process from its inner ventral margin.

Pediopsoides (*Sispocnis*) *triangulus* Li, Li & Dai, sp. nov.

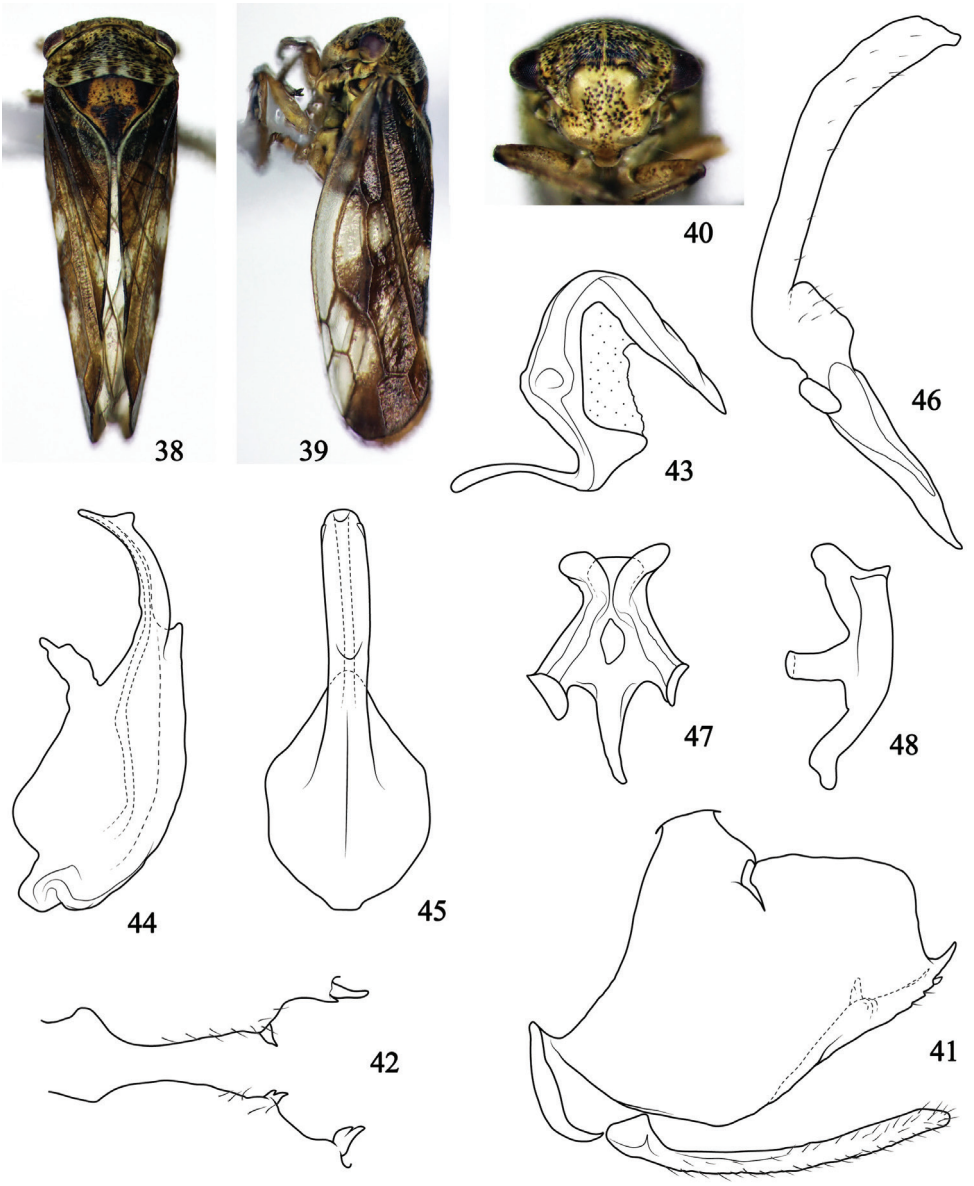
http://zoobank.org/4C4D305F-A4F3-415C-9D88-C5F7B63A3107
Figs 38–48

Type material. HOLOTYPE: ♂, CHINA: Sichuan Province, Tibetan Autonomous Prefecture of Garzê, Luding County, Minya Konka, Yajiageng, 3800 m above sea level, 13.viii.2015, collected by Zhan Hong-Ping.

Etymology. The new species name was derived from the Latin words "*triangulus*" referring to the triangular processes on the lateral margins of the aedeagal shaft.

Description. *Body color*. Background color (Figs 38, 39) yellow brown, punctures on body surface dark brown. Face (Fig. 40) yellowish, eyes dark brown, occasionally with reddish tinge. Pronotum (Fig. 38) with six pale yellowish subtriangular spots on posterior margin. Scutellum (Fig. 38) orange brown, both lateral corners with black triangular spots, and with dark posterior half. Forewing (Figs 38, 39) mainly pigmented by dark brown except transparent parts.

Body appearance. Head (Fig. 38) prominent frontally, clearly shorter medially than next to eyes, head including eyes as wide as pronotum. Face (Fig. 40) inflated in lateral view; frons with intensive punctures, oblique stripes and mid-carina; central part with n-shaped smooth region; ocelli closer to eyes, distance between them nearly 5 times of that from an ocellus to adjacent eye. Pronotum (Fig. 38) oblique forward and laterally, 2.7 times broader than long, with obvious, intensive and transverse striations and punc-



Figures 38–48. *Pediopsoides* (*Sispocnis*) *triangulus* sp. nov. **38** male habitus, dorsal view **39** male habitus, lateral view **40** face **41** male pygofer and subgenital plate, lateral view **42** pygofer ventral processes, ventrocaudal view **43** dorsal connective, lateral view **44** aedeagus, later view **45** aedeagus, ventral view **46** style, dorsal view **47** connective, dorsal view **48** connective, lateral view.

tures, anterior area near eyes depressed, posterior margin excavated in middle. Scutellum (Fig. 38) surface granulose, and scattered with punctures, mid-length about 1.8 times that of pronotum. Forewing (Figs 38, 39) with three anteapical cells, veins prominent.

Male genitalia. Pygofer (Fig. 41) broad basally, with incised dorsal and caudal margins, distal half of each ventral margin produced into two small spine-like processes which sometimes bifid. Subgenital plate (Fig. 41) narrow and elongate, nearly as long as that of ventral margin of pygofer, and with marginal setae. Aedeagus (Figs 44, 45) basally broad, with strongly developed dorsal apodeme and preatrium, shaft short, clearly narrower than basis in lateral view, lateral margins parallel in ventral view, subapex with small triangular processes directed caudally on lateral margins, apex round; gonopore apical. Dorsal connective (Fig. 43), in lateral aspect, S-shaped, process from inner ventral margin short, and horn-like. Style (Fig. 46), stem bent dorsolaterally, apex with small expansion. Connective (Figs 47, 48) typical.

Measurement. Body length (including tegmen): 4.8 mm.

Distribution. China (Sichuan).

Remarks. The new species is similar to *P.* (*S.*) *aomians* in the pattern of body coloration, and somewhat similar to *P.* (*S.*) *dilatus* in male features, but can be distinguished from both by the distal half of the pygofer ventral margin with two small spine-like processes which are sometimes bifid, different shapes of the aedeagus and the dorsal connective.

Key to species of *Pediopsoides* (*Sispocnis*) based on male genitalia

1 Pygofer with articulated lobe, and one definite process inturned from ventral margin; dorsal connective relatively small, without process from inner ventral margin; aedeagal shaft with clear lateral expansions subapically .... ***P.* (*S.*) *kogotensis***

– Pygofer lobe without obvious suture on pygofer side, and with more than one processes or teeth on ventral margin; dorsal connective large, with various process from inner ventral margin; aedeagal shaft not as above **2**

2 Pygofer ventral margin with series of teeth on distal half; aedeagal shaft narrowed basally, and gradually broadened to end in ventral view ***P.* (*S.*) *dilatus***

– Pygofer ventral margin with bifid or multifid processes on distal half; aedeagal shaft broad basally, or with parallel margins in ventral view **3**

3 Dorsal connective with unbranched process from its inner ventral margin .. **4**

– Dorsal connective with branched process from its inner ventral margin **5**

4 Aedeagal shaft with small triangular processes subapically on lateral margins, and round apex; dorsal connective without bifid apex ..... ***P.* (*S.*) *triangulus* sp. nov**.

– Aedeagal shaft without process on lateral margins, but with U-shaped apex; dorsal connective with bifid apex ..... ***P.* (*S.*) *sharmai***

5 Pygofer ventral margin with large and figure-like multifid (2–4) processes at distal half; aedeagus stout, and bent dorsally, apex of shaft expanded lateroapically ..... ***P.* (*S.*) *aomians***

– Pygofer ventral margin with small and short multifid (more than 5) processes at distal half; aedeagal shaft slender, straight, apex of shaft only expanded apically ..... ***P.* (*S.*) *rectus* sp. nov.**

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RESEARCH ARTICLE

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Two new species of the bamboo-feeding planthopper genus *Purohita* Distant from China (Hemiptera, Fulgoromorpha, Delphacidae)

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Abstract

Two new species of the bamboo-feeding genus *Purohita* Distant, 1906, *P. castaneus* **sp. nov.** and *P. circumcincta* **sp. nov.**, are described and illustrated from southwest China (Yunnan), giving the genus thirteen species in total. A key is provided to distinguish eight Chinese species in the genus.

Keywords

Bamboo planthopper, Fulgoroidea, morphology, taxonomy

Introduction

Distant (1906) established the bamboo-feeding planthopper genus *Purohita* with the type species *P. cervina* Distant, 1906 from Ceylon. This genus belongs to the tribe Tropidocephalini of subfamily Delphacinae (Hemiptera, Fulgoromorpha,

Delphacidae) and is easily recognized from other members in this tribe by the very large antennae, first segment flattened, rectangular, longer than the second segment. Yang and Yang (1986) revised the species of *Purohita* and divided the five known species in Taiwan, China into three subgenera. The first to fifth instars of *P. taiwanensis* Muir, 1914, are also described by Yang and Yang (1986). So far, 11 species of *Purohita* are described, including from China (seven species: *P. fuscovenosa* Muir, *P. maculata* Muir, *P. nigripes* Muir, *P. picea* Yang & Yang, *P. sinica* Huang & Ding, *P. taiwanensis* Muir and *P. theognis* Fennah) (Muir 1913, 1916; Huang et al. 1979; Yang and Yang 1986; Ding 2006; Hayashi and Fujinuma 2016), India (two species: *P. arundinacea* Distant and *P. punjabensis* Sharma & Singh) (Distant 1907; Sharma and Singh 1982), Ceylon (one species: *P. cervina* Distant) (Distant 1906), Japan (two species: *P. cervina* Distant and *P. taiwanensis* Muir) (Hayashi and Fujinuma 2016), Philippine (one species: *P. nigripes* Muir) (Muir 1916; Ding 2006), Pakistan (one species: *P. qadrii* Jabbar-Khan & Jabbar-Khan) (Jabbar-Khan and Jabbar-Khan 1985) and Vietnam (one species: *P. theognis* Fennah) (Fennah 1978; Ding 2006).

Species of *Purohita* with reported plant associations feed on bamboo (Distant 1906; Muir 1913; Huang et al. 1979; Yang and Yang 1986; Ding 2006; this paper). These members were always collected on several genera of bamboos including *Sinocalamus*, *Bambusa*, *Pheioblastus*, *Phyllostachys* and *Dendrocalamus* (Huang et al. 1979; Yang and Yang 1986; Ding 2006). *P. taiwanensis* Muir is of economic significance since the species has large populations in the bamboo fields and is widely distributed in southern China.

Herein, two new species: *Purohita castaneus* sp. nov. and *P. circumcincta* sp. nov. are described and illustrated from Yunnan province, China. A key to species of *Purohita* from China is provided.

Materials and methods

The morphological terminology and measurements follow Yang and Yang (1986). Body length was measured from apex of vertex to tip of tegmina. Dry male specimens were used for the description and illustration. External morphology was observed under a stereoscopic microscope and characters were measured with an ocular micrometer. Color pictures for adult habitus were obtained by the KEYENCE VHX-1000 system. The genital segments of the examined specimens were macerated in 10% KOH and drawn from preparations in glycerin jelly using a Leica MZ 12.5 stereomicroscope. Illustrations were scanned with a Canon CanoScan LiDE 200 and imported into Adobe Photoshop 6.0 for labeling and plate composition.

The type specimens of the new species are deposited in the Institute of Entomology, Guizhou University, Guiyang, China (**IEGU**).

Taxonomy

Purohita Distant, 1906

Purohita Distant, 1906: 470; Ishihara 1949: 86; Tian 1983: 43; Yang and Yang 1986: 64; Ding 2006: 201.

Type species. *Purohita cervina* Distant, 1906, by original designation.

Diagnosis. Head including eyes narrower than pronotum. Vertex narrow, quadrate, slightly extending in front of eyes; lateral carinae strongly ridged, foliate, prominent anteriorly, submedian carinae transverse, median carina obsolete. Frons in middle line longer than wide at widest part about 1.5–2.3: 1, lateral margins divergent apically, median carina forked near base. Postclypeus tricarinate. Antennae very large, first segment flattened, rectangular, longer in middle line than widest part about 2.9–3.3: 1, with central ridge distinct, surface on each side of central ridge obliquely reclined, second segment much shorter than the first about 1: 1.4–2.5. Eyes in dorsal view with lateral side emarginate medially distinctly. Ocelli distinct. Pronotum short, scarcely longer than vertex, tricarinate, lateral carinae attaining hind margin. Mesonotum longer than vertex and pronotum together, tricarinate. Spinal formula of hind leg 5-6-4 or 5-7-4. Wings with M and Cu_1 fused except very short portion at base.

Anal segment large, broad, dorsum flattened and lateroapical angles without process. Pygofer slightly compressed laterally, medioventral processes present or absent. Aedeagus with phallus relative long, phallobase process arising from base, directed ventrad, blunt oval or forked at apex. Diaphragm and lateral areas membranous. Without sclerotized margin of opening of genital styles. Seventh abdominal sternite of female present or absent, genital styles narrow and slender, simple.

Plant associations. Bamboo.

Distribution. Oriental region.

Key to species (males) of *Purohita* from China (modified from Ding 2006)

1 Tegmina with transverse veins (nodal line) bordered with brown stripe (see Ding 2006: fig. 104H)..... ***P. theognis***

– Tegmina with transverse veins not bordered with brown stripe **2**

2 Pygofer with distinct medioventral processes..... **3**

– Pygofer without medioventral process..... **7**

3 Pygofer with medioventral processes protruding in front of margin deeply incised at apex; in posterior view genital styles with inner margin basal half extending quadrate **4**

– Pygofer with medioventral processes not protruding in front of margin, outer pair distinctly higher than median ones, median portion deeply cleft; in posterior view genital styles slender **6**

4 Medioventral process bifurcated, hook-like **5**
– Medioventral process flattened, with minute production on outer side (see Huang et al. 1979: fig. 24) ..... ***P. sinica***
5 Medioventral processes with apices directed dorsolaterally, each side with a process enlarging at apex, apical margin truncate (see Ding 2006: fig. 101C) ..... ***P. taiwanensis***
– Medioventral processes with apices directed dorsomedially, each side with a large triangular process (Fig. 7) ..... ***P. castaneus* sp. nov.**
6 Medioventral processes with median ones each with two processes at apex (see Yang and Yang 1986: fig. 42E, H) ..... ***P. picea***
– Medioventral processes with median ones each with single process at apex (see Yang and Yang 1986: fig. 41B, D) ..... ***P. nigripes***
7 Pygofer with medioventral margin V-like; anal segment with length longer than width more 1.6: 1 (Fig. 19) ..... ***P. circumcincta* sp. nov.**
– Pygofer with medioventral margin broadly U-shaped; anal segment with length longer than width about 1.1: 1 (see Yang and Yang 1986: fig. 40E) ..... ***P. maculata***

***Purohita castaneus* sp. nov.**
http://zoobank.org/47C580B3-61BE-4777-91AF-6163AFFBB699
Figs 1–12

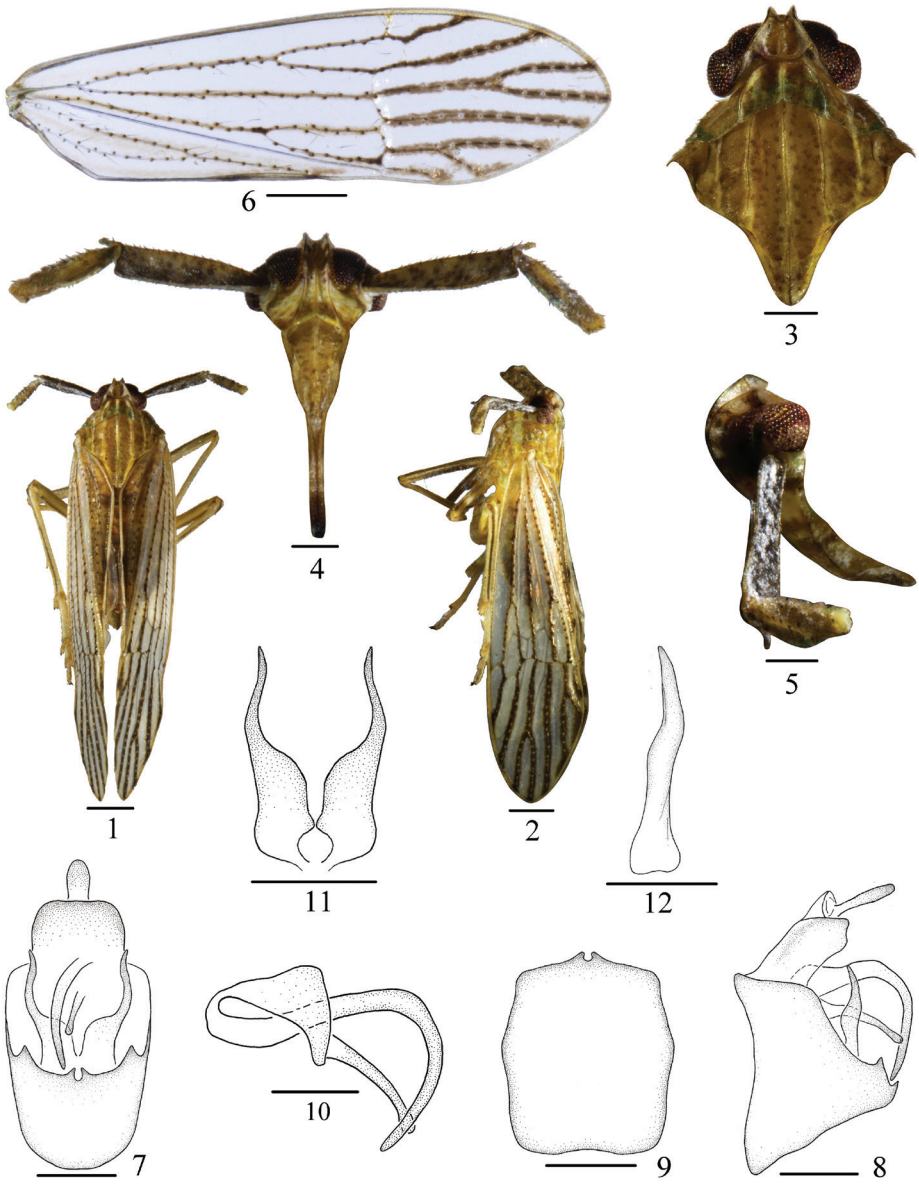
Type material. Holotype: ♂, **China:** Yunnan, Yingjiang County (24°44'N, 97°33'E), on bamboo, 17 August 2018, Hong-Xing Li; paratypes, 1♂, 3♀♀, same data as holotype, Hong-Xing Li and Qiang Luo.

Etymology. Specific epithet derived from "*castaneus*", referring to the brown color of the pronotum and mesonotum.

Measurements. Body length (from apex of vertex to tip of tegmina): male 4.6–4.8 mm (n = 2); female 5.1–5.3 mm (n = 3); tegmen length: male 3.9–4.0 mm (n = 2); female 4.4–4.7 mm (n = 3).

Diagnosis. The salient features of the new species include the following: pygofer with medioventral processes forming a bifurcate hook, apices directed dorsomedially, and each side with a large triangular process (Fig. 7).

Description. *Coloration*. General color brown (Figs 1–6). Vertex yellowish brown. Frons with basal half brown speckled with milky white, thence milky white to apical quarter, the apical quarter yellowish brown. Genae milky white at basal two thirds and yellow at apical third. Clypeus yellowish brown. Rostrum black brown at apex. Antennae brown. Eyes reddish brown, ocelli red. Pronotum yellowish green, with lateral margins milky white. Mesonotum yellowish brown. Tegmina hyaline, veins with small hair-bearing granules, apical half bordered with black brown markings. Wings hyaline. Legs with longitudinal stripes, dark brown.



Figures 1–12. *Purohita castaneus* sp. nov. **1** Male habitus, dorsal view **2** Same, lateral view **3** Head and thorax, dorsal view **4** Face **5** Frons and clypeus, lateral view **6** Forewing **7** Male genitalia, posterior view **8** Same, lateral view **9** Pygofer, ventral view **10** Aedeagus **11** Genital style, posterior view **12** Same, lateral view. Scale bars: 0.5 mm (**1, 2, 6**); 0.2 mm (**3–5, 7–12**).

Head and thorax. Vertex (Figs 1, 3) shorter in middle line than wide at base (0.71: 1), width at apex narrower than at base (0.31: 1), anterior margin distinct sinuate, Y-shaped carina with stalk indistinct, with very short arms. Frons (Fig. 4) longer at mid-

line than wide at widest part, about 1.73: 1, widest at apex. Base of postclypeus wider than apex of frons. Antennae (Fig. 4) with first segment rectangular, with central ridge, longer in middle line than widest part about 3.86: 1, longer than the second about 1.5: 1. Pronotum (Figs 1, 3) slightly shorter than vertex (0.73: 1). Mesonotum longer in middle line than vertex and pronotum together, about 2.08: 1, median carina reaching the end of scutellum, lateral carinae not attaining hind margin. Tegmen (Fig. 6) longer than widest portion about 3.58: 1. Spinal formula of hind leg 5-6-4.

Male genitalia. Anal segment (Figs 7, 8) at widest part narrower than pygofer, large, broad and flattened dorsoventrally. Anal style moderately long. Pygofer (Figs 7–9) with medioventral processes forming a bifurcate hook, apices directed dorsomedially, in lateral view, ventral margin of pygofer much longer than dorsal. Aedeagus (Fig. 10) with phallus slender, long, acute at apex, almost attached to ventral margin of pygofer, in lateral view, phallus turned in right angle at apical half. Phallobasal process rising from the base, long, blunt oval at apex. Genital styles (Figs 11, 12) large, curved inward at apical half, with basal half broad, then become of slender gradually, acute at apex.

Plant associations. Bamboo.

Distribution. Southwest China (Yunnan).

Remarks. This species is similar to *P. taiwanensis* Muir, 1914 but differs from it by: (1) pygofer (Figs 7, 9) with medioventral processes forming a bifurcate hook, apices directed dorsomedially (medioventral processes with apices directed dorsolaterally in *P. taiwanensis*); (2) sides of medioventral processes of pygofer (Fig. 7) each with a large triangular process (sides of medioventral processes each with a process enlarging at apex, apical margin truncate in *P. taiwanensis*); (3) genital styles (Fig. 11) in posterior view basal half distinctly wider than apical half (genital styles in posterior view basal half slightly wider than apical half in *P. taiwanensis*).

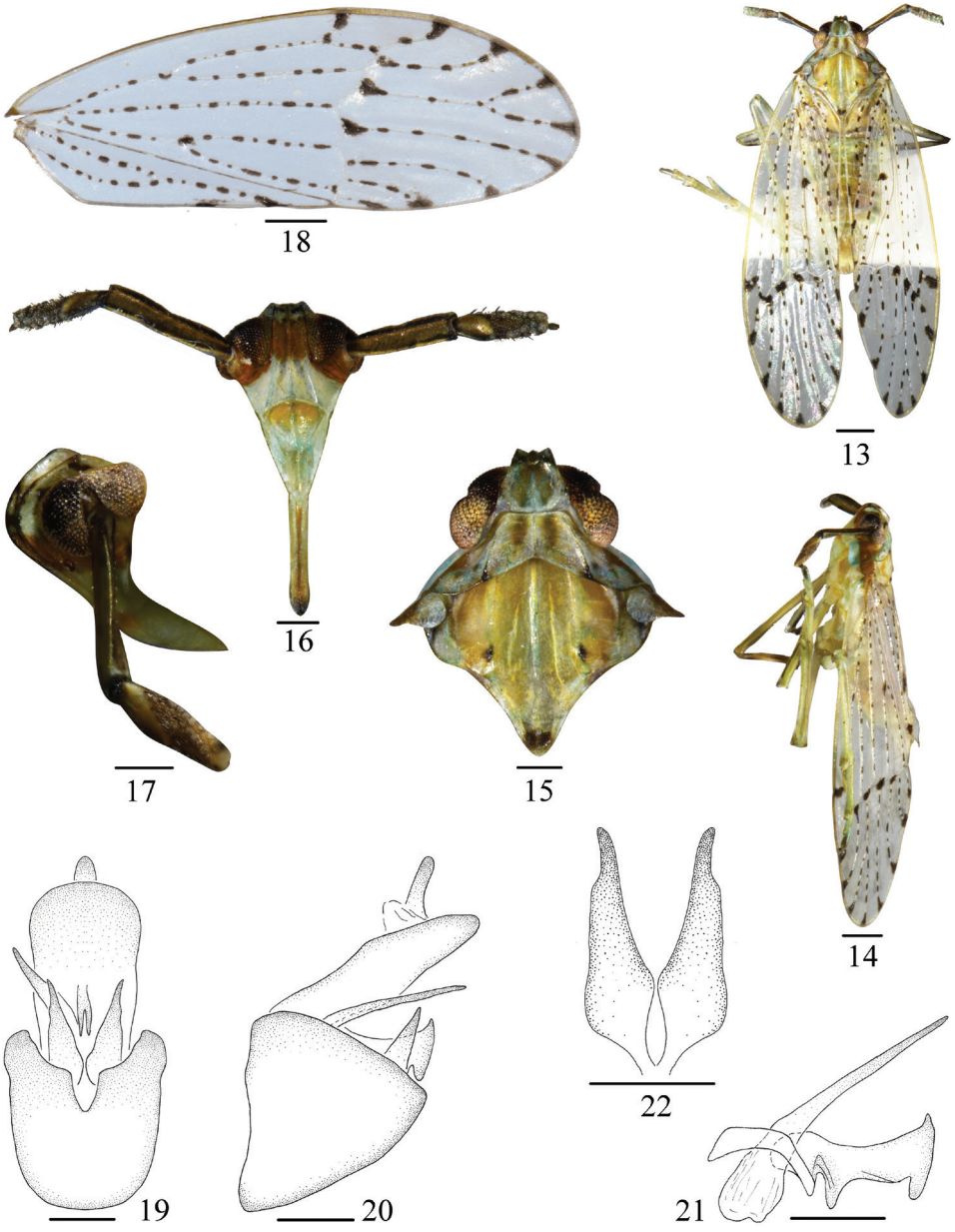
This species is also similar to *P. sinica* Huang & Ding, 1979 but differs from it by: (1) pygofer (Figs 7, 9) with medioventral processes forming a bifurcate hook, without tooth on outer margin (medioventral process flattened, each with a small tooth on outer margin in *P. sinica*); (2) medioventral processes of pygofer (Figs 7, 9) with apices directed dorsomedially (medioventral processes with apices directed dorsolaterally in *P. sinica*); (3) sides of medioventral processes of pygofer (Fig. 7) each with a triangular process, which at a distance from the medioventral processes (each with a triangular process near the medioventral processes in *P. sinica*).

***Purohita circumcincta* sp. nov.**

http://zoobank.org/809655E9-FFAB-402B-9768-95B4DEEB7F47

Figs 13–22

Type material. Holotype: ♂, **China:** Yunnan, Yingjiang County (24°44'N, 97°33'E), on bamboo, 17 August 2018, Hong-Xing Li; paratypes, 2♂♂, 6♀♀, same data as holotype, Hong-Xing Li, Nian Gong, Liang-Jing Yang and Qiang Luo; paratypes, 1♂, 2♀♀, Yunnan, Yingjiang, on bamboo, 18 August 2015, Xiang-Sheng Chen and Lin



Figures 13–22. *Purohita circumcincta* sp. nov. **13** Male habitus, dorsal view **14** Same, lateral view **15** Head and thorax, dorsal view **16** Face **17** Frons and clypeus, lateral view **18** Forewing **19** Male genitalia, posterior view **20** Same, lateral view **21** Aedeagus, lateral view **22** Genital style, posterior view. Scale bars: 0.5 mm (**13, 14, 18**); 0.2 mm (**15–17, 19–22**).

Yang; paratypes, 1♂, 1♀, Yunnan, Ruili, on bamboo, 6 June 2011, Jian-Kun Long; paratypes, 1♂, 1♀, Yunnan, Mangshi, on bamboo, 8 June 2011, Yu-Jian Li.

Etymology. The specific epithet refers to the pygofer without medioventral process.

Measurements. Body length (from apex of vertex to tip of tegmina): male 5.2–5.7 mm (n = 6); female 6.3–6.8 mm (n = 10); tegmen length: male 4.4–4.9 mm (n = 6); female 5.3–5.9 mm (n = 10).

Diagnosis. The salient features of the new species include the following: tegmina milky-hyaline, veins with black hair-bearing granules, many dark markings on veins (Figs 13, 18); pygofer with medioventral margin V-like (Fig. 19); aedeagus with phallus slender, acute at apex (Fig. 21).

Description. *Coloration*. General color milky white to yellowish brown (Figs 13–18). Vertex yellowish green, submedian carinae brown. Frons yellow at basal half and milky white at apical half. Genae white. Postclypeus yellow at basal half and white at apical half. Anteclypeus milky white. Rostrum black brown at apex. Antennae yellowish brown. Eyes and ocelli reddish brown. Pronotum yellowish green, lateral margin milky white, with dark brown markings at apex of lateral carinae. Mesonotum yellowish green, with dark brown markings at near apex of lateral carinae and apex of scutellum. Tegmina milky white, hyaline, veins white with short dark brown stripes. Wings hyaline. Legs with longitudinal stripes, dark brown.

Head and thorax. Vertex (Figs 13, 15) quadrate, wider at base than length about 1.17: 1, width at apex narrower than at base (0.4: 1), anterior margin sinuate, carinae distinct, submedian carinae uniting at apex. Frons (Figs 16, 17) longer at midline than wide at widest part, about 1.19: 1, widest at apex, carinae distinct. Postclypeus as wide at base as frons at apex, median carina distinct. Antennae with first segment rectangular, with central ridge, longer in middle line than widest part about 3.67: 1, longer than the second about 1.48: 1. Pronotum (Figs 13, 15) shorter than vertex (0.72: 1). Mesonotum longer in middle line than vertex and pronotum together, about 1.57: 1, median carina reaching the end of scutellum, lateral carinae not attaining hind margin. Tegmen (Fig. 18) longer than widest portion about 3.7: 1. Spinal formula of hind leg 5-6-4.

Male genitalia. Anal segment (Figs 19, 20) at widest part narrower than pygofer, large, broad, flattened dorsoventrally and apex rounded. Anal style moderately long. Pygofer (Figs 19, 20) slightly compressed laterally, in posterior view with opening longer than wide, medioventral margin V-like. Aedeagus (Fig. 21) with phallus slender, long, with base broad, then become of slender gradually, acute at apex. Phallobasal forked at apex, in profile broad, apex with two finger-like processes and near base with a stout tooth-like process. Genital styles (Fig. 22) large, broad at base, tapering apically.

Plant associations. Bamboo.

Distribution. Southwest China (Yunnan).

Remarks. This species is similar to *P. theognis* Fennah, 1978 but differs from it by: (1) tegmina (Fig. 18) with transverse veins milky white, without brown stripe border (tegmina with transverse veins bordered with brown stripe in *P. theognis*); (2) pygofer of male (Fig. 19) without medioventral process (pygofer with medioventral process in *P. theognis*); (3) genital styles (Fig. 22) with base broad, not twisted apically (genital styles slender, with apical quarter twisted in *P. theognis*).

This species is also similar to *P. maculata* Muir, 1916 but differs from it by: (1) pygofer of male (Fig. 19) with medioventral margin V-like (pygofer with medioventral

margin broadly U-shaped in *P. maculata*); (2) anal segment of male (Fig. 19) with length longer than width, exceeding 1.6: 1 (anal segment with length longer than width about 1.1: 1 in *P. maculata*); (3) aedeagus (Fig. 21) with phallus slender, acute at apex (aedeagus with phallus with apex rounded in *P. maculata*).

Discussion

In this paper, we describe two new species from China and provisionally place it in the genus *Purohita* based on the very large antennae, first segment flattened, rectangular, longer than the second segment. Ishihara, 1949: 16, noted "[*Purohita cervina* Distant, 1906] is the commonest species of the genus", with the same note repeated in Yang and Yang (1986). Up till now we have no information about it in China. Therefore, *P. cervina* may be not widely distributed in China. Muir (1913) added one species, *P. fuscovenosa*, based on a female specimen from Macao, China. Unfortunately, we have not discovered the male specimen. The absence of males for comparison is regrettable.

Acknowledgments

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RESEARCH ARTICLE

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A new species of the genus *Ochthebius* (Coleoptera, Hydraenidae) from the Ogasawara Islands, Japan, with a description of the larva

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Abstract

A new species of the genus *Ochthebius*, *O.* (*O.*) *sasakii* **sp. nov.**, is described from the Ogasawara Islands, Japan, with a description of the larva. This record is the first of the family Hydraenidae from the Ogasawara Islands. This species belongs to the *punctatus* species group and is similar to two Japanese species, *O.* (*O.*) *inermis* Sharp, 1884 and *O.* (*O.*) *danjo* Nakane, 1990, but it differs from them in both adult and larval characters. The larva of *O.* (*O.*) *inermis* is also described for comparison.

Keywords

Ochthebiinae, Ochthebiini, Bonin Islands, chaetotaxy, Staphylinoidea

Introduction

The Ogasawara Islands (= Bonin Islands) are oceanic islands that were never connected to the continental mainland (Japan Wildlife Research Center 2010); therefore, the islands contain many endemic species within a small geographic area and are registered as a UNESCO World Heritage Site (WHS). The fauna of the islands is comparatively well studied (Ohbayashi et al. 2004), and the coleopteran fauna was reviewed by Kuro-

sawa (1976a, b). A few aquatic beetles were recorded from the islands (Ohbayashi et al. 2004); the only known endemic species is *Copelatus ogasawarensis* Kamiya, 1932 (Dytiscidae, Copelatinae).

The genus *Ochthebius* Leach, 1815 (Ochthebiinae, Ochthebiini) is distributed in the Palaearctic, Oriental, Nearctic, Neotropical, Afrotropical, and Australian regions, and includes 540 species within 10 subgenera (Villastrigo et al. 2019). Fourteen species of the genus *Ochthebius* are recorded from Japan under two subgenera and five species groups (Yoshitomi and Satô 2001; Villastrigo et al. 2019), but no species are recorded from the Ogasawara Islands.

In the present paper, we describe a new species of the genus *Ochthebius* from the Ogasawara Islands, with a description of the larva. This record is the first of the family Hydraenidae from the Ogasawara Islands. The larva of *O. inermis* Sharp, 1884 is also described for comparison with the larvae of the new species and *O. danjo* Nakane, 1990.

Material and methods

The material examined in this paper is preserved in the Ehime University Museum, Matsuyama, Japan (EUMJ); Kanagawa Prefectural Museum of Natural History, Odawara (KPMNH); and Naturhistorisches Museum Wien (NMW).

General observations, dissections, and microstructures of dissected parts were made under a Leica MZ95. After observation, the dissected parts were mounted on the same card with the specimen. Photographs were taken under a Leica MZ95.

The terminology follows Jäch et al. (2016) for adults, and Delgado and Soler (1997), Delgado and Matsui (2000), and Delgado (2003) for larval chaetotaxy.

Morphological abbreviations used in this study are as follows:

EL elytral length from anterior margin to elytral apex;
EW maximum elytral width;
HL head length;
PL pronotal length in median line;
PW maximum width of pronotum;
TL total length (PL + EL + HL).

The average is given in parentheses after the range.

Taxonomy

***Ochthebius* (*Ochthebius*) *sasakii* sp. nov.**
http://zoobank.org/7911B6EA-6485-4D6E-80E0-3B65107A4083
Figs 1–5
Japanese name: Ogasawara-sesuji-darumagamushi

Type series. Holotype (EUMJ): male, "Higashi-kaigan, Chichi-jima, Ogasawara Isls., Japan, 22.II.2018, H. Karube leg.". **Paratypes** (EUMJ, NMW, KPMNH): 5 exs, same data as for the holotype; 10 exs, same locality and collector, but "24.II.2019"; 1 ex.,

same locality and collector, but "25.II.2019"; 10 exs, "Inui-sawa, Ani-jima, Ogasawara Isls., Japan, 22. II. 2018, H. Karube leg."; 6 exs, "Kohama, Otouto-jima, Ogasawara Isls., Japan, 22.II.2018, H. Karube leg.".

Diagnosis. *Ochthebius* (*Ochthebius*) *sasakii* belongs to the *punctatus* species group (sensu Villastrigo et al. 2019) and is similar to two Japanese species, *O. inermis* and *O. danjo*. The adult of *O. sasakii* differs from the two Japanese species in having a smaller body size (see Table 1), anterior margin of labrum not shallowly concave, median groove of pronotum shallow, and short elytral setae. The larva of this species differs in the following characteristics: mandibles strongly curved inwardly in the apical part (gently curved in *O. inermis* and *O. danjo*); labrum arcuate in anterior margin (projecting apically in *O. inermis*); and presence of subprimary setae on pronotum and mesonotum (see Table 2).

Table 1. Measurement of three Japanese species of the *Ochthebius* punctatus species group.

	O. sasakii	***O. inermis***	***O. danjo***
no.	13	16	6
TL (mm)	1.83–2.16 (2.00)	2.20–2.55 (2.37)	2.42–5.47 (2.99)
HL (mm)	0.30–0.42 (0.39)	0.45–0.52 (0.48)	0.45–0.55 (0.50)
PW (mm)	0.55–0.63 (0.60)	0.67–0.76 (0.70)	0.68–0.74 (0.71)
PL (mm)	0.40–0.48 (0.44)	0.46–0.55 (0.50)	0.50–0.55 (0.54)
EL (mm)	1.03–1.28 (1.17)	1.25–1.50 (1.39)	1.40–4.45 (1.96)
EW (mm)	0.72–0.90 (0.83)	0.45–0.52 (0.48)	0.90–1.00 (0.97)
PW/PL	1.21–1.50 (1.36)	1.34–1.50 (1.40)	1.29–1.36 (1.33)
EL/EW	1.31–1.53 (1.41)	0.35–3.26 (2.32)	1.42–4.49 (2.01)
EL/PL	2.29–2.98 (2.66)	2.60–3.09 (2.81)	2.58–8.09 (3.63)
EW/PW	1.24–1.50 (1.39)	0.61–0.72 (0.68)	1.29–1.41 (1.36)
TL/EW	2.17–2.75 (2.42)	4.64–5.35 (4.98)	2.50–5.53 (3.08)

Table 2. Chaetotaxy of 3rd instar larvae of *Ochthebius* spp. (after Delgado and Matsui for *O. danjo*). Cross: present; dash: absent.

		O. sasakii sp. nov. present study	*O. inermis* present study	*O. danjo* Delgado & Matsui 2000
pronotum	A1–A4	×	×	×
	L1–L3	×	×	×
	P1–P4	×	×	×
	Da1, Db1, Dc1	×	×	×
	C1	×	×	×
	C2, C3	–	×	×
	C4, C5	×	×	×
	Da'–Dc', Dc''	×	–	–
mesonotum	A1–A4	×	×	×
	L1–L3	×	×	×
	P1–P4	×	×	×
	Da'	×	–	–
tergum I	A1, A3–A4	×	×	×
	L1–L3	×	×	×
	P1, P3–P4	×	×	×
	P2	×	–	–
	DP1, DP2	×	×	×
	C1–C2, C4	–	–	–
	C3, C5	×	×	×

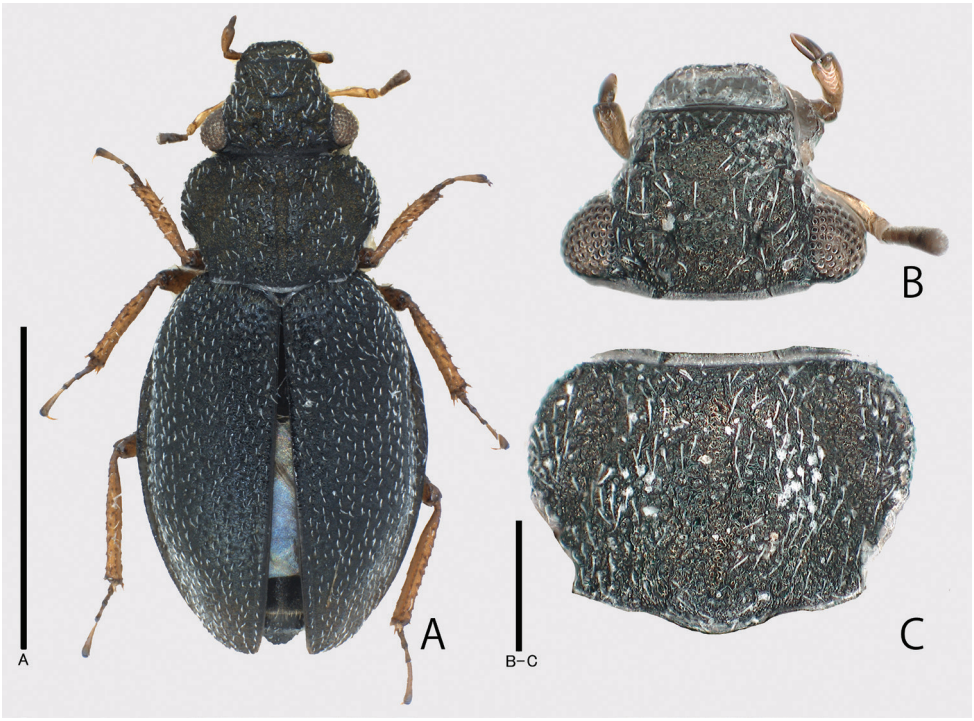

Figure 1. Holotype of *Ochthebius sasakii* sp. n. **A** dorsal habitus **B** head **C** pronotum. Scale bars: 1.0 mm.

Description. Adults. Body oblong, slightly convex dorsally, weakly shiny in dorsal surface. Coloration of body black, with weak bluish lustre; ventral surface of body blackish brown; antennae, maxillary palpi and legs yellowish brown, but fuscous in antennomeres IV–IX, terminal palpomere of maxillary palpi and femur.

Head (Fig. 1B) finely punctate, distinctly microreticulate, with deep ocular grooves, closely covered with short setae; fronto-clypeal suture straight. Labrum (Figs 1B, 2C) transverse, finely punctate, almost straight in front margin from dorsal view (Fig. 1B), but shallowly concave from antero-dorsal view (Fig. 2C). Maxillary palpi (Fig. 2B) long, provided with oblong terminal palpomere; approximate ratio of each palpomere (n = 1) as 10 : 14 : 9. Antennae (Fig. 2A) relatively short; approximate ratio of each antennomere (n = 1) as 22.5 : 9.0 : 4.5 : 1.0 : 1.5 : 3.0 : 2.5 : 2.0 : 7.0. Pronotum (Fig. 1C) transversely rectangular, widest at anterior 1/3, finely punctate, distinctly microreticulate, bearing short setae same as in head; anterior margin almost straight, without postocular tooth; posterior margin slightly bisinuous; lateral margins arcuate in anterior parts, straightly tapered in posterior parts; median groove shallow; anterior and posterior discal foveae shallow and indistinct; lateral portions ("ear" in Jäch 1998) slightly depressed dorsally; hyaline membranous cuticula present on anterior and posterior margins; PW/PL 1.21–1.50 (1.36). Elytra oval, gently arcuate in lateral margins, broadest at the middle, irregularly and finely punctate, bearing fine short suberect setae; lateral gutter narrowly explanate; epipleura pubescent, almost

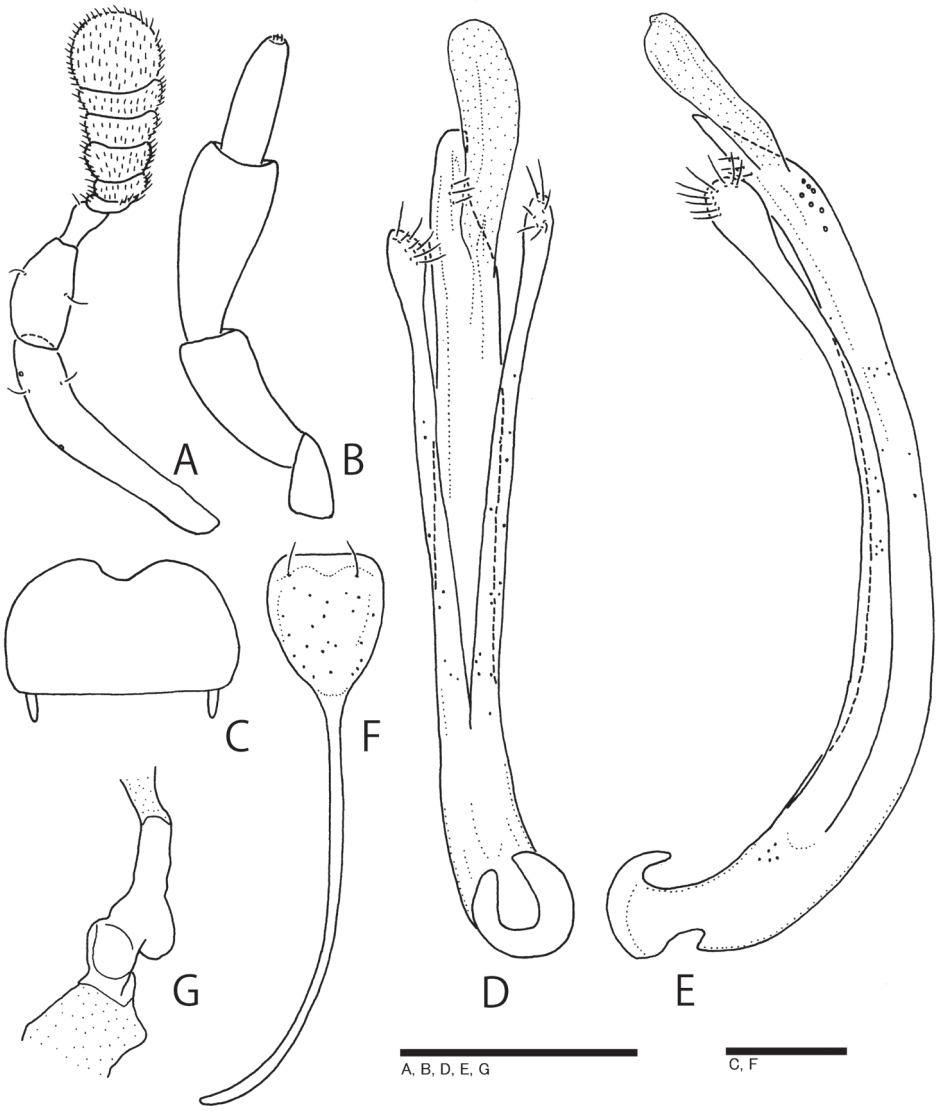

Figure 2. *Ochthebius sasakii* sp. n., paratypes, male (**A–F**) and female (**G**). **A** antenna **B** maxillary palpus **C** labrum **D** aedeagus in ventral view **E** aedeagus in lateral view **F** sternite X and spiculum gastrale **G** spermathecal duct. Scale bars: 0.1 mm.

reaching elytral apices; elytral apices subacuminate; EL/EW 1.31–1.53 (1.41); EL/PL 2.29–2.98 (2.66); EW/PW 1.24–1.50 (1.39); TL/EW 2.17–2.75 (2.42). Metaventrite pubescent. Legs rather long and slender. Ventrites I–V pubescent; ventrite VI glabrous.

Male. Sternite X (Fig. 2F) subtriangular, with long spiculum. Aedeagus (Fig. 2D, E) ca 0.4 mm, gently curved ventrally; main piece pointed at apex, with three minute setae in subapical area; parameres long, close to main piece, expanded in apical parts.

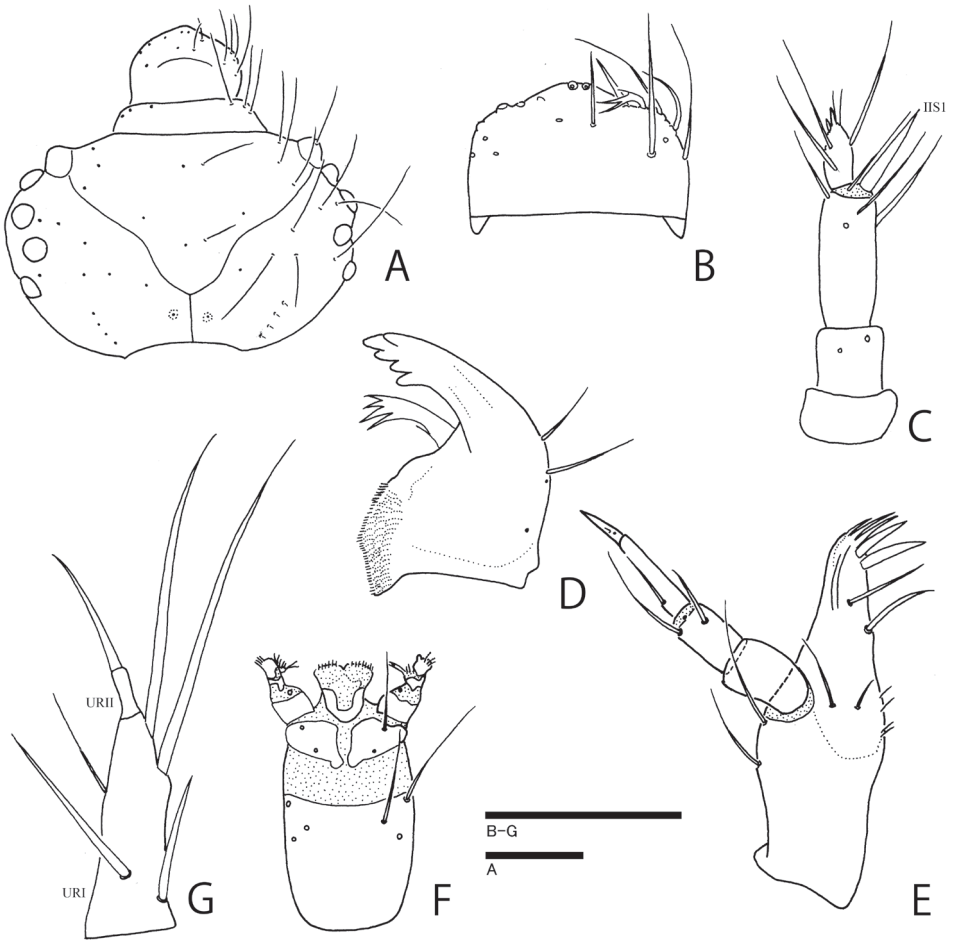

Figure 3. Larva of *Ochthebius sasakii* sp. n. **A** head capsule **B** labrum **C** antenna **D** mandible **E** maxilla **F** labium **G** urogomphus. Scale bars: 0.1 mm.

Female. Sexual dimorphism indistinct in elytral gutter and elytral apices. Capsule of spermathecal duct (Fig. 2G) relatively short.

Measurements (n = 13). TL 1.83–2.16 (2.00) mm; HL 0.30–0.42 (0.39) mm; PW 0.55–0.63 (0.60) mm; PL 0.40–0.48 (0.44) mm; EL 1.03–1.28 (1.17) mm; EW 0.72–0.90 (0.83) mm.

Description of third instar larva (based on a damaged specimen collected with adults from Chichi-jima). Body about 2.0 mm in fully expanded specimen. Coloration of body blackish brown, weakly shining; legs infuscate. Head (Fig. 3A) with five stemmata on each side. Labrum (Fig. 3B) arcuate in anterior margin. Antennae (Fig. 3C) short; IIS1 long, slightly longer than antennomere III; antennomere III about 0.5 times as long as antennomere II. Mandibles (Fig. 3D) strongly curved inwardly in apical parts.

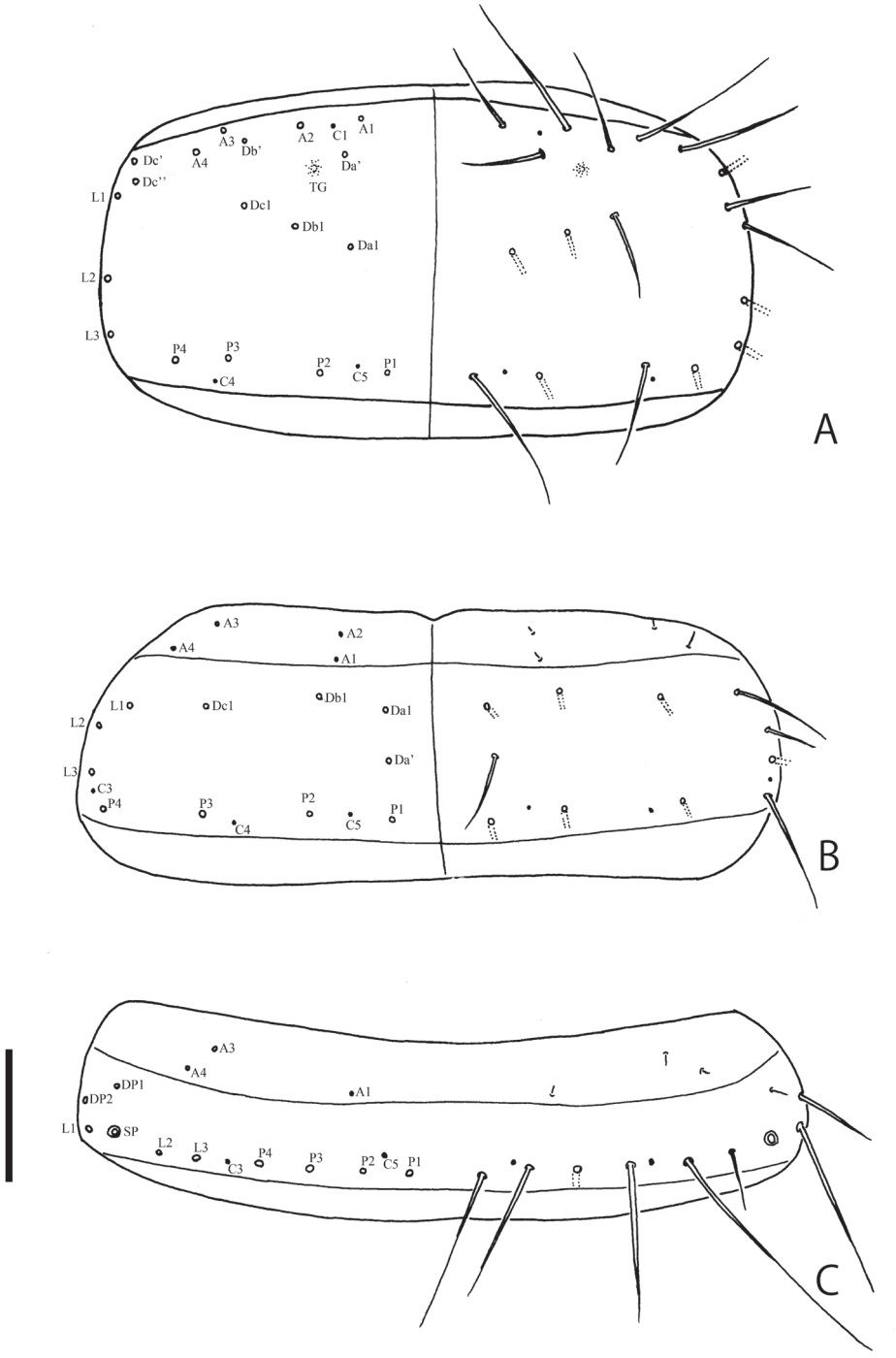

Figure 4. Larval chaetotaxy of *Ochthebius sasakii* sp. n. **A** pronotum **B** mesonotum **C** abdominal tergum I. Scale bar: 0.1 mm.

Figure 5. Habitat of *Ochthebius sasakii* sp. n. **A–C** Chichi-jima **D** Otouto-jima **E** Ani-jima.

Maxillae (Fig. 3E) with palpomere III long and slender. Labium (Fig. 3F) with short mentum. Urogomphi (Fig. 3G) relatively short; URI stout, 4.5 times as long as URII. Chaetotaxy on head capsule, labrum, antennae, maxillae, labium, and urogomphi same as in *O. danjo* (Delgado and Matsui 2000). Pronotum (Fig. 4A) about 1.8 times as wide as long; four anterior (A1–A4), three lateral (L1–L3), four posterior (P1–P4), row of Da1, Db1, and Dc1, four subprimary setae (Da', Db', Dc', Dc"), and three campaniform sensilla (C1, C4, C5) present on each side. Mesonotum (Fig. 4B) about 2.5 times as wide as long, four anterior (A1–A4), three lateral (L1–L3), four posterior (P1–P4), row of Da1, Db1 and Dc1, subprimary setae (Da'), three campaniform sensilla (C3–C5) present on each side; A4 somewhat longer. Abdominal tergum I (Fig. 4C) about 4.4 times as wide as long, three anterior (A1, A3–A4), three lateral (L1–L3), four posterior (P1–P4), DP1 and DP2, two campaniform sensilla (C3, C5) present on each side.

Biological notes. All the specimens (both adults and larvae) were collected from the surface of littoral rocks covered with a film of sheeting fresh water (depth ca 1–2 mm; Fig. 5). All habitats are situated on the seashore (the nearest point from the edge of the water was ca 3 m); we could not find any habitats in inland areas.

The fauna of the Ogasawara Islands was seriously affected by a long drought in 2016–2017. In addition, a serious drought occurred from autumn to winter 2018/2019. In February 2018, HK found many individuals of *O. sasakii* sp. n. at the Ani-jima site (Fig. 5E) and collected some specimens as the type series. However, in February 2019,

HK could not find this species at this site because sheeting fresh water had completely dried up. At the Chichi-jima site, HK found many individuals of this species in both 2018 and 2019, but the area of sheeting fresh water was markedly reduced.

Distribution. Ogasawara Isls. (Chichi-jima, Ani-jima, Otouto-jima).

Description of third instar larva of *Ochthebius inermis*

Specimens examined. 20 exs (mature larvae, EUMJ), Shakunouchi-koen, Unnan-shi, Shimane Pref., 24.VI.2006, M. Hayashi leg.

Description. Body about 3.0 mm in fully expanded specimens. Coloration of body black, strongly shining; legs cream (see Hayashi 2008a: fig. 2F). Head (Fig. 6A) with five stemmata on each side. Labrum (Fig. 6B) projecting apically in anterior mar-

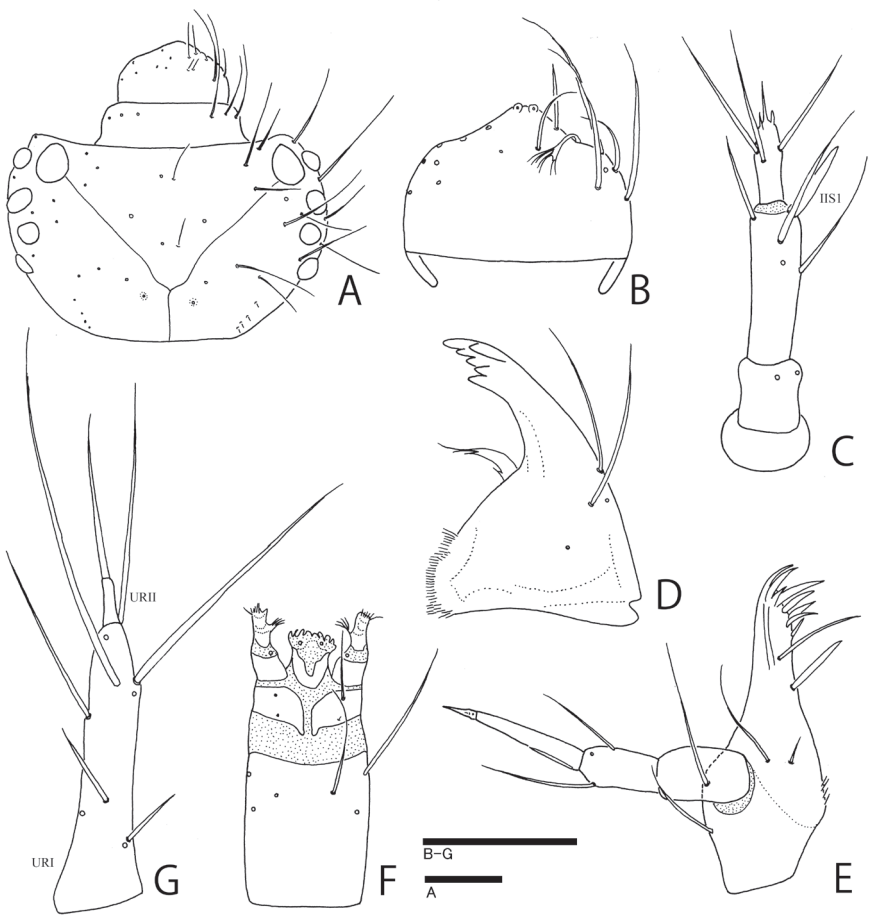

Figure 6. Larva of *Ochthebius inermis*. **A** head capsule **B** labrum **C** antenna **D** mandible **E** maxilla **F** labium **G** urogomphus. Scale bars: 0.1 mm.

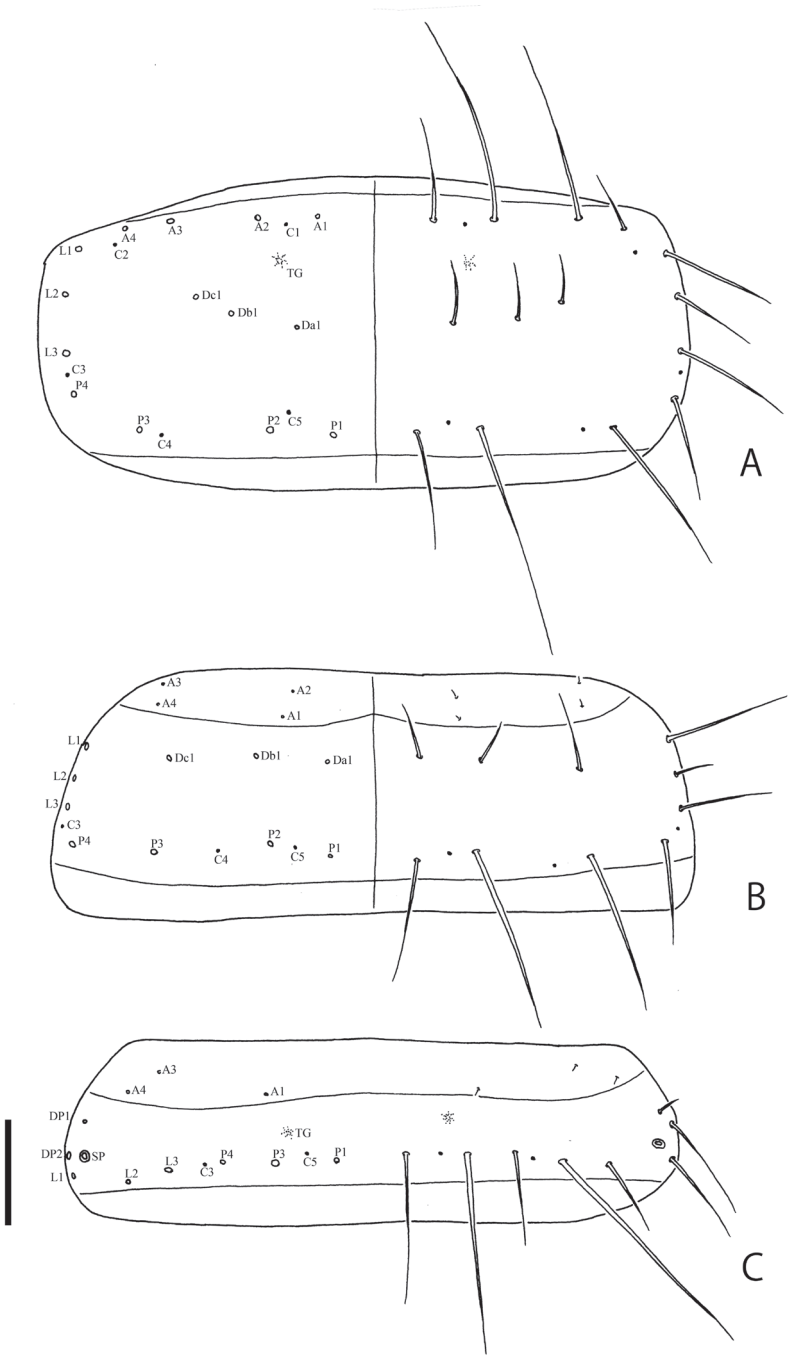

Figure 7. Larval chaetotaxy of *Ochthebius inermis* **A** pronotum **B** mesonotum **C** abdominal tergum I. Scale bar: 0.1 mm.

gin. Antennae (Fig. 6C) long; IIS1 long, as long as antennomere III; antennomere III long, about 0.6 times as long as antennomere II. Mandibles (Fig. 6D) gently curved inwardly in apical parts. Maxillae (Fig. 6E) with palpomere III long and slender. Labium (Fig. 6F) with long mentum. Urogomphi (Fig. 6G) relatively long; URI slender, about 6.5 times as long as URII. Chaetotaxy on head capsule, labrum, antennae, maxillae, labium, and urogomphi same as in *O. sasakii* sp. n. and *O. danjo* (Delgado and Matsui 2000; present study). Pronotum (Fig. 7A) about 2.0 times as wide as long; four anterior (A1–A4), three lateral (L1–L3), four posterior (P1–P4), row of Da1, Db1 and Dc1, five campaniform sensilla (C1–C5) present on each side. Mesonotum (Fig. 7B) about 2.5 times as wide as long; four anterior (A1–A4), three lateral (L1–L3), four posterior (P1–P4), row of Da1, Db1 and Dc1, three campaniform sensilla (C3–C5) present on each side. Tergum I (Fig. 7C) about 3.3 times as wide as long; three anterior (A1, A3–A4), three lateral (L1–L3), three posterior (P1, P3–P4), DP1, and DP2 setae, two campaniform sensilla (C3, C5) present on each side.

Discussion

The new species is closely related to two Japanese species, viz., *O. inermis* distributed in Japan (Honshu, Shikoku, Kyushu), Kunashir, and Taiwan, and *O. danjo* distributed in southern Kyushu (including Danjo Islands and Yakushima). The former species inhabits mainly stagnant or flowing water along rivers, usually associated with filamentous green algae (Jäch 1998), and is sometimes collected from hygropetric microhabitats in mountainous areas (e.g., Yoshitomi 2001) or rocky seashores (e.g., Sugaya 2009). The latter species was found in marine rock pools (Delgado and Matsui 2000; Hayashi 2008b). *Ochthebius sasakii* sp. n. and *O. inermis* live in fresh water, whereas *O. danjo* lives in brackish water.

Key to species of adult *Ochthebius* (*O.*) *punctatus* species group of Japan

1 Elytra subparallel-sided, bearing long setae; anterior margin of labrum excised; apex of median piece short (Jäch 1998, fig. 23) ..... ***O. danjo***

– Elytra arcuate laterally, bearing short setae; anterior margin of labrum gently arcuate or almost straight in dorsal view; apex of median piece long **2**

2 Body larger (2.2–2.6 mm); anterior margin of labrum gently arcuate; elytral setae longer; median groove of pronotum distinct; median piece strongly curved; distal lobe expanded apically (Jäch 1998, fig. 22) ..... ***O. inermis***

– Body smaller (1.8–2.2 mm); anterior margin of labrum shallowly concave in antero-dorsal view; elytral setae shorter; median groove of pronotum shallow; median piece gently curved; distal lobe slender (Fig. 2D, E)..... ***O. sasakii* sp. n.**

Acknowledgements

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RESEARCH ARTICLE

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Three additional new genera of acidocerine water scavenger beetles from the Guiana and Brazilian Shield regions of South America (Coleoptera, Hydrophilidae, Acidocerinae)

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Abstract

Recent study of the water scavenger beetle subfamily Acidocerinae in the Neotropical region has uncovered numerous undescribed species that are not able to be placed in existing genera. Here, we describe three new genera to accommodate 17 of these new species from South America: *Aulonochares* **gen. nov.** for *Aulonochares lingulatus* **sp. nov.** (French Guiana, Suriname), *Aulonochares novoairensis* **sp. nov.** (Brazil), and *Aulonochares tubulus* **sp. nov.** (Brazil, Guyana, Suriname, Venezuela)*; Ephydrolithus* **gen. nov.** for *Ephydrolithus hamadae* **sp. nov.** (Brazil), *Ephydrolithus minor* **sp. nov.** (Brazil), *Ephydrolithus ogmos* **sp. nov.** (Brazil), *Ephydrolithus spiculatus* **sp. nov.** (Brazil), and *Ephydrolithus teli* **sp. nov.** (Brazil); and *Primocerus* **gen. nov.** for *Primocerus cuspidis* **sp. nov.** (Venezuela), *Primocerus gigas* **sp. nov.** (Venezuela), *Primocerus neutrum* **sp. nov.** (Guyana, Suriname, Venezuela), *Primocerus ocellatus* **sp. nov.** (Venezuela), *Primocerus petilus* **sp. nov.** (Brazil), *Primocerus pijiguaense* **sp. nov.** (Venezuela), *Primocerus maipure* **sp. nov.** (Venezuela), *Primocerus semipubescens* **sp. nov.** (Guyana), and *Primocerus striatolatus* **sp. nov.** (Suriname). The genus *Ephydrolithus* **gen. nov.** is currently known to be restricted to seepages in the mountainous regions of the Brazilian Shield. *Aulonochares* **gen. nov.** and *Primocerus* **gen. nov.** are both currently only known from the Guiana Shield, though widespread in that region where they are associated with streams and seeps. We present differential diagnoses, maps, habitat details, and illustrations of all new genera and species here described.

Resumen

El estudio reciente de escarabajos acuáticos de la subfamilia Acidocerinae en la región neotropical, ha revelado numerosas especies no descritas que no pueden ser atribuidas a los géneros existentes. Aquí describimos tres géneros nuevos para acomodar 17 de estas especies nuevas de Suramérica: *Aulonochares* **gen. nov.** para *Aulonochares lingulatus* **sp. nov.** (Guyana Francesa, Surinam), *Aulonochares novoairensis* **sp. nov.** (Brasil), y *Aulonochares tubulus* **sp. nov.** (Brasil, Guyana, Surinam, Venezuela)*; Ephydrolithus* **gen. nov.** para *Ephydrolithus hamadae* **sp. nov.** (Brasil), *Ephydrolithus minor* **sp. nov.** (Brasil), *Ephydrolithus ogmos* **sp. nov.** (Brasil), *Ephydrolithus spiculatus* **sp. nov.** (Brasil), y *Ephydrolithus teli* **sp. nov.** (Brasil); y *Primocerus* **gen. nov.** para *Primocerus cuspidis* **sp. nov.** (Venezuela), *Primocerus gigas* **sp. nov.** (Venezuela), *Primocerus neutrum* **sp. nov.** (Guyana, Surinam, Venezuela), *Primocerus ocellatus* **sp. nov.** (Venezuela), *Primocerus petilus* **sp. nov.** (Brazil), *Primocerus pijiguaense* **sp. nov.** (Venezuela), *Primocerus maipure* **sp. nov.** (Venezuela), *Primocerus semipubescens* **sp. nov.** (Guyana), y *Primocerus striatolatus* **sp. nov.** (Surinam). El género *Ephydrolithus* **gen. nov.** se restringe hasta ahora a hábitats higropétricos en las regiones montañosas del Escudo Brasileño. *Aulonochares* **gen. nov.** y *Primocerus* **gen. nov.** son ambos hasta ahora conocidos del Escudo Guyanés, no obstante, ampliamente distribuidos en esa región en la que están asociados con corrientes y hábitats higropétricos. Presentamos diagnosis diferenciales, mapas, detalles sobre los hábitats e ilustraciones para todos los géneros y especies que aquí se describen.

Keywords

aquatic beetles; new species; Neotropical region; taxonomy; seepage habitat

Introduction

The cosmopolitan subfamily Acidocerinae currently includes 16 genera, with eleven of these occurring in the Neotropical region (Short and Fikáček 2013, Minoshima et al. 2015, Girón and Short 2018). Until this century, the number of acidocerine lineages known from South America was relatively modest and their documented distribution quite spotty, particularly in the tropical areas of the continent. Recent fieldwork combined with renewed taxonomic efforts over the last two decades have revealed an eye-opening diversity of lineages and forms, resulting in the description of seven of the eleven presently recorded genera since 1999. And still, the discoveries continue unabated: an ongoing review of the Neotropical acidocerine fauna has revealed three additional new genera, which appear biogeographically restricted to the Brazilian and Guiana Shield regions of South America. Most of these new taxa occur in seepage habitats, which likely explains why they have remained hidden until now. Here we describe these three new genera to contain seventeen previously undescribed species.

Materials and methods

Depositories of examined material:

CBDG Center for Biological Diversity, University of Guyana, Georgetown
INPA Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (N Hamada)

MALUZ Museo de Artrópodos de la Universidad del Zulia, Maracaibo, Venezuela (J Camacho, M García)
MIZA Museo del Instituto de Zoología Agrícola, Maracay, Venezuela (L Joly)
NZCS National Zoological Collection of Suriname, Paramaribo (P Ouboter, V Kadosoe)
SEMC Snow Entomological Collection, University of Kansas, Lawrence, KS (A Short)
USNM US National Museum of Natural History, Smithsonian Institution, Washington, DC (C Micheli).

Morphological methods

Nearly 280 specimens were examined. Specimen preparation and examination methods are identical to those given in Girón and Short (2017).

Descriptive sequence and morphological terminology largely follows Hansen (1991) except for the use of meso- and metaventrite instead of meso- and metasternum, and abdominal ventrites instead of abdominal sternites (see Lawrence and Ślipiński 2013). Terms for the ventral surface of the head follow Komarek (2004). Terminology for the metafurca follows Velázquez de Castro (1998; see also fig. 5C in Girón and Short 2017).

Descriptions of genera and species are organized in alphabetical order, whereas in the habitus figures species are grouped by similarity for ease of comparison. Maps were created using SimpleMappr (Shorthouse 2010). All specimen data which can be searched by species and/or collecting event are available online through the Collection Resources for Aquatic Coleoptera (CReAC) portal at http://creac.kubiodiversityinstitute.org/collections/.

Results

List of species and their known distribution

Aulonochares gen. nov.	
1. *Aulonochares lingulatus* sp. nov.	French Guiana, Suriname
2. *Aulonochares novoairensis* sp. nov.	Brazil (Amazonas)
3. *Aulonochares tubulus* sp. nov.	Brazil (Roraima), Guyana, Suriname, Venezuela (Amazonas)
Ephydrolithus gen. nov.	
4. *Ephydrolithus hamadae* sp. nov.	Brazil (Minas Gerais)
5. *Ephydrolithus minor* sp. nov.	Brazil (Bahía)
6. *Ephydrolithus ogmos* sp. nov.	Brazil (Bahía)
7. *Ephydrolithus spiculatus* sp. nov.	Brazil (Minas Gerais)
8. *Ephydrolithus teli* sp. nov.	Brazil (Bahía, Minas Gerais)

Primocerus gen. nov.

9. *Primocerus cuspidis* sp. nov.	Venezuela (Amazonas)
10. *Primocerus gigas* sp. nov.	Venezuela (Amazonas)
11. *Primocerus neutrum* sp. nov.	Guyana, Suriname, Venezuela (Bolívar)
12. *Primocerus ocellatus* sp. nov.	Venezuela (Amazonas)
13. *Primocerus petilus* sp. nov.	Brazil (Pará)
14. *Primocerus pijiguaense* sp. nov.	Venezuela (Bolívar)
15. *Primocerus maipure* sp. nov.	Venezuela (Amazonas)
16. *Primocerus semipubescens* sp. nov.	Guyana
17. *Primocerus striatolatus* sp. nov.	Suriname

Taxonomy

Aulonochares gen. nov.

http://zoobank.org/B6E8B78C-3B5B-492E-A202-13E508E1799E
Figs 1–4

Type species. *Aulonochares tubulus* sp. nov.

Differential diagnosis. Medium sized beetles (5.8–7.5 mm), elongate oval in dorsal view, weakly convex in lateral view (see Fig. 1B, E, H). Color orange brown to dark brown; ventral surface covered with rather long golden setae, especially on abdominal ventrites. Head subquadrate in dorsal view (see Fig. 2A, F, H). Eyes relatively small. Clypeus with anterior margin only slightly narrower than posterior margin. Labrum fully exposed. Mentum and submentum roughly punctate (e.g., Fig. 1F). Antennae with nine antennomeres (e.g., Fig. 1C). Maxillary palps nearly 1.5 × longer than maximum width of head (e.g., Fig. 1A). Elytra without sutural striae, with net-like patterning visible throughout the entire surface (e.g., Fig. 1G); ground punctures and systematic punctures similar in size, shallowly impressed; serial punctures absent. Posterior elevation of mesoventrite simple, without carinae or ridges (Fig. 2B). Posterior femora glabrous at most along apical seventh. Ventral face of tarsomeres 1–4 densely covered by stiff setae. Apex of fifth abdominal ventrite strongly emarginate; emargination fringed by stout setae (Fig. 2D). Aedeagus (Fig. 2E, G, I) somewhat cylindrical, with parameres forming a 5–7 × longer than wide tube; basal piece very short and strongly concave.

Aulonochares can be easily mistaken for *Helochares*, especially in the field, based on overall body size, shape and coloration, number of antennomeres and apical emargination of the fifth ventrite. *Aulonochares* can be distinguished from other Neotropical acidocerines by the following unique combination of characters: head subquadrate in shape (clypeus with anterior margin only slightly narrower than posterior margin; as opposed to head rather trapezoidal, with anterior margin of clypeus conspicuously narrower than its posterior margin as in Neotropical *Helochares*); eyes relatively small, separated by a distance nearly 6.5 × the maximum width of an eye (as opposed to eyes of moderate size, separated by approximately 4 × the width of one eye as in *Helochares*

(see Hansen 1991: 150)); mentum and submentum roughly punctate (submentum usually rather smooth in Neotropical *Helochares*); pubescence covering abdominal ventrites composed of long golden setae (short setae in Neotropical *Helochares*); ventral surface of tarsomeres 1–4 densely setose (tarsomeres bearing two longitudinal rows of denticles in Neotropical *Helochares*); aedeagus narrow and tubular in shape.

Description. Medium sized beetles, total body length 5.8–7.5 mm, width 3.1–4.0 mm; body elongate oval, weakly convex in lateral view (see Fig. 1B, E, H), orange brown to dark brown in color (Fig. 1), slightly paler on labrum, labial palpi, along lateral margins of pronotum and elytra, on ventral surface (including abdominal ventrites), and tarsi; body setae, including hydrofuge pubescence, setae of systematic punctures, and especially on abdominal ventrites, golden and rather long; hydrofuge pubescence on surface of femora denser, with shorter setae. ***Head.*** Subquadrate in dorsal view, with lateral margins seemingly constricted at anterior margin of eyes (Fig. 2A, F, H). Frons and clypeus with moderately marked ground punctures, irregularly and rather densely distributed over the surface, accompanied by scattered seta-bearing systematic punctures, longer and denser on antero-lateral areas of frons and along anterior area of clypeus; surface between punctures smooth and shiny. Frons transversely impressed by anterior margin of pronotum. Frontoclypeal and midcranial sutures well defined, visible as complete, fine grooves; distance between inner anterior corner of eye and frontoclypeal suture approximately 0.5 × maximum length of eye. Clypeus with lateral margins slightly convex, anterior corners roundly angulate, forming a nearly straight angle; anterior margin of clypeus widely roundly emarginate, only slightly narrower than posterior margin. Eyes relatively small and subquadrate in dorsal view; maximum length of eye 0.5 × distance between anterior margin of eye and anterior margin of clypeus; distance between eyes nearly 6.5 × maximum width of eye. Labrum wide, fully exposed, nearly half as long, and collinear to perpendicular to clypeus; dorsal surface only slightly convex, with scattered fine punctures and few systematic punctures; anterior margin only slightly sinuate, mesally slightly roundly bent inwards, with few denticles along emargination; anterior corners with few setae. Temporae slightly concave, densely covered by rather long and relatively thick setae (hydrofuge pubescence); posteroventral area rather strongly produced. Gular sutures opposite, semicircular, with surface slightly elevated and shiny. Surface of gula and postgenae covered by long fine setae. Mentum (e.g., Fig. 1F) parallel sided, with lateral margins fringed by golden setae; surface coarsely punctate, with punctures somewhat obliquely directed; anterior margin with deep U-shaped emargination, sometimes marked by a carina; surface distad of emargination perpendicular to ventral surface of head, smooth, concave, and dorsally directed. Submentum as elevated plate, coarsely punctate, with scattered setae; posterior margin as a low, sinuate, wide ridge; well-developed ocular ridge (e.g., Fig. 1F). Maxilla with ventral surface of cardo and stipes with scattered punctures and setae; outer dorsal margin of palpifer with few stiff, spiniform setae; limit between cardo and stipes oblique; maxillary palps curved inward, orange brown, longer than antennae, nearly 1.5 × longer than maximum width of head (e.g., Fig. 1A); each palpomere paler towards its apex; apex of palpomere 3 bearing sensilla. Mandibles with apex bifid (examined in *A. tubulus*). La-

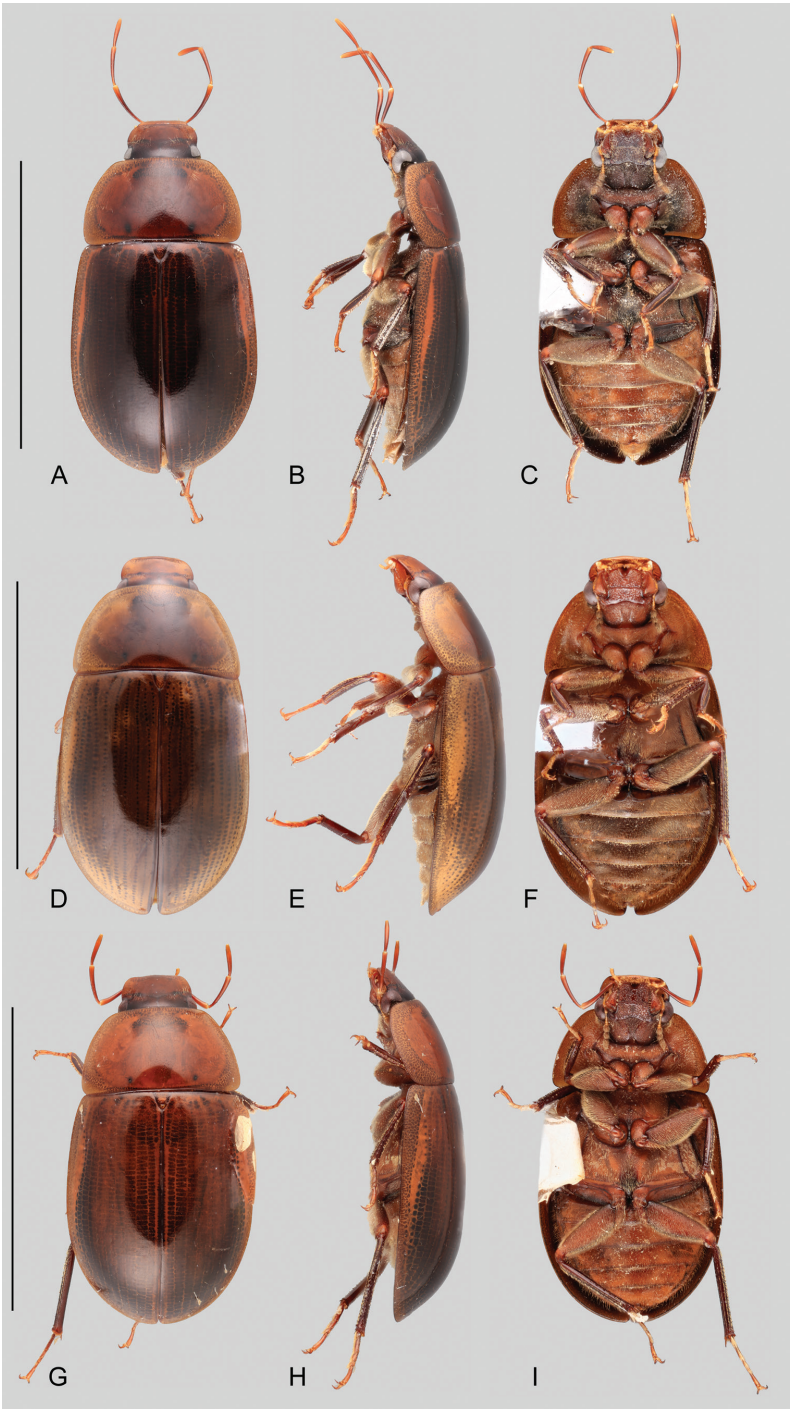

Figure 1. Habitus of *Aulonochares* spp.: **A–C** *Aulonochares tubulus*: **A** dorsal view **B** lateral view **C** ventral view. **D–F** *Aulonochares novoairensis*: **D** dorsal view **E** lateral view **F** ventral view. **G–I** *Aulonochares lingulatus*: **G** dorsal view **H** lateral view **I** ventral view. Scale bars: 5 mm.

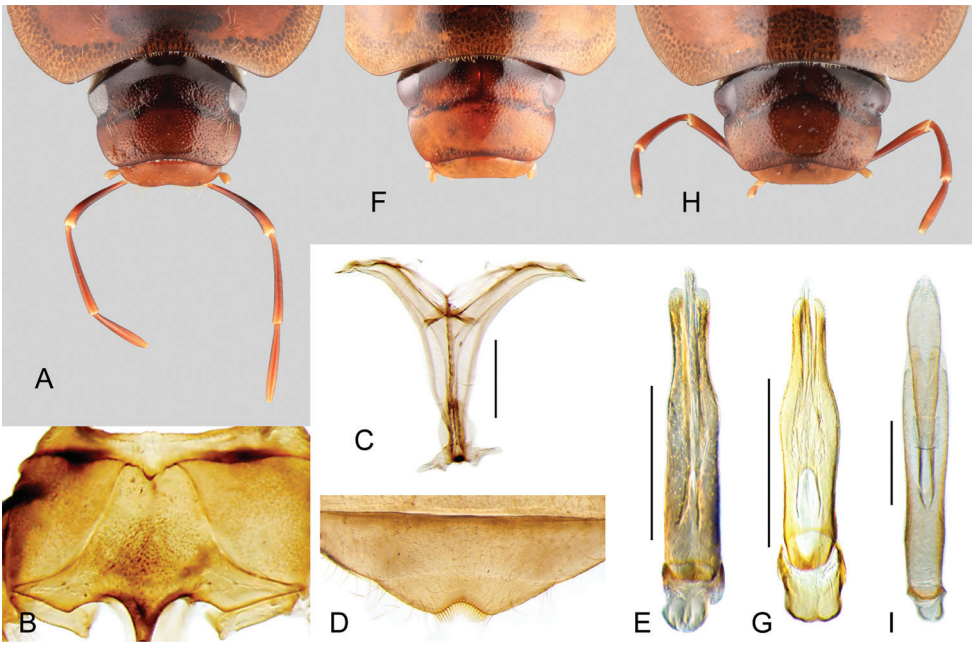

Figure 2. Head and internal structures of *Aulonochares* spp.: **A–E** *Aulonochares tubulus*: **A** head, dorsal view **B** ventral view of mesoventrite with simply convex posterior elevation **C** posterior view of metafurca **D** fifth abdominal ventrite **E** aedeagus. **F, G** *Aulonochares novoairensis*: **F** head, dorsal view **G** aedeagus. **H, I** *Aulonochares lingulatus*: **H** head, dorsal view **I** aedeagus. Scale bars: 0.5 mm.

bial palps yellowish, nearly as long as maximum length of mentum, dorsoventrally flattened; palpomere 2 with outer margin only slightly convex near apex, with several long setae around midlength and at apex; palpomere 3 obovate, with a long subapical seta on outer corner. Antennae (e.g., Fig. 1C) with nine antennomeres, paler (yellowish) than general coloration of head; antennomere 1 reaching anterior third of ventral surface of eye (reaching midlength of cardo), nearly 2.5 × longer than antennomere 2, with outer surface densely covered by setae; antennomere 2 thicker, and nearly as long as antennomere 3; antennomere 3 cylindrical, 4 and 5 trapezoid; antennomere 6 forming a well differentiated, asymmetric cupule; antennomeres 7–9 slightly flattened, forming a loosely articulated, pubescent club, with antennomeres 7 and 8 similar in shape and length, and antennomere 9 1.5 × longer than 7; apex of antennomere 9 with a few longer setae compared to general pubescence of club. ***Thorax.*** Pronotum widest at base, narrowed anteriorly, surface evenly convex, with internal structural reticulations visible along lateral areas; ground punctation shallow, uniformly sparse, with surface between punctures smooth and shiny; seta-bearing systematic punctures forming paired anterolateral semicircles; anterior margin of pronotum fringed by short, rather sparse setae; lateral and anterior areas of pronotum translucent, with inner reticulations. Scutellar shield of moderate size, triangular, posteriorly rounded, nearly as long as wide, with punctation as in pronotum. Prosternum (e.g., Fig. 1I) nearly as long as half the length

of a procoxa; anterior margin of prosternum mesally projected as a wide triangle, slightly carinate along longitudinal midline; surface of median area of prosternum slightly elevated, somewhat densely covered by rather long, fine setae; intercoxal process projected from posterior margin of procoxal cavities, rectangularly shaped in outline, mesally longitudinally carinate. Mesoventrite (Fig. 2B) not fused to mesepisterna, densely setose for the most part, with posterolateral smooth and glabrous areas; anterior margin nearly 0.3 × as wide as anterior margin of mesepisternum; anterior rib of mesoventrite bearing paired oblique to parallel pearlescent maculae; posterior elevation of mesoventrite simply convex, without carinae or ridges (Fig. 2B); mesepisternum with surface nearly flat, densely covered by fine setae; mesepimeron trapezoid, with densely pubescent surface. Mesofurca (examined in *A. tubulus*) with short arms, 0.7 × length of mesocoxae; apical half of arms free, somewhat triangular at apex. Metaventrite mesally elevated, narrowly anteriorly, widely and flat posteriorly; surface of metaventrite densely and uniformly pubescent; mesal region of posterior margin rounded to truncate. Metepisterna approximately 3 × longer than wide, with posterior margin oblique. Metepimeron triangular, elongate to short. Metafurca (examined in *A. tubulus*, Fig. 2C) 1.46 × wider than long, with furcal arms as long as stalk; stalk triangular (wider near the crux, gradually narrowing ventrally), with paired longitudinal keels extending along basal third of posterior face, fusing together towards crux; with a well-developed median keel on anterior face extending to anterior margin of dorsal sheets; outer margins of stalk diverging towards crux, more strongly so along basal third; each furcal arm sickle-shaped, with apex (hemiductus) explanate in dorsal view, with apical region sinuate, pointing laterally; anterior tendons inserted nearly at mid length of dorsal edge of furcal arms; well-developed dorsal sheaths, wider than widest point of lateral sheaths. ***Elytra.*** Surface even (without elevations or depressions) and smooth, without sutural striae; ground punctures and systematic punctures very shallowly marked, all similar in size and degree of impression, and evenly distributed across surface; seta-bearing systematic punctures rather scarce, at most only distinguishable as rows along midline, third outer fourth, and near outer margin of each elytron, more evident along posterior fourth; serial punctures absent; elytral margins slightly flared; net-like patterning visible throughout the entire surface, especially along outer margins (e.g., Fig. 1G), with a pale lateral band extending from anterior margin up to apical third on each elytron. Epipleura well-developed, surface flat, with sparse fine setae and irregular sculpture, anteriorly wide, gradually narrowing posteriorly, extending up to line of posterior margin of first abdominal ventrite; inner margin of epipleura at most slightly bent at anterior outer corner of metepisternum; well-developed pseudepipleura, perpendicularly positioned, nearly as wide as anterior portion of epipleura, extending along entire outer margin of elytra, with rather smooth surface. Hind wings well developed. ***Legs.*** All coxae, trochanters and femora with dense pubescence, except on (at most) apical seventh of femora, in which surface is mostly glabrous, shiny and slightly reticulated. Anterior surface of mesocoxae with interspersed small denticles. All femora antero-posteriorly flattened; metafemora with rather well-developed tibial grooves, at most glabrous along apical seventh. Tibiae slender, cylindrical; spines forming longitudinal rows along tibiae rather small, accompa-

nied by conspicuous and somewhat dense golden setae; protibiae with median longitudinal row of small, appressed spines along anterior surface; apical spurs of protibiae very short (not exceeding length of tarsomere 1) and stout; apical spurs of metatibiae asymmetrical, inner posterior spur largest, nearly as long as metatersomere 1, 2 × longer than shorter spur (inner anterior). All tarsi with five tarsomeres, bearing numerous long hair-like setae on dorsal face, and densely covered by stiff setae on ventral face of tarsomeres 1–4; pro- and mesotarsomeres 1–4 similar in size and shape, with tarsomere 5 approximately as long as tarsomeres 2–4 combined, with few setae on ventral face; metatarsomeres 2, 3+4, and 5 similar in length; metatarsomere 4 shortest; claws rather large, curved; well-developed empodium, bearing a pair of long, curved apical setae. ***Abdomen.*** Abdomen with five ventrites, all uniformly and rather densely covered by fine and rather long, fine, golden setae, particularly longer along lateral margins; first ventrite medially convex, remainder ventrites rather flat; posterior margin of fifth ventrite with a medial triangular emargination, fringed by thick, flat spine-like setae (Fig. 2D); ninth tergite with transverse V-shaped impression, lateral margins deeply emarginate near midlength, and posterior margin rounded to mesally emarginate; ninth ventrite as fully sclerotized plate, with lateral margins posteriorly diverging, and posterior margin widely, roundly emarginate. Aedeagus (Fig. 2E, G, I) with well-developed basal piece, 0.1–0.25 × the length of parameres, longitudinally strongly convex; parameres basally fused together into a rather cylindrical tube, 5–7 × longer than wide, with basal margin rounded to truncate, and lateral margins straight to sinuate; median lobe nearly as long as parameres, with well-developed lateral basal apodemes; median lobe rounded at apex, either as a narrow tube throughout, or tongue-like and distally widened; gonopore reduced (inconspicuous), situated near apex of median lobe.

Larvae. The immature stages are unknown.

Etymology. Named from the Greek *aulon*, meaning pipe, tube, in reference to the unique tubular shape of the aedeagus of the species in the genus, combined with the ending *-chares*, as a reference to the general similarity with *Helochares* in the Acidocerinae. To be treated as masculine.

Distribution. To date known only from the Guiana Shield region of South America, where it is broadly distributed from southern Venezuela to French Guiana (Fig. 3).

Remarks. All known species are associated with small forested streams, typically with sand and detritus substrate where they are found along the margins (see Fig. 4). Adult females of *Aulonochares tubulus* have been observed to carry their egg case attached to the ventral side of their abdomen as other closely-related genera such as *Helochares* and *Helobata*.

Characters of taxonomic importance for *Aulonochares*

The external morphology of *Aulonochares* is extremely uniform across species.

Coloration. Even though coloration is not typically a reliable diagnostic feature in acidocerines, the dorsal coloration in *Aulonochares* is helpful for recognizing the species

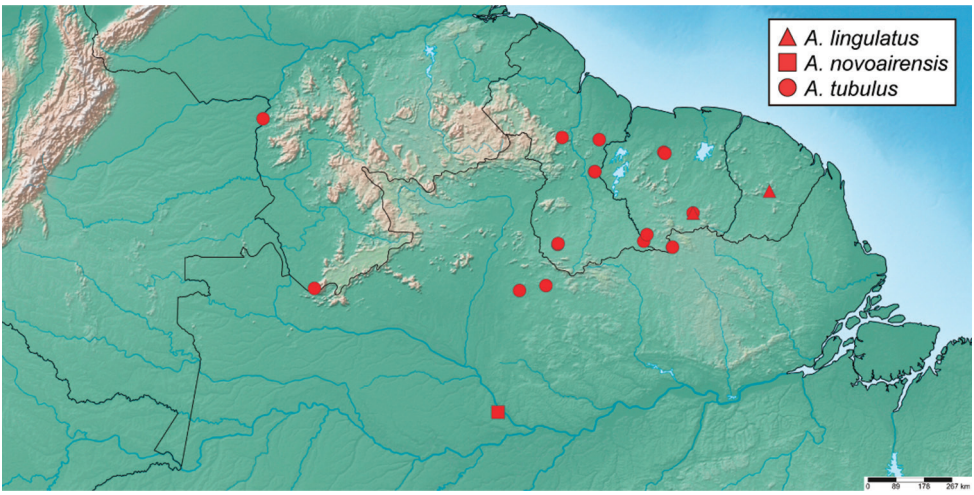

Figure 3. Distribution of *Aulonochares* spp.

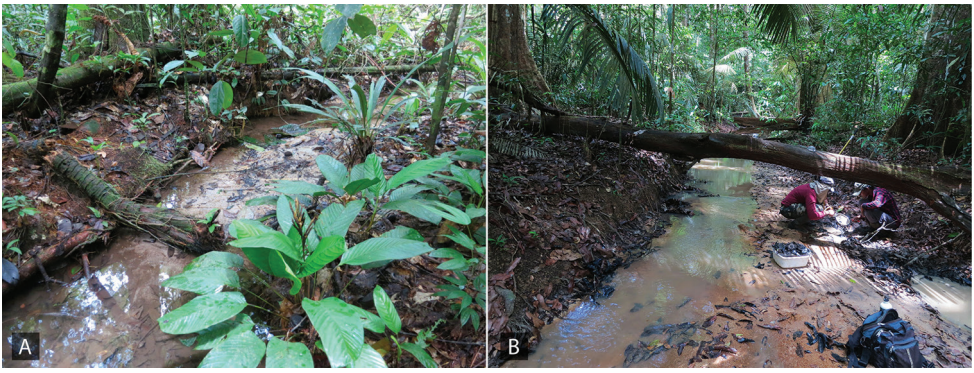

Figure 4. Habitat of *Aulonochares* spp. **A** habitat and type locality for *A. lingulatus*, Suriname: Kasikasima, collecting event SR12-0320-02A **B** habitat for *A. tubulus*, Guyana: Upper Berbice, collecting event GY14-0921-03H.

described here: *A. tubulus* is typically dark brown, *A. lingulatus* is orange brown and *A. novoairensis* is yellowish brown (see Fig. 1). Because teneral specimens may appear paler, the color of a specimen should not alone be considered as diagnostic. Specimens that have been extracted for DNA become uniformly dark brown in coloration.

Aedeagus. In all the known species of *Aulonochares* the aedeagus has basally fused parameres forming a tube which is 5–7 × longer than wide and becomes dorsoventrally flattened along the apical half; the median lobe is either cylindrical or broad and flat, and can slide within the parameres, so its extension beyond the apex of the parameres cannot be considered a diagnostic feature to distinguish species. The apex of the parameres can also be cylindrical or flattened. The basal piece is very short. The general form of the aedeagus of *Aulonochares* is unique among the Acidocerinae.

Key to the species of *Aulonochares*

1 General coloration orange brown (Fig. 1G–I); median lobe of aedeagus broad and flat, wider than apical portion of a paramere (Fig. 2I) ..... ***A. lingulatus***
– General coloration dark brown to yellowish brown; median lobe of aedeagus cylindrical, as wide as apical portion of a paramere **2**
2 General coloration dark brown (Fig. 1A–C); aedeagus parallel sided along basal 2/3 (Fig. 2E) ..... ***A. tubulus***
– General coloration yellowish brown (Fig. 1D–F); aedeagus widened at 2/3 (Fig. 2G)..... ***A. novoairensis***

***Aulonochares lingulatus* sp. nov.**
http://zoobank.org/F03E9C40-595C-4EAA-B84A-37EAC2B753D3
Figs 1G–I, 2H, I, 3, 4A

Type material. Holotype (♂): "SURINAME: Sipaliwini District; 2.97731N, 55.38500W; 200 m; Camp 4 (low), Kasikasima; sandy stream on trail to METS camp; 20.iii.2012; leg. A. Short; SR12-0320-02A" (NZCS). **Paratypes (12): FRENCH GUIANA:** "Unnamed Trib. To Crique Nouvelle France, 3.59627N, 53.17637W, above Courant double; 09.xi.2016, leg. D. Post" (SEMC, 1, DNA voucher specimen SLE 1173). **SURINAME: Sipaliwini District:** Same data as holotype (NZCS, SEMC, 10, including DNA voucher SLE 415); same, except "sandy creek, trail to Kasikasima; flotation; 22.iii.2012; SR12-0322-02A" (SEMC, 1).

Differential diagnosis. *Aulonochares lingulatus* can be distinguished by its orange brown general coloration (Fig. 1G–I), and the shape of the median lobe of aedeagus, which is broad and flat (Fig. 2I).

Description. Body length 6.0–6.5 mm, width 3.2–3.6 mm. General coloration orange brown (Fig. 1G–I). Aedeagus (Fig. 2I) with outer margins of parameres subparallel, slightly diverging apically; median lobe flat, gradually widening towards apical region, widely rounded at apex.

Etymology. Named with the Latin word *lingulatus* meaning tongue-like, after the shape of the median lobe of the aedeagus in this species.

Distribution. *Aulonochares lingulatus* is known from the area surrounding Mt. Kasikasima in Suriname and a locality in central French Guiana (Fig. 3).

Remarks. All specimens were collected in densely forested sandy streams (Fig. 4A).

***Aulonochares novoairensis* sp. nov.**
http://zoobank.org/F78999DD-14F1-405C-9262-DA883BDFB1F3
Figs 1D–F, 2F, G, 3

Type material. Holotype (♂): "BRAZIL: Amazonas: Novo Airão; 2°41'2.2878"S, 60°56'18.24"W; 60 m; detrital pools in forest along sides of blackwater creek; 9.vi.2017;

leg. Benetti; BR17-0609-04B" (INPA). **Paratype (1):** Same data as holotype (SEMC, DNA voucher specimen SLE 1268).

Differential diagnosis. *Aulonochares novoairensis* can be distinguished by its yellowish brown general coloration (Fig. 1D–F), and the shape of the aedeagus, which is widened at 2/3, with cylindrical median lobe (Fig. 2G).

Description. Body length 6.3–6.9 mm, width 3.4–3.6 mm. General coloration yellowish brown (Fig. 1D–F). Aedeagus (Fig. 2G) with outer margins of parameres sinuate, widest along 2/3; median lobe cylindrical, somewhat acute at apex.

Etymology. Named after Novo Airão municipality in the state of Amazonas in Brazil.

Distribution. Currently only known from a single locality in the central Amazon near Manaus (Fig. 3).

Remarks. The single collection of this species was from densely forested, shallow detrital pools immediately adjacent to a blackwater stream.

Aulonochares tubulus sp. nov.

http://zoobank.org/B79D0338-3EE9-4B12-8357-20006B091877
Figs 1A–C, 2A–E, 3, 4B

Type material. Holotype (♂): "SURINAME: Sipaliwini District; 2°00.342'N, 55°58.149'W; 337 m; Sipaliwini Savanna nature Res., 4-Brothers Mts.; clearwater stream, sandy with emergent vegetation; at night; 31.iii.2017; leg. A. Short; SR17-0331-01F" (NZCS). **Paratypes (156): BRAZIL: Roraima:** "00°46'35.1"N, 60°19'58.7"W; 97 m; Rorainópolis, Recanto da Cachoeira, vicinal 12; creek flowing through gallery forest; 10.1.2018; leg. A. Short; BR18-0110-04A" (SEMC, 3); "00°54.786'N, 59°34.397'W; 150 m; Caroebe, Rio Caroebe, ca. 13 Km NE of Caroebe; margins of sandy river; 17.i.2018; leg. A. Short & Benetti; BR18-0117-04A" (SEMC, 1). **GUYANA: Region 9:** "2°05.095'N, 59°14.174'W; 250 m; Parabara, trail to mines; detrital pools in forest; 2.xi.2013; leg. Short, Isaacs, Salisbury; GY13-1102-01A" (CBDG, SEMC, 8); same, except "2°06.492'N, 59°13.653'W;274 m; Parabara, N side of river; small flowing forested creek, detritus margins & leaf packs; 3.xi.2013; GY13-1103-02A" (SEMC, 2). **Region 8:** "5°07.539'N, 59°06.732'W; 80 m; Konawaruk River, basecamp 2 (NARIL basecamp); unnamed clearwater creek, slow flowing, shallow; 15.ix.2014; leg. Salisbury & La Cruz; GY14-0915-02" (SEMC, 6). **Region 6:** "4°09.143'N, 58°11.207'W; 105 m; Upper Berbice, c. 1 Km W Basecamp 1; small sandy stream; 21.ix.2014; leg. A. Short; GY14-0921-03A" (SEMC, 2); same, except "margins of creek; 22.iv.2014; leg. Short, Salisbury, La Cruz; GY14-0921-03H" (SEMC, 4); same, except "4°09.136'N, 58°11.365'W; 106 m; Upper Berbice, ca. 1.1 Km W of basecamp 1; stream detrital pool; 23.ix.2014; GY14-0923-02A" (SEMC, 1); same, except "4°09.289'N, 58°10.717'W; 95 m; Upper Berbice, Basecamp 1; margins of basecamp creek; 24.ix.2014; GY14-0924-01A" (SEMC, 1); same, except "4°09.241'N, 58°10.627'W; 109 m; puddles along road; GY14-0924-02A" (SEMC, 4); same, except "margins of creek with leaf

packs and mud; 25.ix.2014; leg. Short & La Cruz; GY14-0925-01B" (SEMC, 1); same, except "detritus pools in dry creekbed; leg. Short, Salisbury, La Cruz; GY14-0925-01D" (SEMC, 1); same, except "5°03.892'N, 58°03.303'W; 71 m; Upper Berbice, Logging Road Km 1; marsh and creek; 29.ix.2014; GY14-0929-01B" (CBDG, SEMC, 12). **SURINAME: Sipaliwini District:** "2°10.521'N, 56°47.244'W; 228 m, Camp 1, on Kutari River; forest swamp; 22.viii.2010; leg. Short & Kadosoe; SR10-0822-02A; 2010 CI-RAP Survey" (SEMC, 2); same, except "2°21.776'N, 56°41.861'W; 237 m; Camp 3, Wehepai; sandy forest creek; 4–6.ix.2010; SR10-0904-01A" (SEMC, 7); "2.97731N, 55.38500W; 200 m; Camp 4 (low), Kasikasima; sandy stream on trail to METS camp; 20.iii.2012; leg. A. Short; SR12-0320-02A; 2010 CI-RAP Survey" (SEMC, 2); same, except "detrital pools along trail to METS camp; 20–25.iii.2012; SR12-0320-03A" (SEMC, 3); same, except "sandy creek, trail to Kasikasima; flotation; 22.iii.2012; SR12-0322-02A" (SEMC, 7); "04°40.910'N, 56°11.138'W; 78 m; Raleighvallen Nature Reserve, Voltzberg Station; stream margins; 29.vii.2012; leg. Short, Maier, McIntosh, Kadosoe; SR12-0729-02A" (SEMC, 1); same, except "detrital side pool; leg. Short & McIntosh; SR12-0729-02B" (SEMC, 1); same, except "margin of stream; 30.vii.2012; leg. Maier & Kadosoe; SR12-0730-01A" (SEMC, 1); same, except "detrital pools along stream; leg. Short & McIntosh; SR12-0730-01B" (NZCS, SEMC, 10); "4°42.48'N, 56°13.15908'W; 24 m; Raleighvallen Nature Reserve, Lolopaise area; side pool of creek; 14.iii.2016; leg. Short et al.; SR16-0314-02D" (SEMC, 1); "4°40.432'N, 56°11.079'W; 86 m; Raleighvallen Nature Reserve, base of Voltzberg; pooled up stream; 16.iii.2016; SR16-0316-01B" (SEMC, 1); "Raleighvallen Nature Reserve, trail from plateau to Voltzberg stream with roots, mud; 17.iii.2016; leg. J. Girón; SR16-0317-04A" (SEMC, 4); "4°42.48'N, 56°13.15908'W; 24 m; Raleighvallen Nature Reserve, Lolopaise area; intermittent stream margins; flotation; 18.iii.2016; leg. Short et al.; SR16-0318-01D" (SEMC, 2); same, except "intermittent stream pools; pan/screen method; 18.iii.2016; leg. Toussaint et al.; SR16-0318-01E" (SEMC, 1); "Raleighvallen Nature Reserve, Copename River, Voltzberg trail; detrital pools in stream bed; 17.iii.2016; leg. A. Short; SR16-0319-01A" (SEMC, 1); "4°42.48'N, 56°13.15908'W; 24 m; Raleighvallen Nature Reserve, Lolopaise area; intermittent stream pools; 19.iii.2016; leg. Toussaint et al.; SR16-0319-02C" (SEMC, 2); "2°00.397'N, 55°58.371'W; 306 m; Sipaliwini Savanna nature Res., palm swamp nr. 4-Brothers Mts.; mud/detritus; 30.iii.2017; leg. Short & Baca; SR17-0330-03A" (SEMC, 1); same, except "2°00.342'N, 55°58.149'W; 337 m; 4-Brothers Mts.; clearwater stream, sandy with emergent vegetation; 31.iii.2017; SR17-0331-01C" (SEMC, 23); same, except "sandy pools in creek; leg. S. Baca; SR17-0331-01E" (SEMC, 10); same data as holotype (NZCS, SEMC, 23). **VENEZUELA: Amazonas:** "0°50'N, 66°10'W; 140 m; Cerro de la Neblina, 1 Km S Basecamp; along small whitewater stream; pools of dead leaves and sticks; 17.ii.1985; leg. P.J. & P.M. Spangler, R. Faitoute, W. Steiner" (USNM, 2); "Puerto Ayacucho; in small ponds full of dead leaves; 22.i.1985; leg. G.E. Ball" (SEMC, USNM, 5).

Differential diagnosis. *Aulonochares tubulus* can be distinguished by its dark brown general coloration (Fig. 1A–C), and the shape of the aedeagus, which is parallel sided along its basal 2/3, with cylindrical median lobe (Fig. 2E).

Description. Body length 5.8–7.5 mm, width 3.1–4.0 mm. General coloration dark brown (Fig. 1A–C). Aedeagus (Fig. 2E) with outer margins of parameres subparallel along basal 2/3, slightly concave along apical third; median lobe cylindrical, rounded at apex.

Etymology. Named with the Latin word *tubulus* meaning pipe, after the shape of the median lobe of the aedeagus in this species.

Distribution. Broadly distributed in the Guiana Shield region, from the Orinoco River to central Suriname (Fig. 3).

Remarks. The majority of collecting events of this species are from forested streams, including those actively flowing as well as pooled up, or from isolated marginal pools in the stream bed (Fig 4B). A few collections were made in forested detrital pools, although most if not all of these were near or associated with riparian corridors. They are usually found in habitats with abundant detritus or decaying organic matter. Females have been observed on numerous occasions to carry their egg case beneath their abdomen.

Ephydrolithus gen. nov.

http://zoobank.org/2A3C09E9-53A5-4CF8-BE8C-D11D27D363E9
Figs 5–9

Type species. *Ephydrolithus hamadae* sp. nov.

Differential diagnosis. Small beetles (1.8–3.3 mm), oval in dorsal view, moderate to strongly convex in lateral view (e.g., Figs 5B, 6F), yellowish brown to dark brown. Antennae with nine antennomeres (e.g., Fig. 6C). Maxillary palps short (e.g., nearly two thirds the width of the head) and stout (e.g., Fig. 6H). Elytra without sutural striae, and only rarely with impressed striae (e.g., *Ephydrolithus ogmos*); ground punctures sharply marked, uniformly and rather densely distributed; systematic punctures slightly larger and deeper than remainder punctures; serial punctures usually absent (present but reduced in *E. ogmos*). Prosternum flat (e.g., Figs 5C, 6C), sometimes only slightly elevated along longitudinal midline. Posterior elevation of mesoventrite usually with a transverse ridge (Fig. 7A; except in *E. ogmos* and *E. spiculatus* which bear a well-developed tooth, e.g. Fig. 6C). Metaventrite densely pubescent, except for a large median teardrop-shaped glabrous patch. Posterior femora glabrous for the most part, with few scattered setae along basal half to basal two thirds, with hydrofuge pubescence along anterodorsal margin; well-developed tibial grooves, sometimes covered by hydrofuge pubescence. Fifth abdominal ventrite apically truncate, with stout setae (e.g., Fig. 7C).

Among Neotropical acidocerines, *Ephydrolithus* has a general resemblance to *Katasophistes* (see Girón and Short 2018), especially by characters of the elytral punctation, which exhibits five rows of deep/large systematic punctures. *Ephydrolithus* can be easily recognized from *Katasophistes* by the mostly glabrous metafemora, with only few scattered setae on anterior surface, as opposed to at most glabrous along apical third in *Katasophistes*. *Ephydrolithus* might also resemble some species of *Chasmogenus*; nevertheless, the absence of sutural striae in *Ephydrolithus* allows its recognition.

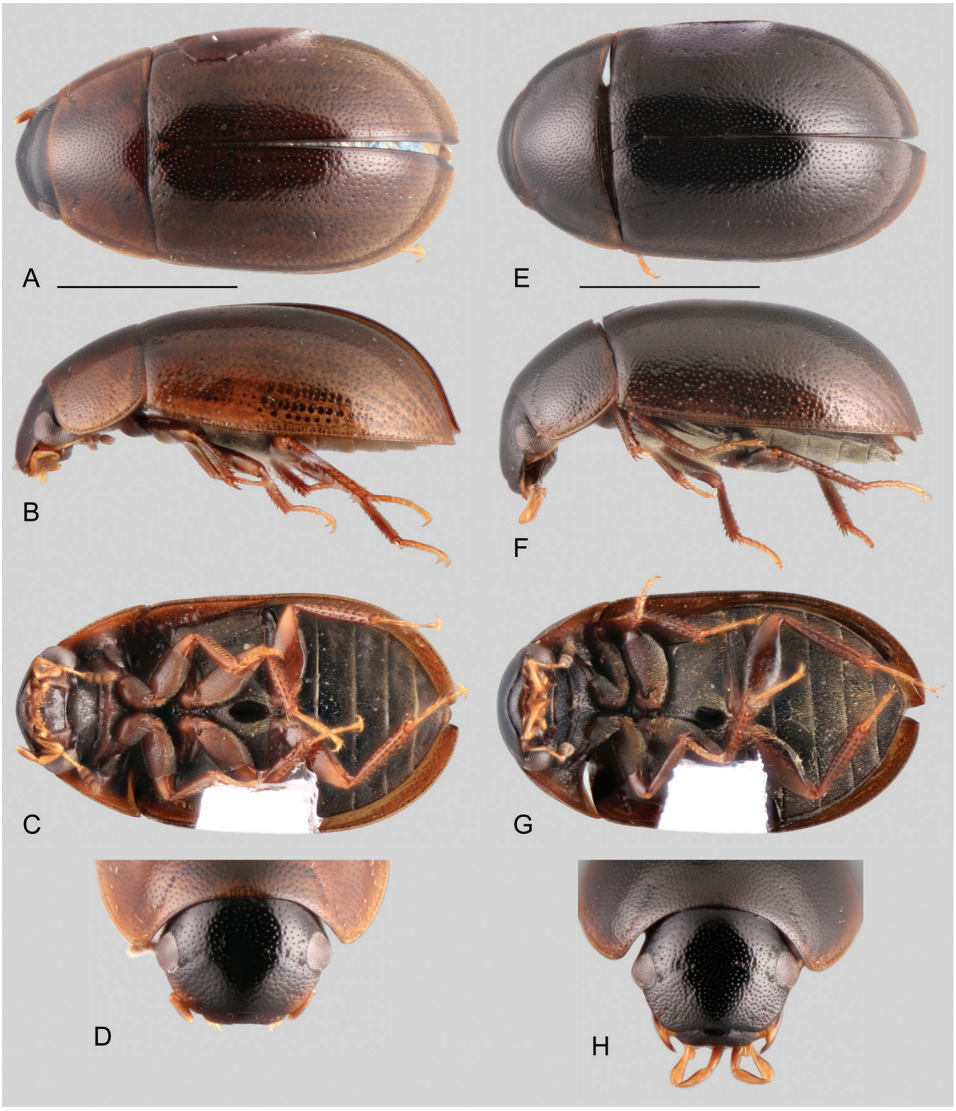

Figure 5. Habitus of *Ephydrolithus* spp.: **A–D** *Ephydrolithus hamadae*: **A** dorsal view **B** lateral view **C** ventral view **D** head, dorsal view. **E–H** *Ephydrolithus teli*: **E** dorsal view **F** lateral view **G** ventral view **H** head, dorsal view. Scale bars: 1 mm.

Ephydrolithus can be distinguished from other Neotropical acidocerines with mostly glabrous metafemora such as *Quadriops* (e.g. Girón and Short 2017) by the entire (as opposed to divided) eyes. From *Tobochares* (e.g. Kohlenberg and Short 2017) *Ephydrolithus* can be distinguished by the number of antennomeres (nine in *Ephydrolithus*, eight in *Tobochares*). In addition, in some species of *Ephydrolithus* the tibial grooves of the metafemora are covered by hydrofuge pubescence, which is an unusual condition among Neotropical acidocerines with mostly glabrous metafemora.

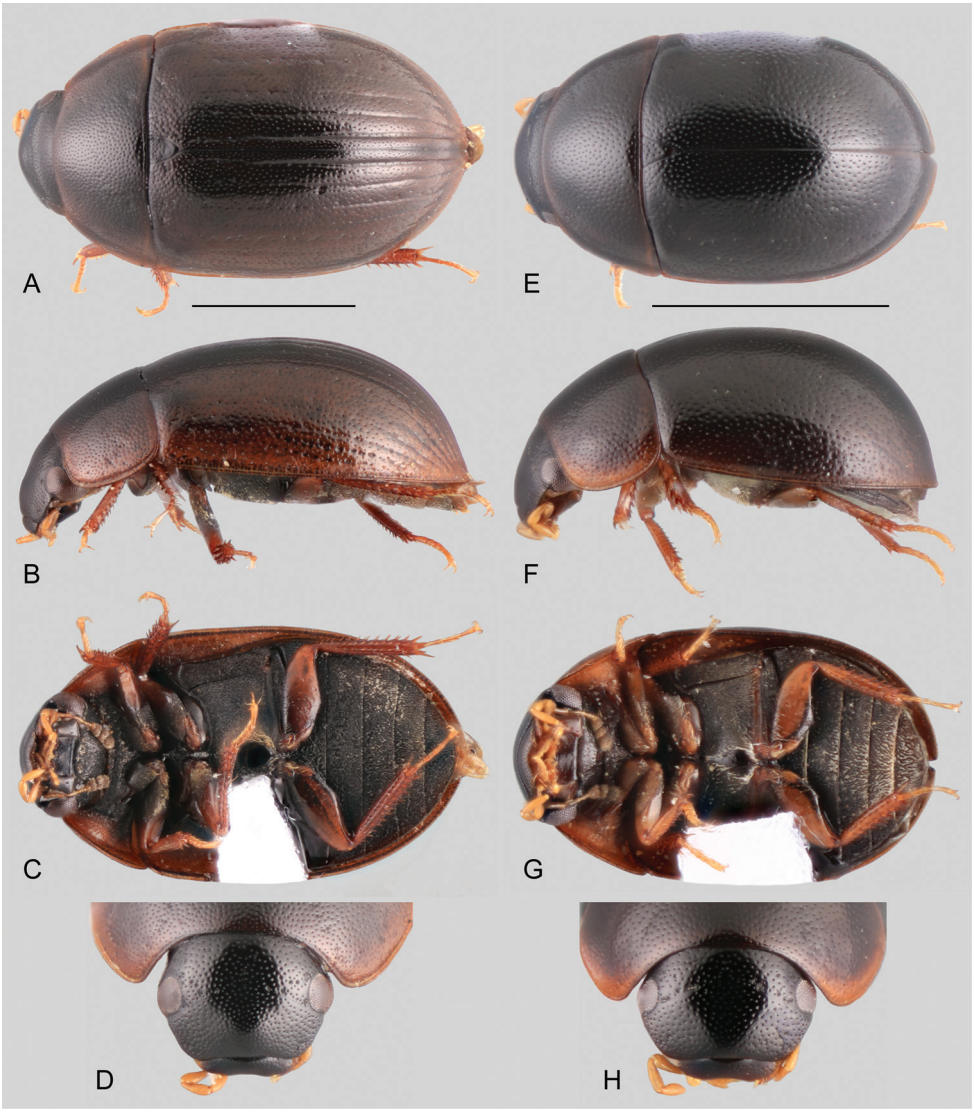

Figure 6. Habitus of *Ephydrolithus* spp.: **A–D** *Ephydrolithus ogmos*: **A** dorsal view **B** lateral view **C** ventral view **D** head, dorsal view. **E–H** *Ephydrolithus minor*: **E** dorsal view **F** lateral view **G** ventral view **H** head, dorsal view. Scale bars: 1 mm.

The smaller members of *Ephydrolithus* might resemble species of *Crucisternum* (see Girón and Short 2018), but the prosternal keel of *Crucisternum* easily separates them.

Description. Small beetles, total body length 1.8–3.3 mm; body elongate oval, moderate to strongly convex in lateral view (e.g., Figs 5B, 6F), yellowish brown to dark brown in color, sometimes paler along lateral margins of pronotum and elytra, legs (especially tarsi), mouthparts and antennae. ***Head.*** Frons and clypeus (e.g., Fig. 5H) with moderately marked ground punctures, irregularly and rather densely distributed

over the surface, with only few seta-bearing systematic punctures along lateral areas of frons and clypeus; surface between punctures smooth and shiny. Eyes oval in dorsal view, separated by nearly 5 × width of one eye; in lateral view, anterior margin slightly emarginate. Clypeus trapezoid, with medial surface moderately convex, and anterior corners forming widely rounded obtuse angles; anterior margin of clypeus widely roundly emarginate, 0.7 × width of posterior margin; membranous preclypeal area absent. Labrum 0.7 × as wide as anterior margin of clypeus, fully exposed, nearly 1/3 as long, and usually collinear to clypeus (e.g., Fig. 6D); dorsal surface convex, with fine punctures; anterior margin roundly bent inwards, mesally emarginate and with tiny denticles along emargination; anterior corners fringed by setae. Temporae densely covered by very short and fine setae (hydrofuge pubescence). Mentum parallel sided, with surface mostly smooth and undulated, sometimes anteromesally depressed; anterior margin mesally depressed, usually depression marked by a u-shaped transverse carina. Submentum sunken and pubescent at base, glabrous, shiny, and ascending at apex; well-developed ocular ridge. Maxilla (see Fig. 6C) with ventral surface of cardo and stipes smooth and shiny, at most with few scattered and shallow punctures; cardo positioned collinear to oblique to ventral surface of head; outer dorsal margin of palpifer with a row of stiff, decumbent, spiniform setae; limit between cardo and stipes parallel to posterior margin of mentum; maxillary palps curved inward, yellowish, nearly as long as antennae, short (e.g., nearly two thirds the width of the head) and stout (e.g., Fig. 6H); palpomere 1 strongly widened near apex (with outer apical margin strongly convex); palpomere 2 gradually widening towards apex; palpomere 3 fusiform, bearing apical sensilla; all palpomeres similar in length. Mandibles with apex bifid (examined in *E. ogmos*). Labial palps yellow, slightly shorter than mentum, dorsoventrally flattened; palpomere 2 with outer margin strongly convex apicad of midpoint, sometimes with one preapical seta on outer surface; palpomere 3 digitiform, with a long subapical seta on outer corner. Antennae (see Fig. 6C) with nine antennomeres, usually yellow with darker club; antennomere 1 with surface evenly convex near base, reaching midpoint of ventral surface of eye (reaching cardo-stipes joint), 1.5–2.5 × longer than antennomere 2; antennomere 2 nearly as long as antennomeres 3–5 combined; antennomere 6 forming a well differentiated, asymmetric cupule; antennomeres 7–9 each wider than long, slightly flattened, forming a loosely articulated, pubescent club (antennomere 8 shortest, 9 longest); pubescence of antennomere 9 with few scattered longer setae on apical area. ***Thorax.*** Pronotum widest at base, narrowed anteriorly, surface evenly convex; ground punctation moderate, uniformly dense, with surface between punctures smooth and shiny; seta-bearing systematic punctures forming paired anterolateral semicircles, and paired short posterolateral transverse bands. Scutellar shield of moderate size, triangular, nearly as long as wide, with punctation as in pronotum. Prosternum flat (e.g., Figs 5C, 6C), sometimes only slightly elevated along longitudinal midline (e.g., Fig. 5G), nearly as long as half the length of a procoxa; anterior margin of prosternum straight to slightly convex; surface finely crenulate, with scattered fine setae, slightly impressed along procoxal area; intercoxal process projected from posterior margin of procoxal cavities, rectangularly shaped in outline, mesally

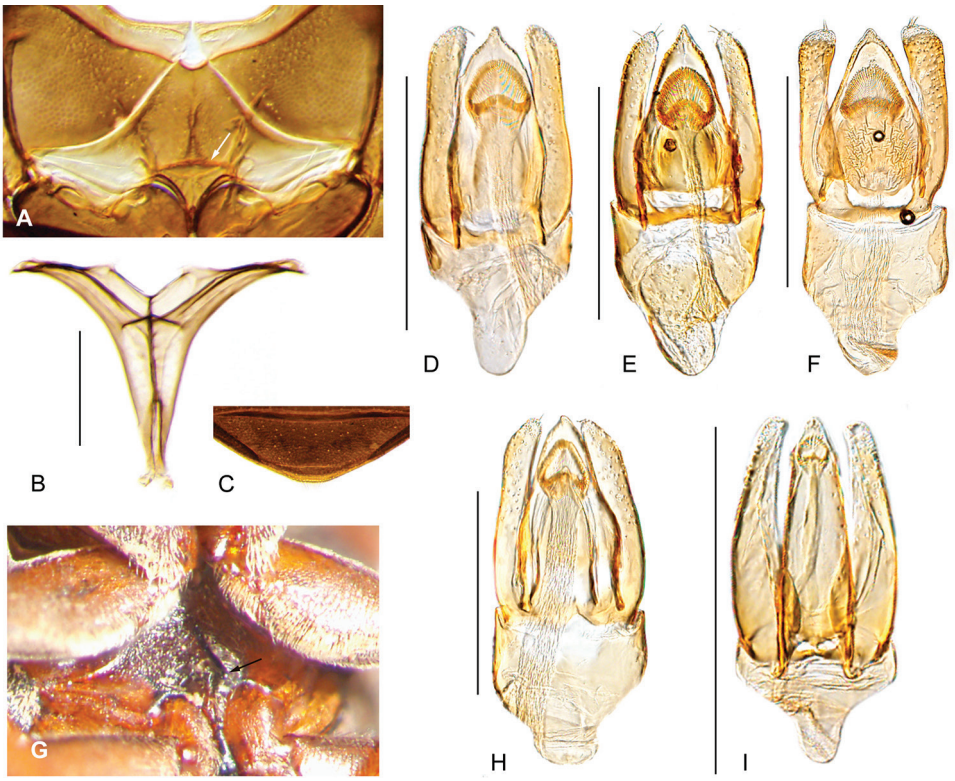

Figure 7. Thorax, abdomen and genitalia of *Ephydrolithus* spp.: **A–D** *Ephydrolithus hamadae*: **A** ventral view of mesoventrite (white arrow pointing transverse ridge) **B** posterior view of metafurca **C** fifth abdominal ventrite **D** aedeagus **E** aedeagus of *Ephydrolithus teli*. **F, G** *Ephydrolithus spiculatus*: **F** aedeagus **G** oblique view of mesoventrite (black arrow pointing well-developed tooth) **H** aedeagus of *Ephydrolithus ogmos* **I** aedeagus of *Ephydrolithus minor*. Scale bars: 0.25 mm.

longitudinally carinate. Mesoventrite (Fig. 7A, G) not fused to mesepisterna, with anterior margin 0.2–0.4 × as wide as anterior margin of mesepisternum; anterior rib of mesoventrite with median, triangular, pale macula; posterior elevation of mesoventrite either with a sharp, low, transverse, curved ridge (Figs 5C, 7A), or bearing a basally transverse, well-developed tooth that extends anteriorly as a longitudinal carina (Figs 6C, 7G); surface of mesoventrite with posterolateral smooth and glabrous areas; mesepisternum obliquely widely concave; mesepimeron trapezoid, with pubescent surface. Mesofurca (examined in *E. hamadae*) with short arms, 0.9 × length of mesocoxae; apical half of arms free, somewhat triangular at apex. Metaventrite posteromesally elevated, with elevation somewhat narrow anteriorly, widening posteriorly; surface of metaventrite densely pubescent, except for a median to posteromedian, large teardrop-shaped glabrous patch; anteromedian area of metaventrite with a deep and narrow transverse depression before anterior intercoxal process. Metepisterna nearly 4 × longer than wide, slightly narrowing at posterior end. Metepimeron triangular and posteriorly

slightly projected. Metafurca (examined in *E. hamadae*, Fig. 7B) 1.3 × wider than long, with furcal arms 0.8 × the length of stalk; stalk triangular (wider near the crux, gradually narrowing ventrally), with paired longitudinal keels extending along basal third of posterior face, fusing together towards crux, with a well-developed median keel on anterior face extending to anterior margin of dorsal sheets; outer margins of stalk diverging from basal third towards crux; furcal arms somewhat trapezoid, with apex (hemiductus) roundly explanate, with apex pointing laterally; anterior tendons inserted at basal third of dorsal edge of furcal arms; well-developed dorsal sheaths, wider than widest point of lateral sheaths. ***Elytra.*** Surface even (without elevations or depressions), without sutural striae (in *E. ogmos* elytral striae well-marked, more strongly so along stria 1); ground punctures sharply marked, uniformly and rather densely distributed; seta-bearing systematic punctures rather enlarged and deep, forming five longitudinal rows along each elytron, fifth row very close to outer margin of elytron; serial punctures usually absent (present but reduced in *E. ogmos*); elytral margins slightly flared. Epipleura well developed, surface rather oblique, with fine setae, anteriorly wide, gradually narrowing posteriorly, extending up to line of posterior margin of metaventrite; inner margin of epipleura slightly concave at articulation of anterior outer corner of metepisternum; well-developed pseudepipleura, rather obliquely positioned, anteriorly nearly as wide as anterior portion of epipleura, narrowing towards line of posterior margin of metaventrite, extending as narrow band along remainder outer margin of elytron. Hind wings well developed (examined in *E. hamadae* and *E. teli*). ***Legs.*** Pro- and mesofemora covered with hydrofuge pubescence along at least basal half; metafemora with hydrofuge pubescence as a narrow stripe along basal 2/3 of anterodorsal margin, remainder anterior surface usually smooth and shiny, with only few scattered setae; all femora antero-posteriorly flattened, with sharp tibial grooves; sometimes tibial grooves with hydrofuge pubescence (in *E. hamadae* and *E. teli*). Tibiae slender, weakly flattened, with well-developed spines; protibiae with a median longitudinal row of long setae along anterior surface; apical spurs of protibiae rather large and slender. All tarsi with five tarsomeres, bearing long apical hair-like setae on dorsal face, and two lateral rows of hair-like spines on ventral face of tarsomeres 2–4; pro- and mesotarsomeres 1–4 similar in size and shape; pro- and mesotarsomere 5 similar in size to pro- and mesotarsomeres 1–4 combined; metatarsomere 2 nearly as long as tarsomeres 3–4 combined; metatarsomere 5 similar in size to metatarsomere 2, without spines on ventral face; claws rather large, curved; well-developed empodium, bearing a pair of long, curved apical setae. ***Abdomen.*** Abdomen with five ventrites, very weakly convex medially; all ventrites with uniform, dense, fine pubescence; posterior margin of fifth ventrite truncate, set with a row of thick, flat spine-like setae (Fig. 7C). Aedeagus (Fig. 7D–F, H, I) with outer margins convex, straight or sinuate, with basal piece between 0.45 and 0.9 X the length of parameres; median lobe somewhat triangular in shape, with well-developed lateral basal apodemes; widest point of median lobe wider than widest point of each paramere; apex of median lobe widely to narrowly acute, sometimes "pinched" (e.g. *E. hamadae*, Fig. 7D); parameres nearly as long as median lobe, with greatest width near base, bearing apical setae; well-developed gonopore, preapically situated.

Figure 8. Distribution of *Ephydrolithus* spp.

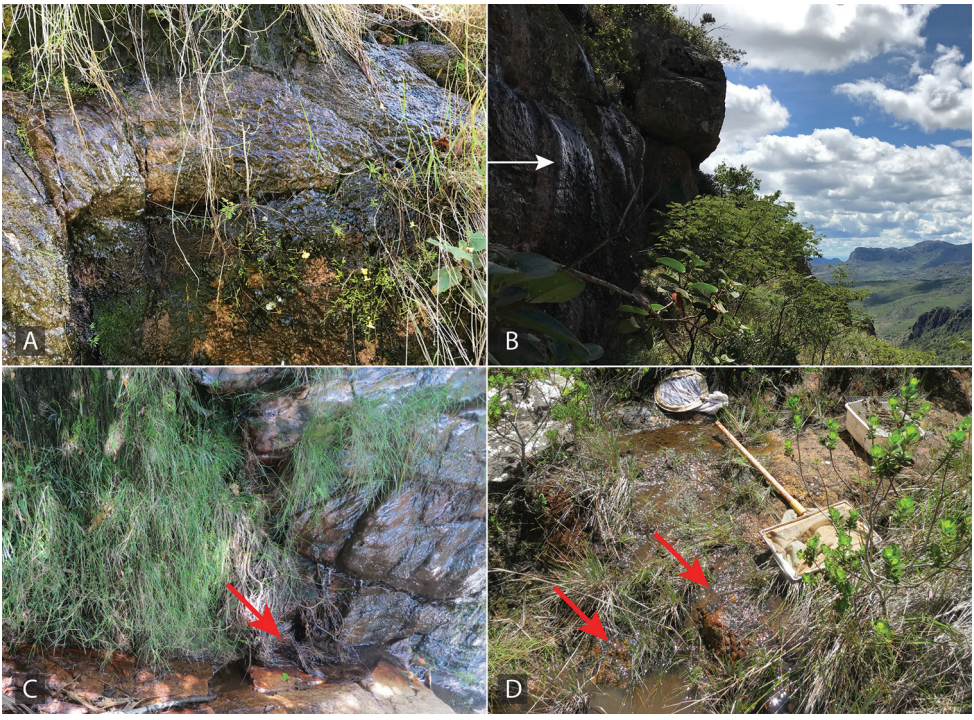

Figure 9. Habitat of *Ephydrolithus* spp. **A, B** habitat and type locality for *E. minor* and *E. ogmos*, Brazil, Pico do Barbado, collecting event BR18-0226-01C **C** habitat and type locality for *E. hamadae* and *E. spiculatus*, Brazil, Cachoeira da Palmeira, collecting event BR18-0302-04A **D** habitat and type locality for E. *teli*, Brazil, Pico do Barbado, collecting event BR18-0226-01B.

Larvae. The immature stages are unknown.

Etymology. Named by the combination of the Greek words *ephydros* meaning wet, and *lithus* meaning rock, in reference to the seepage habitat in which the genus has been collected. To be treated as neuter.

Distribution. The genus is currently only known from the northeastern highlands of Brazil (Bahía, Minas Gerais) on the Brazilian Shield (Fig. 8).

Remarks. Species of *Ephydrolithus* have been collected in an altitudinal range between 568 and 1705 m. All known species are exclusively associated with rock seepages (see Fig. 9).

Characters of taxonomic importance for *Ephydrolithus*

Even though members of *Ephydrolithus* are externally relatively homogeneous, there are some useful characters for species identification.

Body size. Most *Ephydrolithus* species range in size from 2.6 to 3.3 mm. *Ephydrolithus minor* is the smallest species, with body size ranging from 1.8 to 2.2 mm.

Elytral surface. Most species of *Ephydrolithus* lack elytral striae; only *E. ogmos* has impressed striae along almost the entire length of the elytra.

Tibial grooves of metafemora. In some species of *Ephydrolithus* the tibial grooves of the metafemora are covered by hydrofuge pubescence. Only *E. minor* and *E. ogmos* have glabrous metafemoral tibial grooves.

Posterior elevation of mesoventrite. Usually the elevation bears a sharp, low, transverse, curved ridge (Figs 5C, 7A). Only *E. ogmos* and *E. spiculatus* bear a pointed spine (Figs 6C, 7G).

Aedeagus. The overall forms and proportions of the aedeagus of *Ephydrolithus* species are very similar among species, except for *E. minor*, which has a comparatively shorter basal piece and narrower median lobe (see Fig. 7I).

Key to the species of *Ephydrolithus*

1 Elytra with well-defined and impressed striae (Fig. 6A, B) ..... ***E. ogmos***

– Elytral without impressed striae (Figs 5A, E, 6E) **2**

2 Body strongly convex, 1.8–2.2 mm in length; anterior surface of pro- and mesofemora covered by hydrofuge pubescence along basal half (Fig. 6G)..... ..... ***E. minor***

– Body moderately convex, 2.4–2.9 mm in length; anterior surface of pro- and mesofemora covered by hydrofuge pubescence along basal two thirds (Fig. 5C, G) **3**

3 Posterior elevation of mesoventrite bearing a pointed spine (Fig. 7G) .... ***E. spiculatus***

– Posterior elevation of mesoventrite with a sharp, low, transverse, curved ridge (Figs 5C, 7A) **4**

4 Parameres of aedeagus 1.2–1.3 × longer than basal piece; median lobe 2 × longer than its greatest width; outer margins of apex of median lobe straight to slightly sinuate (apex of median lobe triangular) (Fig. 7E) ..... ***E. teli***

– Parameres of aedeagus 1.5–1.6 × longer than basal piece; median lobe nearly 2.5 × longer than its greatest width; outer margins of apex of median lobe clearly sinuate (apex of median lobe "pinched") (Fig. 7D)..... ***E. hamadae***

***Ephydrolithus hamadae* sp. nov.**
http://zoobank.org/3129CD1D-7BAE-4C2B-86B4-25B08D27E712
Figs 5A–D, 7A–D, 8, 9C

Type material. Holotype (♂): "BRAZIL: Minas Gerais: Lassance; 17.83384S, 44.50515W; 568 m; Cachoeira da Palmeira; flotation of root mats and moss from side of waterfall & seepage; 2.iii.2018; leg. Benetti & team; BR18-0302-04A" (INPA). **Paratypes (7): BRAZIL: Minas Gerais:** Same data as holotype (INPA, SEMC, 7 including DNA voucher SLE 1506).

Differential diagnosis. *Ephydrolithus hamadae* is very similar to *E. teli*. Both species can only be distinguished from each other by characteristics of the aedeagus.

Description. Body length 2.6–3.2 mm, width 1.5–1.7 mm. Body elongate oval, moderately convex (Fig. 5B). General coloration yellowish to dark brown, slightly paler along margins of pronotum and elytra. Posterior elevation of mesoventrite with well-defined, curved transverse ridge. Elytra without striae or serial punctures. Pro- and mesofemora covered with hydrofuge pubescence along basal 2/3; metafemora with hydrofuge pubescence on tibial grooves. Apex of fifth abdominal ventrite truncate (Fig. 7C). Aedeagus (Fig. 7D) with basal piece 0.6 × the length of parameres; parameres nearly 0.5 × greatest width of median lobe, with outer margins slightly sinuate; apex of parameres rounded, obliquely directed; apex of median lobe "pinched", narrowly rounded.

Etymology. Named after Neusa Hamada from the Instituto Nacional de Pesquisas da Amazônia, Manaus (INPA), in recognition of her support on recent expeditions collecting aquatic beetles in Brazil.

Distribution. Known only from the type locality (Fig. 8).

Remarks. This species was collected by gathering moss and roots from bottom and margin of a seepage that was next to a large waterfall (Fig. 9C). Specimens were collected by placing the moss and roots in a pan with water, where they floated to the surface along with one specimen of *E. spiculatus*.

***Ephydrolithus minor* sp. nov.**
http://zoobank.org/E49E34BB-6106-451D-A670-0ACF02FBB604
Figs 6E–H, 7I, 8, 9A, B

Type material. Holotype (♂): "BRAZIL: Bahia: Abaíra; 13.29053S, 41.90489W; 1705 m; Pico do Barbado W of Catolés; vertical seep on rock; 26.ii.2018; leg. Benetti

& team; BR18-0226-01C" (INPA). **Paratypes (15): BRAZIL: Bahia:** Same data as holotype (SEMC, 8 including DNA vouchers SLE-1511, SLE-1512; INPA, 7).

Differential diagnosis. *Ephydrolithus minor* is easily recognized among its congeners by its small size.

Description. Body length 1.8–2.2 mm, width 0.9–1.3 mm. Body elongate oval, strongly convex (Fig. 6F). General coloration dark brown, slightly paler along margins of pronotum. Posterior elevation of mesoventrite with well-defined, curved transverse ridge. Elytra without striae or serial punctures. Pro- and mesofemora covered with hydrofuge pubescence along basal half; metafemora with glabrous tibial grooves. Apex of fifth abdominal ventrite rounded. Aedeagus (Fig. 7I) with basal piece 0.45 × the length of parameres; greatest width of parameres similar to greatest width of median lobe, with outer margins evenly convex; apex of parameres truncate, obliquely directed; apex of median lobe rather widely rounded.

Etymology. Named with the Latin word *minor* meaning small, in reference to the species being the smallest member of the genus.

Distribution. Only known from the type locality, Pico do Barbado (Fig. 8).

Remarks. The type series was collected on a high-elevation seepage over a vertical cliff. The rock face had moss and algal growth on same areas (Fig. 9A, B).

***Ephydrolithus ogmos* sp. nov.**
http://zoobank.org/7ECC48CA-7772-4FD1-B5EE-820957C3B5C3
Figs 6A–D, 7H, 8, 9A, B

Type material. Holotype (♂): "BRAZIL: Bahia: Abaíra; 13.29053S, 41.90489W; 1705 m; Pico do Barbado, W of Catolés; vertical seep on rock; 26.ii.2018; leg. Benetti & team; BR18-0226-01C" (INPA). **Paratypes (4): BRAZIL: Bahia:** Same data as holotype (SEMC, 2 including DNA voucher SLE-1510; INPA, 2).

Differential diagnosis. *Ephydrolithus ogmos* is easily distinguished from all the other known species by its well-defined striae along the posterior third of the elytra.

Description. Body length 3.1–3.3 mm, width 1.8–2.0 mm. Body elongate oval, strongly convex (Fig. 6B). General coloration brown, slightly paler along margins of pronotum and elytra. Posterior elevation of mesoventrite with well-developed spine, forming high anterior carina. Elytra with well-developed striae along posterior half and reduced serial punctures. Pro- and mesofemora covered with hydrofuge pubescence along basal half; metafemora with glabrous tibial grooves. Apex of fifth abdominal ventrite truncate. Aedeagus (Fig. 7H) with basal piece 0.7 × the length of parameres; parameres nearly 0.7 × greatest width of median lobe, with outer margins slightly sinuate; apex of parameres rounded, obliquely directed; apex of median lobe widely acute.

Etymology. Named with the Greek word *ogmos* meaning furrow, in reference to the well-defined elytral striae of the species.

Distribution. Only known from the type locality, Pico do Barbado (Fig. 8).

Life history. The type series was collected on a high-elevation seepage over a vertical cliff. The rock face had moss and algal growth on same areas (Figs 9A, B).

***Ephydrolithus spiculatus* sp. nov.**
http://zoobank.org/EEAFB6BE-5C09-4572-B963-321840A6E871
Figs 7F, G, 8, 9C

Type material. Holotype (♂): "BRAZIL: Minas Gerais: Lassance; 17.83384S, 44.50515W; 568 m; Cachoeira da Palmeira; flotation of root mats and moss from side of waterfall & seepage; 2.iii.2018; leg. Benetti & team; BR18-0302-04A" (INPA).

Differential diagnosis. *Ephydrolithus spiculatus* is very similar to *E. hamadae* and *E. teli*. It can be easily distinguished from both by the presence of a pointed spine on the posterior elevation of the mesoventrite (see Fig. 7G).

Description. Body length 3.2 mm, width 1.7 mm. Body elongate oval, moderately convex. General coloration brown, slightly paler on pronotum and along margins of elytra, with dark brown head. Posterior elevation of mesoventrite with a pointed spine (Fig. 7G). Elytra without striae or serial punctures. Pro- and mesofemora covered with hydrofuge pubescence along basal 2/3; metafemora with hydrofuge pubescence along basal 2/3 of anterior margin, and on tibial grooves. Apex of fifth abdominal ventrite truncate. Aedeagus (Fig. 7F) with basal piece 0.9 × the length of parameres; parameres nearly 0.3 × greatest width of median lobe, with outer margins nearly straight for most of their length; apex of parameres truncate, with outer corners broadly rounded; apex of median lobe widely acute.

Etymology. Named with the Latin word *spiculatus* meaning sharpen to a point, in reference to the pointed spine on the posterior elevation of the mesoventrite.

Distribution. Known only from the type locality (Fig. 8).

Remarks. This species was collected by gathering moss and roots from bottom and margin of a seepage that was next to a large waterfall (Fig. 9C). The only known specimen was collected by placing the moss and roots in a pan of water, where it floated to the surface along with several specimens of *E. hamadae*.

***Ephydrolithus teli* sp. nov.**
http://zoobank.org/A1E4159C-2BAC-4B4D-B215-2D4A109C1D5E
Figs 5E–H, 7E, 8, 9D

Type material. Holotype (♂): "BRAZIL: Bahia: Abaíra; 13.29053S, 41.90489W; 1705 m; Pico do Barbado, W of Catolés; flotation of mud and moss from seepage; 26.ii.2018; leg. Benetti & team; BR18-0226-01B" (INPA). **Paratypes (8): BRAZIL: Bahia:** Same data as holotype (SEMC, 6 including DNA voucher SLE-1486). **Minas Gerais:** "Monte Azul; 15.17067S, 42.80351W; 970 m; Serra do Espinhaço, c. 7 Km E of Monte Azul; seepage areas in stream on rock; 28.ii.2018; leg. Benetti & team; BR18-0228-02B" (SEMC, 3 including DNA voucher SLE-1509).

Differential diagnosis. *Ephydrolithus teli* is very similar to *E. hamadae*. Both species can only be distinguished from each other by characteristics of the aedeagus.

Description. Body length 2.8–3.3 mm, width 1.5–1.9 mm. Body elongate oval, moderately convex (Fig. 5F). General coloration dark brown. Posterior elevation of

mesoventrite with well-defined, curved transverse ridge. Elytra without striae or serial punctures. Pro- and mesofemora covered with hydrofuge pubescence along basal 2/3; metafemora with hydrofuge pubescence on tibial grooves. Apex of fifth abdominal ventrite truncate. Aedeagus (Fig. 7E) with basal piece 0.85 × the length of parameres; parameres nearly 0.4 × greatest width of median lobe, with outer margins only slightly convex; apex of parameres truncate, obliquely directed; apex of median lobe triangular, very narrowly rounded.

Etymology. Named with the Latin word *teli* meaning spear, in reference to the shape of the median lobe of the aedeagus of the species.

Distribution. Known from two localities in the highlands of northeastern Brazil (Fig. 8).

Remarks. Both collections of this species were taken from rocky seepage habitats (e.g., Fig. 9D).

Primocerus **gen. nov.**

http://zoobank.org/0EA5176F-B2BB-4E50-8799-C93F09B412B6
Figs 10–16

Type species. *Primocerus neutrum* sp. nov.

Differential diagnosis. Small to medium sized beetles (2.4–4.9 mm), elongate oval in dorsal view, moderate to strongly convex in lateral view (e.g., Figs 11F, 12B), brown, dark brown, reddish brown, or rather orange. Antennae with eight antennomeres (e.g., Fig. 10G). Maxillary palps short to moderately long (e.g., shorter to nearly as long as the width of the head; e.g., Figs 10H, 12H). Elytra with sutural striae; elytral punctures from shallow to sharply marked (e.g., Figs 11E, 12E); serial punctures, ground punctures and systematic punctures similar in size and degree of impression throughout elytra; all punctures seemingly arranged in rows, sometimes evidently so. Prosternum flat to mesally only slightly produced. Posterior elevation of mesoventrite with a curved transverse ridge, rather sharp and low (Fig. 14A), except in *P. cuspidis* which bears a sharp, pyramidal (triangular) projection. Posteromesal glabrous patch on metaventrite nearly as wide as long. Pubescence on anterior surface of metafemora ranging from sparse to densely covering basal three fourths of the femur (e.g., Figs 12C, 10G, 11G). Fifth abdominal ventrite apically rounded, truncate or slightly emarginate, usually with stout setae (e.g., Fig. 14C). Basal piece of aedeagus as long as or longer than parameres; median lobe triangular, nearly as wide at base as basal width of one paramere, with apical projection (Fig. 14D–L); gonopore absent (Fig. 14D–L).

At first sight, the dorsally smoother members of *Primocerus* (Figs 10, 11) can be mistaken for *Chasmogenus*, given that both genera exhibit sutural striae. The presence of a transverse curved ridge (sometimes very low) on the posterior elevation of the mesoventrite distinguishes *Primocerus* from *Chasmogenus*, in which the mesoventrite is either flat, broadly elevated or with a longitudinal elevation (e.g., figs 2, 4 in Clarkson and Ferreira 2014). In addition, the maxillary palps of most *Chasmogenus* species are

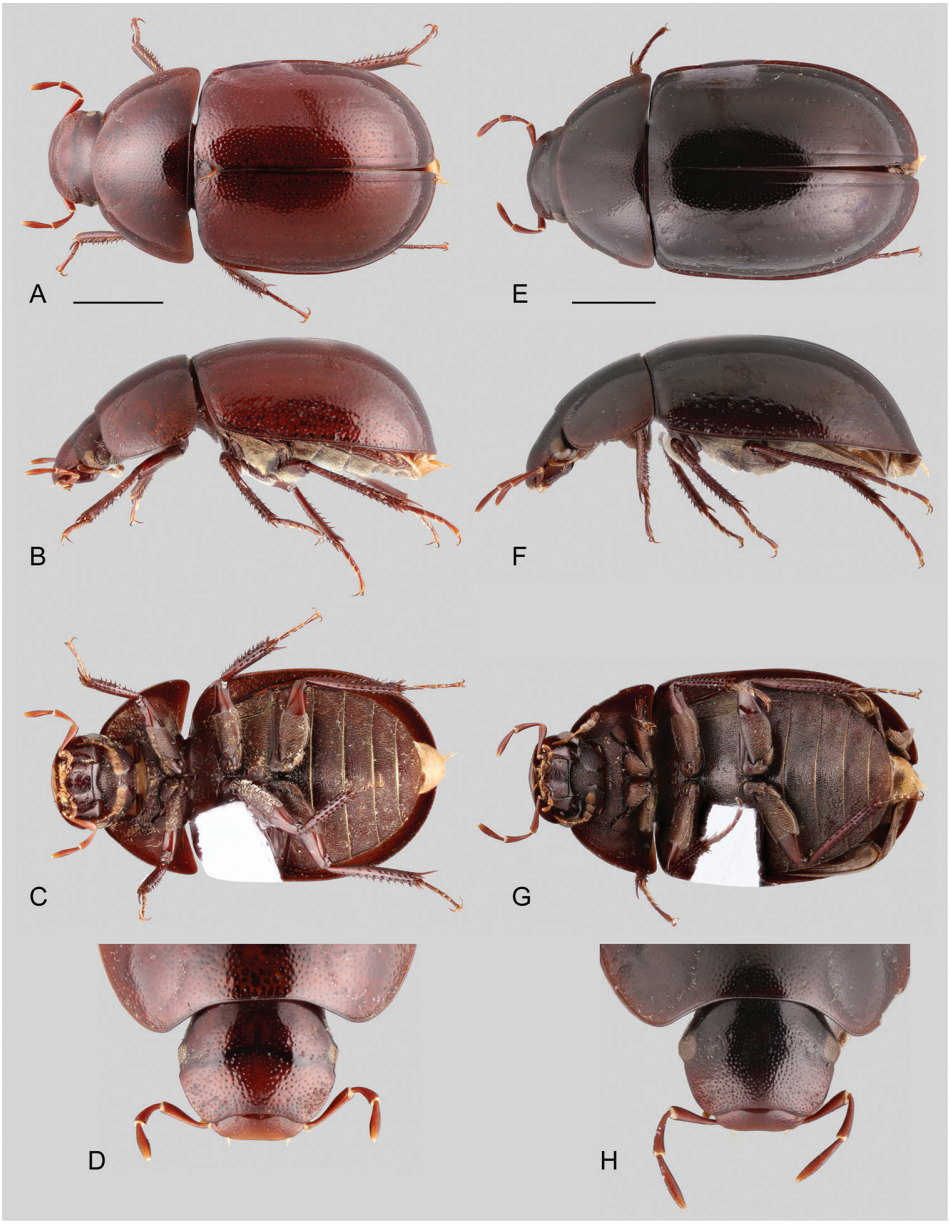

Figure 10. Habitus of *Primocerus* spp.: **A–D** *Primocerus ocellatus*: **A** dorsal view **B** lateral view **C** ventral view **D** head, dorsal view. **E–H** *Primocerus gigas*: **E** dorsal view **F** lateral view **G** ventral view **H** head, dorsal view. Scale bars: 1 mm.

nearly 1.5 × longer than the maximum width of the head, whereas in *Primocerus* the maxillary palps are nearly as long as the width of the head.

Punctate members of *Primocerus* (in particular *P. maipure* and *P. pijiguaense*, Fig. 12) may resemble some species of *Tobochares* (e.g. *T. canthus*, *T. pallidus*; Kohenberg

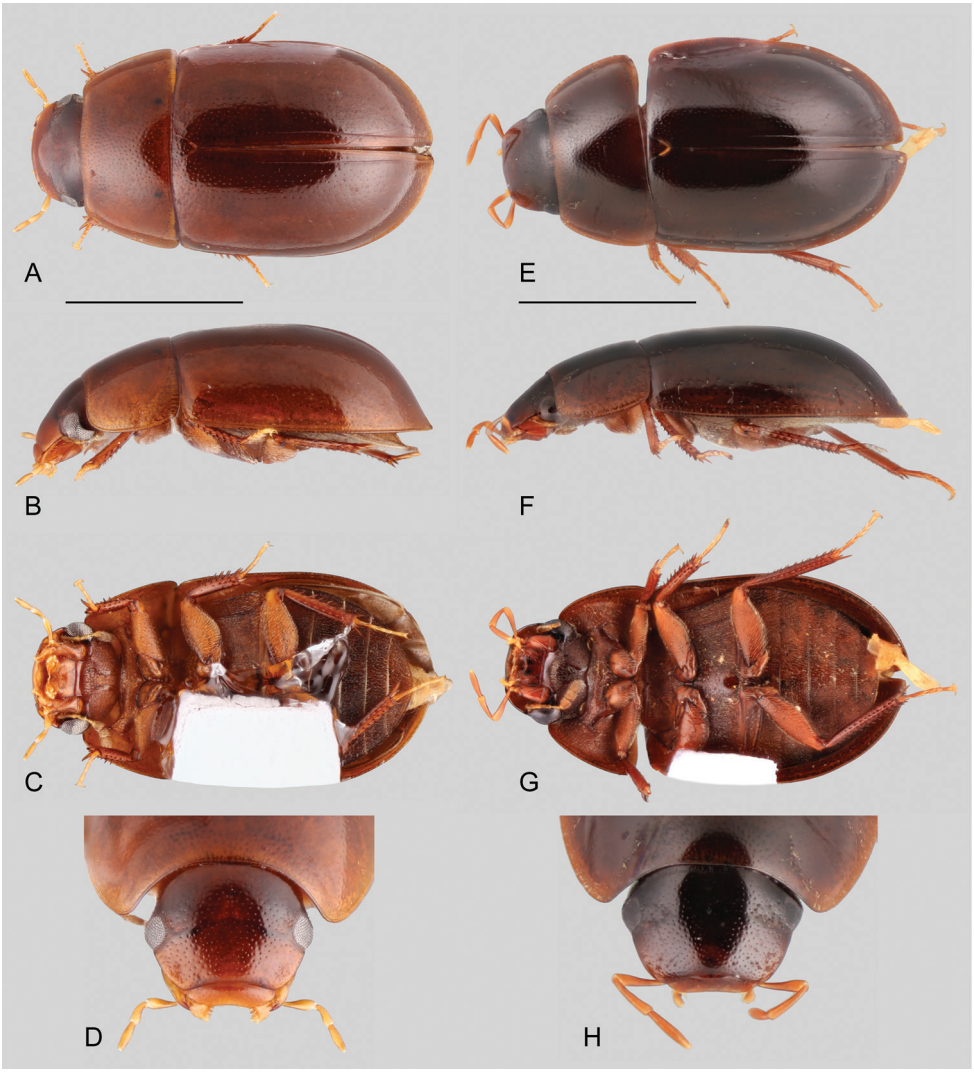

Figure 11. Habitus of *Primocerus* spp.: **A–D** *Primocerus cuspidis*: **A** dorsal view **B** lateral view **C** ventral view **D** head, dorsal view. **E–H** *Primocerus neutrum*: **E** dorsal view **F** lateral view **G** ventral view **H** head, dorsal view. Scale bars: 1 mm.

and Short 2017); striate *Primocerus* may resemble a very small *Radicitus* (see Short and García 2014). In those cases, *Primocerus* can be easily recognized by the presence of sutural striae. Some *Primocerus* may also superficially resemble certain New World cylomine genera, such as *Andotypus* (see Fikáček et al. 2014), from which it may be distinguished by the fully exposed labrum of *Primocerus*.

In addition, the presence of sutural striae and the relative size of the basal piece of the aedeagus resemble some species of *Enochrus* (Enochrinae) in that the basal piece is as long as or longer than the median lobe + parameres (e.g. see figs 11 and 14 in

Fernández 2006). The maxillary palps curved inwards in *Primocerus* (as opposed to zig-zag-like as in *Enochrus*) allows for its recognition.

The aedeagus of *Primocerus* is so far unique among the Acidocerinae in the lack of a well-developed gonopore, and the presence of a lightly sclerotized projection beyond the apex of the median lobe.

Description. Small to medium sized beetles, total body length 2.4–4.9 mm; body elongate oval, moderate to strongly convex in lateral view (e.g., Figs 11F, 12B); orange brown (Fig. 11A–D), reddish brown (Fig. 10 A–D), to dark brown in coloration (e.g., Fig. 13), usually uniform along body regions, sometimes slightly paler along margins, pronotum, ventral surfaces, and appendages, particularly maxillary palps and tarsi. ***Head.*** Frons and clypeus with either shallow (e.g., Fig. 10D) or sharply marked (e.g., Fig. 12D) ground punctures, irregularly and rather densely distributed over the surface, accompanied by scattered seta-bearing systematic punctures, particularly noticeable along anterior and inner margins of eyes, and lateral areas of clypeus; surface between punctures smooth and shiny. Clypeus roughly trapezoid, with posterior margin wider than anterior margin; anterior corners roundly angulated, anterior margin widely roundly emarginate; membranous preclypeal area not visible (visible in *Chasmogenus*; e.g., fig. 28 in Clarkson and Ferreira 2014); surface mesally moderately convex, laterally flattened to slightly concave (Figs 12D, H). Eyes subquadrate in dorsal view, usually protruding from outer outline of head. Labrum wide, fully exposed, collinear to perpendicular to clypeus, and usually around 0.3 times as long as clypeus (e.g., Fig. 10D); dorsal surface flat to convex, with scattered fine punctures; anterior margin markedly roundly bent inwards, mesally emarginate, with tiny denticles along emargination, and setae on lateral areas of anterior margin. Temporae densely covered by very short and fine setae (hydrofuge pubescence). Mentum parallel sided, often with lateral margins densely fringed by short setae; surface rather flat, smooth, and glabrous, sometimes with lateral oblique longitudinal ridges, and few crenulations; anterior margin with wide, deep, concave median impression, sometimes marked by a transverse carina. Submentum sunken, concave, and pubescent at base, glabrous, shiny, flat and ascending at apex; ocular ridge of variable development. Maxilla (e.g., Fig. 10G) with ventral surface of cardo and stipes smooth, shiny, and glabrous; outer dorsal margin of palpifer with a row of stiff, decumbent, spiniform setae; limit between cardo and stipes oblique; maxillary palps curved inward, brown to orange or yellow, longer than antennae, short to moderately long (e.g., shorter to nearly as long as the width of the head; e.g., Figs 10H, 12H); maxillary palpomere 1 gradually broadening towards apex, with inner margin straight and outer margin apically convex; apex of palpomere 3 bearing sensilla; palpomeres 1 and 3 similar in length, palpomere 2 only slightly shorter. Mandibles with apex bifid (observed in *P. gigas*, *P. pijiguaense*, *P. striatolatus* and *P. petilus*; e.g., Fig. 12H). Labial palps yellowish to brown, usually nearly as long as mentum, dorsoventrally flattened; palpomere 2 with outer margin convex apicad of midpoint, sometimes with setae near apex; palpomere 3 digitiform to somewhat kidney-shaped, with one or two long subapical setae on outer margin. Antennae (e.g., Fig. 10G) with eight antennomeres, slightly paler than general coloration of head; antennomere 1 an-

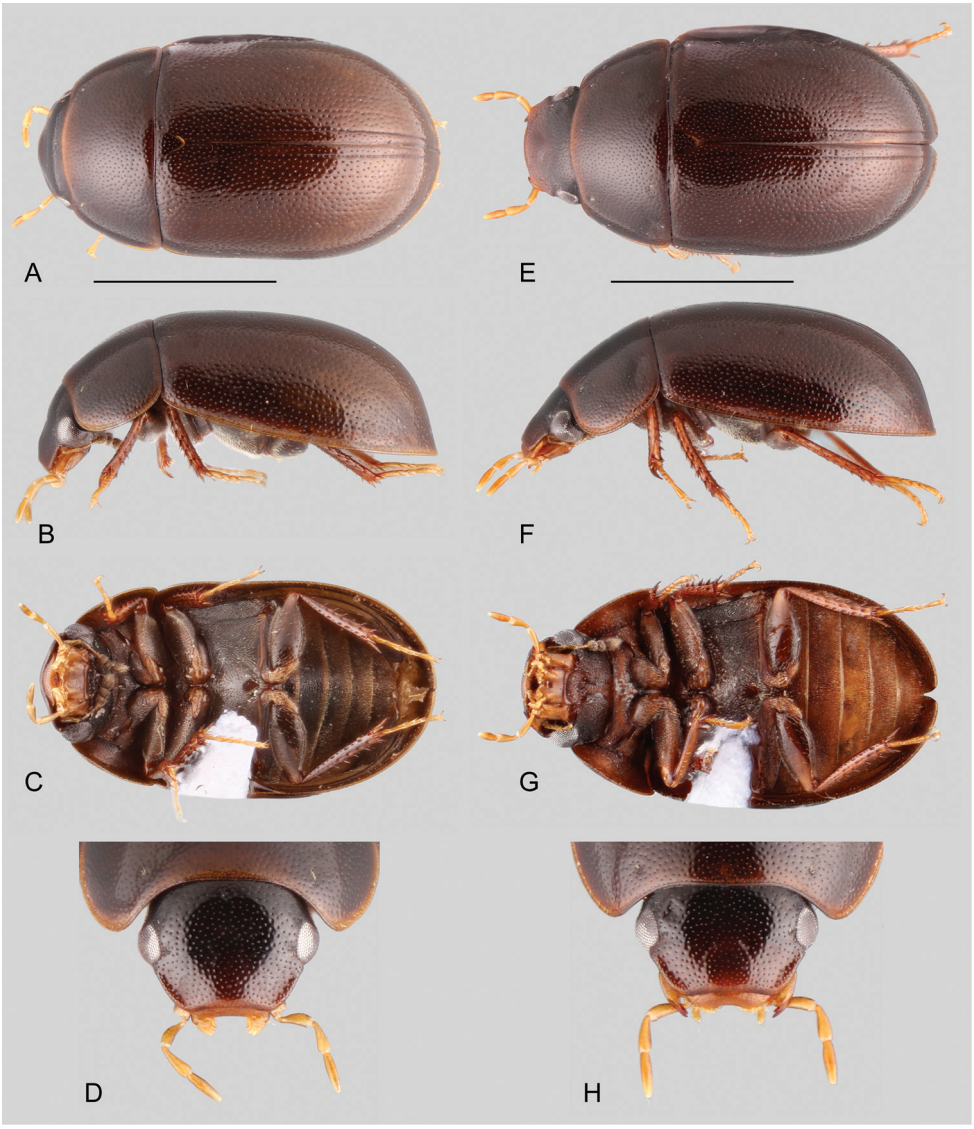

Figure 12. Habitus of *Primocerus* spp.: **A–D** *Primocerus maipure*: **A** dorsal view **B** lateral view **C** ventral view **D** head, dorsal view. **E–H** *Primocerus pijiguaense*: **E** dorsal view **F** lateral view **G** ventral view **H** head, dorsal view. Scale bars: 1 mm.

teriorly projected near base, at most reaching midpoint of ventral surface of eye, reaching to surpassing cardo-stipes joint, nearly 2.0 × longer than antennomere 2; antennomere 2 nearly as long as antennomeres 3–4 combined; antennomere 5 forming a well differentiated, symmetric cupule; antennomeres 6–8 slightly flattened, forming a loosely articulated, pubescent club (antennomere 7 shortest, 8 longest); apex of antennomere 8 with longer setae than general pubescence of club. ***Thorax.*** Pronotum widest

at base, narrowed anteriorly, surface evenly convex; anterior and posterior corners widely rounded, sometimes posterior corners almost forming a sharp straight angle (e.g., Fig. 10G); anterior and posterior margins nearly straight; ground punctation either shallow or sharp, uniformly dense, with surface between punctures smooth and shiny; seta-bearing systematic punctures forming paired anterolateral semicircles. Scutellar shield of moderate size, triangular, nearly as long as wide, with punctation as in pronotum. Prosternum nearly as long as 0.7 × the length of a procoxa; anterior margin of prosternum mesally projected as a wide triangle, apically either acute or rounded (except in *P. ocellatus*); surface of prosternum flat to only weakly broadly convex, covered by scattered, fine, rather long setae; intercoxal process projected from posterior margin of procoxal cavities, rectangular in outline, mesally longitudinally carinate. Mesoventrite (Fig. 14A) not fused to mesepisterna, with anterior margin nearly 0.3 × as wide as anterior margin of mesepisternum; anterior rib of mesoventrite bearing paired medial teardrop-shaped, pearlescent maculae; posterior elevation of mesoventrite with a transverse curved ridge, rather sharp and low, reduced in *P. maipure*, *P. pijiguaense* and *P. ocellatus*, with a sharp, pyramidal (triangular) spine-like projection in *P. cuspidis* (Fig. 11C); surface of mesoventrite reticulated for the most part, covered by scattered, fine and rather long setae, with anteromedial depression, and posterolateral smooth and glabrous areas; mesepisternum obliquely widely concave, with reticulated surface; mesepimeron trapezoid, with reticulate and pubescent surface. Mesofurca (examined in *P. neutrum*) with short arms, 0.75 × length of mesocoxae; apical half of arms free, explanate at apex, somewhat square. Metaventrite mesally widely elevated, rather wide throughout and flat posteromesally; surface densely pubescent, except for posteromesal nearly as wide as long glabrous patch, and soemtimes postero-lateral areas (Fig. 10G; except in *P. ocellatus*, Fig. 10D). Metepisterna 3–4 × longer than wide, narrowing only at posterior end. Metepimeron clearly visible, triangular. Metafurca (examined in *P. neutrum*, Fig. 14B) 1.3 × wider than long, with furcal arms slightly shorter than stalk; stalk triangular (wider near the crux, gradually narrowing ventrally), with paired longitudinal keels extending along basal third of posterior face, fusing together towards crux, with a well-developed median keel on anterior face extending to anterior margin of dorsal sheets; outer margins of stalk gradually diverging from base towards basal third of furcal arms; furcal arms somewhat parallelogram-shaped, with apex (hemiductus) only slightly explanate, with apex pointing obliquely; anterior tendons inserted basad of mid length of dorsal edge of furcal arms; well-developed dorsal sheaths, narrower than widest point of lateral sheaths. ***Elytra.*** Surface even (without elevations or depressions), with sutural striae; ground punctures and systematic punctures either shallow or sharply marked (e.g., Figs 11E, 12E), similar in size and degree of impression throughout elytra, seemingly arranged in rows; serial punctures, when present (e.g., Fig. 13A, D, G), larger and deeper than ground punctures, and clearly arranged in longitudinal rows (striae); serial punctures only very slightly impressed into grooves along posterior half of elytra in striate species (e.g., *P. petilus*, *P. striatolatus*, and *P. semipubescens*; see Fig. 13); seta-bearing systematic punctures rather scarce; elytral outer margins flared, usually along entire length. Epipleura usually well developed, surface either flat or oblique,

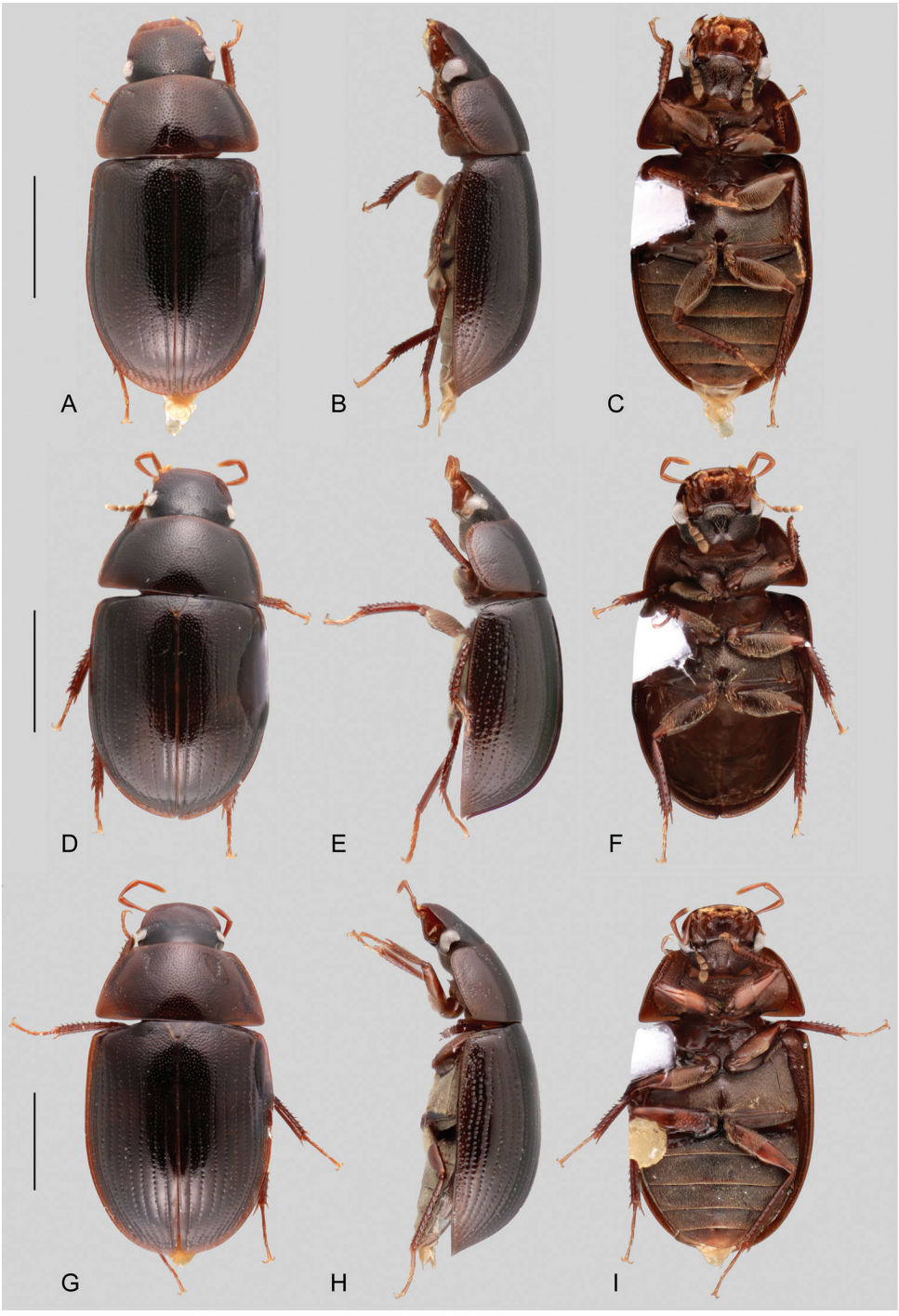

Figure 13. Habitus of *Primocerus* spp.: **A–C** *Primocerus petilus*: **A** dorsal view **B** lateral view **C** ventral view. **D–F** *Primocerus striatolatus*: **D** dorsal view **E** lateral view **F** ventral view. **G–I** *Primocerus semipubescens*: **G** dorsal view **H** lateral view **I** ventral view. Scale bars: 1 mm.

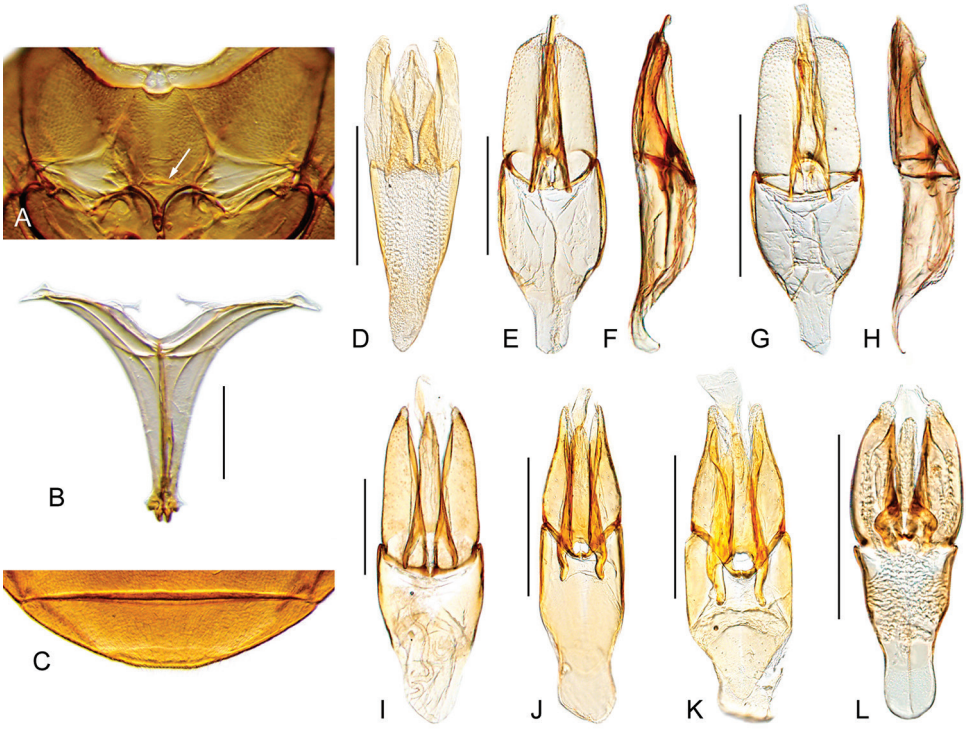

Figure 14. Thorax, abdomen and aedeagus of *Primocerus* spp.: **A–D** *Primocerus neutrum*: **A** ventral view of mesoventrite (white arrow pointing transverse ridge) **B** posterior view of metafurca **C** fifth abdominal ventrite **D** aedeagus. **E–L** aedeagus: **E, F** *Primocerus maipure*: **E** dorsal view **F** lateral view. **G, H** *Primocerus pijiguaense*: **G** dorsal view **H** lateral view **I** *Primocerus gigas* **J** *Primocerus petilus* **K** *Primocerus striatolatus* **L** *Primocerus cuspidis.* Scale bars: 0.25 mm.

with sparse setae and irregular sculpture, anteriorly wide, gradually narrowing posteriorly, extending up to midlength of first abdominal ventrite; inner margin of epipleura only slightly indented at anterior outer corner of metepisternum; pseudepipleura usually well developed and perpendicularly positioned, ranging in width from nearly as wide as anterior portion of epipleura, to half as wide, extending up to basal half of abdomen along outer margin of elytra. Hind wings well developed. ***Legs.*** Pubescence on anterior surface of metafemora ranging from scarce and limited to anterior margin (e.g., Fig. 12C), to densely covering most surface up to apical fifth (e.g., Fig. 11G); glabrous area of metafemur with shiny and sometimes slightly reticulated surface; all femora antero-posteriorly flattened; metafemora usually with sharply marked tibial grooves. Tibiae slender, rather cylindrical; longitudinal rows of well-developed spines along pro-, meso- and metatibiae, composed of rather sharp and stout spines, slightly sparser along metatibiae; protibiae with a median longitudinal row of rather long and thick setae along anterior surface; protibial apical spurs large, extending beyond apex of protarsomere 2, sometimes reaching apex of protarsomere 3. All tarsi with five tar-

someres, bearing long apical hair-like setae on dorsal face, and spine-like or hair-like setae on ventral face of tarsomeres 2–4, sometimes also tarsomere 5; pro- and mesotarsomeres 1–4 similar in size and shape; pro- and mesotarsomere 5 approximately as long as 3–4 combined; metatarsomere 2 similar in length to metatarsomere 5; claws rather large, curved; well-developed empodium, bearing a pair of long, curved apical setae. ***Abdomen.*** Abdomen with five ventrites, rather flat to medially convex; all ventrites with uniform, dense, fine pubescence; posterior margin of fifth ventrite either rounded, truncate, or slightly emarginate, usually fringed with spine-like setae (Fig. 14C). Aedeagus (Fig. 14D–L) with basal piece as long or longer than parameres; median lobe triangular, with base nearly as wide as base of a paramere, with well-developed lateral basal apodemes; apex of median lobe variable, with a membranous to lightly sclerotized apical projection; gonopore not differentiated; parameres nearly as long as median lobe, with outer margins usually straight along basal 3/4, with setae at apex.

Larvae. The immature stages are unknown.

Etymology. Named from the Latin *primus*, meaning first, with the ending *-cerus*, in reference to the belonging of the genus to the Acidocerinae. To be treated as masculine.

Distribution. Broadly distributed across the Guiana Shield region of South America, including Brazil (Pará), Guyana, Suriname and southern Venezuela (Amazonas, Bolívar) (Fig. 15).

Remarks. The habitats occupied by members of *Primocerus* range from forested pools to seepages (Fig. 16), in an elevational range from 80 to 1950 m. Only one specimen has been collected with a flight intercept trap. Specimens of *Primocerus* are relatively rare, given that so far have only been found in low numbers of specimens per collecting event.

Characters of taxonomic importance for *Primocerus*

The external morphology of *Primocerus* species may be considered very heterogeneous in comparison with other acidocerine genera (e.g., *Globulosis* García (see Short et al. 2017), *Quadriops* Hansen, 1999 (see Girón and Short 2017), *Crucisternum* Girón & Short, 2018).

Body size. Species of *Primocerus* measure approximately 3.0–3.5 mm, except for the largest species *Primocerus grandis*, with approximately 5.0 mm.

Elytral punctation. Two main groups of species can be recognized by the degree of impression of the ground punctures: the smooth group (with shallowly impressed elytral punctures: *P. cuspidis*, *P. gigas*, *P. neutrum*, *P. ocellatus*; Figs 10, 11) and the punctate group (with sharply marked punctures: *P. maipure*, *P. pijiguaense*, *P. petilus*, *P. semipubescens*, *P. striatolatus*; Figs 12, 13). Within the punctate group, two groups of species can be distinguished by how evident the longitudinal rows of serial punctures are: the homogeneous group (with serial punctures only slightly distinguishable from ground and systematic punctures: *P. maipure*, *P. pijiguaense*, Fig. 12) and the striate group (with serial punctures larger than the ground punctures and clearly organized into rows: *P. petilus*, *P. semipubescens*, *P. striatolatus*; Fig. 13). In some cases (*P. petilus* (Fig. 13A, B) and *P. striatolatus* (Figs 13D, E)), the striae are very slightly impressed along the posterior half of the elytra.

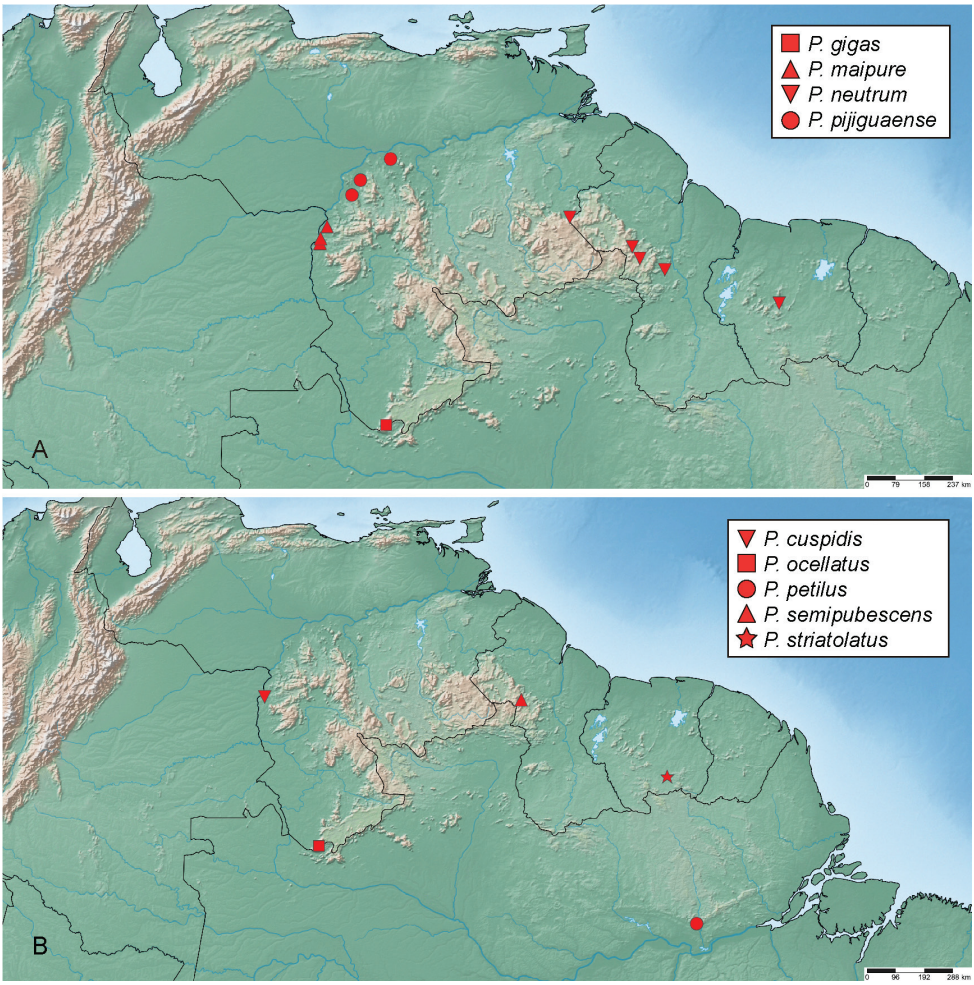

Figure 15. Distribution of *Primocerus* spp.

Coloration. The general coloration of *Primocerus* specimens range from orange and reddish brown to dark brown, although there is not much variation within species groups. Teneral specimens are significantly paler than fully sclerotized ones. Specimens that have been extracted for DNA are darker. Coloration should not alone be taken as a diagnostic feature.

Hydrofuge pubescence on metafemora. The extent of coverage of hydrofuge pubescence of the anterior surface of the metafemora varies across species. Most species have at least the basal half of the surface covered, but in some the coverage is limited to the dorsal margin (*P. maipure*, *P. pijiguaense*, Fig. 12C, G).

Aedeagus. As is usual for the subfamily, the general configuration of the aedeagus (e.g., large basal piece, median lobe at base nearly as wide as base of a paramere, median

Figure 16. Habitat of *Primocerus* spp. **A** habitat and type locality for *P. cuspidis*, Venezuela, Tobogán de la Selva, collecting event AS-08-080b **B** habitat and type locality for *P. pijiguaense*, Venezuela, Los Pijiguaos, collecting event AS-07-015 **C** habitat and type locality for *P. neutrum*, Venezuela, along La Escalera, collecting event AS-08-058 **D** habitat and type locality for *P. petilus*, Brazil, Vale do Paraiso, collecting event BR18-0203-01G.

lobe rather triangularly shaped, and nearly as long as parameres) is conserved across the genus, with specific diagnostic features (e.g., shape of parameres) at the species group and species level. Species groups distinguishable by characters of the elytra can also be recognized by aedeagal traits.

Key to the species of *Primocerus*

1 Elytra with ground punctures shallowly to very weakly marked (Figs 10A, E, 11A, E) **2**

– Elytra with ground punctures sharply marked (e.g., Figs 12A, E, 13A, D, G) **5**

2 Body length equal to or larger than 4.0 mm **3**
– Body length smaller than 4.0 mm **4**
3 Eyes in dorsal view of the head, very small (distance separating eyes 17 × the width of an eye) (Fig. 10D) ..... ***Primocerus ocellatus***
– Eyes in dorsal view of the head, of moderate size (distance separating eyes 7.5 × the width of an eye) (Fig. 10H)..... ***Primocerus gigas***
4 Posterior elevation of mesoventrite with a sharply pointed pyramidal (triangular) spine (Fig. 11C)..... ***Primocerus cuspidis***
– Posterior elevation of mesoventrite with a curved transverse ridge, rather sharp and low (Fig. 14A)..... ***Primocerus neutrum***
5 Hydrofuge pubescence on metafemora limited to dorsal margin of anterior surface (Fig. 12C, G) **6**
– Hydrofuge pubescence on metafemora covering at least the entire basal third of anterior surface (Fig. 13C, F, I) **7**
6 Apex of median lobe of aedeagus simply rounded in lateral view; base of parameres in lateral view oblique (Fig. 14F) ..... ***Primocerus maipure***
– Apex of median lobe of aedeagus carinate (dorsally projected in lateral view, Fig. 14H); base of parameres in lateral view perpendicular to longitudinal axis of aedeagus (Fig. 14H)..... ***Primocerus pijiguaense***
7 Hydrofuge pubescence covering slightly less than the basal half of the anterior surface of all femora (Fig. 13I) ..... ***Primocerus semipubescens***
– Hydrofuge pubescence covering at least basal 3/4 of the anterior surface of all femora Fig. 13C, F) **8**
8 Elytra in dorsal view 3 × longer than wide; serial punctures not well differentiated along basal fourth of elytral striae IX and X (Fig. 13A, B) ..... ***Primocerus petilus***
– Elytra in dorsal view nearly 2.6 × longer than wide; serial punctures of elytral striae IX and X well developed along entire length (Fig. 13D, E) ..... ***Primocerus striatolatus***

***Primocerus cuspidis* sp. nov.**
http://zoobank.org/0EA5176F-B2BB-4E50-8799-C93F09B412B6
Figs 11A–D, 14L, 15B, 16A

Type material. Holotype (♂): "VENEZUELA: Amazonas/ 5°23.207'N, 67°36.922'W; 125 m/ Tobogán de la Selva, old "Tobogancito"/ on seepage area with detritus/ 8.viii.2008; leg. A. Short, M. García, / L. Joly; AS-08-080b" (MIZA). **Paratypes (3): VENEZUELA: Amazonas:** same data das holotype (SEMC, 3).

Differential diagnosis. *Primocerus cuspidis* belongs to the group of species with shallowly impressed, rather irregularly distributed, and undifferentiated elytral punctures. It can be easily distinguished among its congeners by its paler (orange) colora-

tion, and the presence of a sharp, pyramidal (triangular) projection on the posterior elevation of the mesoventrite.

Description. Body length 2.4 mm, width 1.5 mm. Body elongate oval, moderately convex (Fig. 11B). General coloration orange-brown. Elytra with ground punctures shallowly marked; serial punctures absent. Posterior elevation of mesoventrite with sharply pointed pyramidal (triangular) spine. Metafemora with hydrofuge pubescence covering basal 4/5. Apex of fifth abdominal ventrite slightly emarginate. Aedeagus (Fig. 14L) with basal piece 1.3 × longer than parameres; parameres 1.15 × longer than median lobe; distal end of parameres with anteapical constriction, apex rounded and obliquely directed; apex of median lobe widely rounded.

Etymology. Named with the Latin word *cuspidis* meaning point, in reference to the sharp projection on the posterior elevation of the mesoventrite.

Distribution. *Primocerus cuspidis* has only been collected at Tobogán de la Selva in the Venezuelan Amazon, at an elevation of 125 m (Fig. 15B).

Remarks. The type series was collected in a flat, horizontal seepage area that was formed from water seeping from the banks of the Rio Coromoto (Fig. 16A).

***Primocerus gigas* sp. nov.**
http://zoobank.org/D56F83E7-8B5C-4A07-87FE-30E16A936BCA
Figs 10E–H, 14I, 15A

Type material. Holotype (♂): "VENEZUELA: Amazonas/ 0°50'N, 65°59'W; 2100 m/ Cerro de la Neblina, camp II; beetles in flight over sunlit stream/ 16:00hrs. 31.i.1985/ leg. W.E. Steiner et al." (USNM). **Paratypes (8): VENEZUELA: Amazonas:** Same data as holotype (SEMC, USNM, 7, including DNA voucher SLE 1374); same except 0°52'N, 65°58'W, 1450 m, camp XI, 25–28.ii.1985, seine of rapids in small mountain stream, leg. P.J. & P.M. Spangler, R. Faitoute (USNM, 1).

Differential diagnosis. *Primocerus gigas* is among the largest species of the genus. It can be distinguished from similarly sized species by the moderately sized eyes being separated by a distance of 7.5 × the width of an eye (Fig. 10H).

Description. Body length 4.9 mm, width 2.8 mm. Body elongate oval, moderately convex (Fig. 10F). General coloration dark brown. Elytra with ground punctures shallowly marked, seta-bearing systematic punctures slightly enlarged, and serial punctures absent. Posterior elevation of mesoventrite with simple transverse ridge. Metafemora with hydrofuge pubescence covering slightly more than basal half of anterior surface. Apex of fifth abdominal ventrite truncate. Aedeagus (Fig. 14I) with basal piece nearly 1.1 × longer than parameres; parameres slightly longer than median lobe, truncate and obliquely directed at apex; apex of median lobe narrowly pointed.

Etymology. Named with the Latin word *gigas* meaning giant, in reference to the large size of this species compared to most members of the genus.

Distribution. *Primocerus gigas* is only known from Cerro de la Neblina in the Venezuelan Amazon, at elevations between 1450 and 2100 m (Fig. 15A).

Remarks. Label data indicates the beetles were collected "in flight", with one specimen collected by seining rapids in a mountain stream.

***Primocerus maipure* sp. nov.**
http://zoobank.org/7C0A2BDC-E227-49C7-9940-A0F3836D50A0
Figs 12A–D, 14E, F, 15A

Type material. Holotype (♂): "VENEZUELA: Amazonas: 5°30.623'N, 67°36.109'W; 100 m; ca. 15 Km S. of Puerto Ayacucho; rock pools on top; 14.ix.2007; leg. A. Short; AS-07-011b" (MIZA). **Paratypes (10): VENEZUELA: Amazonas:** 5°23.207'N, 67°36.922'W; 125 m/ Tobogán de la selva, old "Tobogancito"/ upstream at small slide; 12.ix.2007/ leg. M. García; AS-07-007b (SEMC, 1); "5°30.518'N, 67°36.079'W; 100 m/ ca. 15 Km S. of Puerto Ayacucho; isolated seepage/ 13.ix.2007; leg. A. Short; AS-07-009a" (SEMC, 1); same data as holotype (SEMC, 2, including DNA voucher specimen SLE 1034); same except "pools at outcrop base, AS-07-011x" (SEMC, 2); "110 m; rock outcrop pools; 8.ix.2007; leg. A. Short, M. García; AS-08-081b" (SEMC, 1); 5°48.414'N, 67°26.313'W; 80 m/ nr. Iboruwa, "Tobogancito"/ 7.viii.2008; leg. A. Short, M. García, L. Joly/ AS-08-078" (SEMC, 3).

Differential diagnosis. *Primocerus maipure* can be differentiated by the presence of sharply impressed elytral punctures, with serial punctures only slightly differentiated, longitudinally aligned (more evidently so along posterior half of elytra, Fig. 12A, B). It is very similar to *P. pijiguaense*, from which it can be distinguished by its simple median lobe and the oblique and rather angulate outer margins of the apical region of the parameres (Fig. 14E, F; apical region of median lobe dorsally keeled along apical region, and widely rounded outer margins of the apical region of the parameres in *P. pijiguaense*, Fig. 14G, H).

Description. Body length 2.6 mm, width 1.5 mm. Body elongate oval, strongly convex (Fig. 12A, B). General coloration brown. Elytra with ground punctures sharply marked, with serial punctures only slightly differentiated, longitudinally aligned, more evidently so along posterior half of elytra (Fig. 12A, B). Posterior elevation of mesoventrite with simple, very lowly raised curved transverse ridge. Metafemora with hydrofuge pubescence limited to anterodorsal surface. Apex of fifth abdominal ventrite truncate. Aedeagus (Fig. 14E, F) with basal piece nearly 1.2 × longer than parameres; parameres nearly as long as median lobe, in lateral view with base oblique to longitudinal axis of aedeagus; outer margin of apical region of parameres oblique and rather angulate; apical region of median lobe simple, non-carinate.

Etymology. Noun in apposition. Named after the Maipure, one of the pre-Columbian indigenous tribes that inhabited the "Spanish Guyana" region, and the language they spoke.

Distribution. *Primocerus maipure* has been collected at localities south of Puerto Ayacucho in the Venezuelan Amazon, at elevations between 80 and 125 m (Fig. 15A).

Remarks. All collections of this species were made either on small seepages over granite outcrops, or in small rock pools that had formed on the outcrops.

***Primocerus neutrum* sp. nov.**
http://zoobank.org/3129F0EC-8A73-47E3-839C-C65BDC6AAFBB
Figs 11E–H, 14D, 15A, 16C

Type material. Holotype (♂): "VENEZUELA: Bolívar/ 6°2'10.5"N, 61°23'57.8"W; 630 m/ along La Escalera; rocky stream/ 31.vii.2008; leg. A. Short, M. García, L. Joly/ AS-08-058" (MIZA). **Paratypes (20): GUYANA: Region 8**: "4°43'49"N, 59°1'35"W; 300 m/ Iwokrama Forest, Pakatau hills/ flight intercept trap; 26–29.v.2001/ leg. R. Brooks & Z. Falin; GUY1BF01 063" (SEMC, 1); "5°0.730'N, 59°38.965'W; 585 m/ Upper Potaro camp I, c. 7 km NW Chenapau, Ridge Trail/ 11.iii.2014; leg. Short, Baca, Salisbury; GY14-0311-02A" (CBDG, SEMC, 11); "5°18.261'N, 59°50.257'W; 687 m/ Ayanganna Airstrip, trail from airstrip to Ayanganna/ forest detrital pools; 17.iii.2014/ leg. A. Short; GY14-0317-01A" (SEMC, 1); same except "18.iii.2014, GY14-0318-01B" (SEMC, 1); same except "seepage area over rocks in forest flowing into stream, GY14-0318-01C" (SEMC, 1). **SURINAME: Sipaliwini District:** "3°53.942'N, 56°10.849'W; 733 m/ CSNR: Tafelberg Summit, nr. Caiman Creek Camp/ pools in forest; 19.viii.2013/ leg. Short & Bloom; SR13-0819-05B" (SEMC, DNA voucher specimen SLE 1085). **VENEZUELA: Bolívar:** Same data as holotype (MIZA, SEMC, 8, including DNA voucher SLE 529).

Differential diagnosis. *Primocerus neutrum* can be regarded as very plain in appearance, lacking remarkable features. It can be distinguished among similarly sized species with shallowly punctured elytra by its dark brown coloration and simple transverse ridge on the posterior elevation of the metaventrite.

Description. Body length 2.6–3.5 mm, width 1.4–1.9 mm. Body elongate oval, moderately convex (Fig. 11F). General coloration brown. Elytra with ground punctures very shallowly marked. Posterior elevation of mesoventrite with simple curved transverse ridge. Metafemora with hydrofuge pubescence covering nearly basal 4/5 of anterior surface. Apex of fifth abdominal ventrite slightly emarginate. Aedeagus (Fig. 14D) with basal piece nearly 1.25–1.35 × longer than parameres; parameres slightly longer than median lobe, truncate to rounded and obliquely directed at apex; apex of median lobe somewhat "pinched" and narrowly pointed.

Etymology. Named with the Latin word *neutrum* meaning neutral, in reference to the comparatively unremarkable appearance of the species.

Distribution. *Primocerus neutrum* has been collected at the locality known as La Escalera in the Venezuelan Amazon, the Upper Potaro region and the Iwokrama Forest in Guyana, and the Tafelberg summit in Suriname. Specimens have been collected at elevations of 300–733 m (Fig. 15A).

Remarks. This species has been collected in detrital pools in densely forested areas, typically associated with streams (Fig. 16C).

***Primocerus ocellatus* sp. nov.**
http://zoobank.org/77A81130-1B8D-427F-83F8-B4F65662202C
Figs 10A–D, 15B

Type material. Holotype (♀): "VENEZUELA: Amazonas/ Cerro de la Neblina/ Camp XII, 1950 m/ near Pico Phelps/26.ii.1985// from leaf packs and wood pieces in small stream/ leg. W. Steiner, W. Buck, B. Boom, C. Brewer" (USNM).

Differential diagnosis. *Primocerus ocellatus* can be easily recognized by its large size (4.4 mm), reddish coloration, and very small eyes in dorsal view (separated by a distance 17 × larger than the width of an eye).

Description. Body length 4.4 mm, width 2.4 mm. Body elongate oval, strongly convex (Fig. 10B). General coloration reddish brown. Elytra with ground punctures shallowly marked, systematic punctures slightly enlarged, and serial punctures absent. Posterior elevation of mesoventrite with very lowly raised transverse ridge. Metafemora with hydrofuge pubescence covering slightly more than basal half of anterior surface. Apex of fifth abdominal ventrite rounded.

Etymology. Named from the Latin word *ocellatus* which means "having little eyes", in reference to the unusually small eyes of the species.

Distribution. *Primocerus ocellatus* has only been collected at Cerro de la Neblina in the Venezuelan Amazon, at an elevation of 125 m (Fig. 15B).

Remarks. The single known specimen is a female that was found in "leaf packs and wood pieces in a small stream".

***Primocerus petilus* sp. nov.**
http://zoobank.org/46ABEE79-02F3-4D51-BCD1-6D9BB5717CAA
Figs 13A–C, 14J, 15B, 16D

Type material. Holotype (♂): "BRAZIL: Pará: Alenquer/ 1.49292S, 54.51566W; 150 m/ Vale do Paraíso, ca. 55 km N. of Alenquer/ tiny wet rock/seepage on trail; 3.ii.2018/ leg. A. Short; BR18-0203-01G" (INPA, DNA voucher specimen SLE 1498).

Differential diagnosis. *Primocerus petilus* can be recognized by the presence of sharply impressed elytral punctures, with serial punctures well differentiated (larger and deeper than remainder punctures), longitudinally aligned to form elytral striae. It is similar to *P. semipubescens*, from which it can be differentiated by the hydrofuge pubescence of the metafemora covering basal 3/4 of the anterior surface (covering less than basal half in *P. semipubescens*). It is also very similar to *P. striatolatus*, from which it can be differentiated by the undefined elytral striae IX and X along the basal fourth of the elytra (Fig. 13B; elytral striae IX and X clearly impressed along their entire length in *P. striatolatus*, Fig. 13E).

Description. Body length 3.4 mm, width 1.6 mm. Body elongate oval, moderately convex (Fig. 12A, B). General coloration dark brown. Elytra with ground punctures sharply marked, and well-defined rows of serial punctures (forming elytral striae); elytral striae very slightly impressed along posterior half of elytra. Posterior elevation of mesoventrite with simple, curved transverse ridge. Metafemora with hydrofuge pubescence covering basal 4/5 of anterior surface. Apex of fifth abdominal ventrite rounded. Aedeagus (Fig. 14J) with basal piece nearly 1.3 × longer than parameres; parameres nearly as long as median lobe (median lobe inserted further into basal piece, thus appearing shorter than parameres); apex of parameres narrowly rounded; apex of median lobe widely rounded.

Etymology. Named with the Latin word *petilus* meaning slender, in reference to the relative slenderness of the body in this species.

Distribution. *Primocerus petilus* has only been collected at one locality in the north of Brazil, at an elevation of 150 m (Fig. 15B).

Remarks. The single known specimen is missing the maxillary palps. It was collected on a temporary wet spot on an exposed forested rock outcrop. The rock was wet when the specimen was collected due to recent rains but was dry by the following day (Fig. 16D).

***Primocerus pijiguaense* sp. nov.**
http://zoobank.org/BB20F156-C882-4971-8032-636A036AFD2A
Figs 12E–H, 14G, H, 15A, 16B

Type material. Holotype (♂): "VENEZUELA: Bolívar: 6°35.617'N, 66°49.238'W; 80 m; Los Pijiguaos; morichal/rock outcrop; 14.ix.2007; leg. A. Short, M. García, L. Joly; AS-07-015" (MIZA). **Paratypes (14): VENEZUELA: Bolívar:** same data as holotype (MALUZ, SEMC, 7, including DNA voucher specimen SLE 1029); same, except "6.viii.2008, AS-08-076" (SEMC, 1); same, except "at rock outcrop, seeps and streams at night, 9.vii.2010, leg. Short, Tellez, Arias, VZ10-0709-03A" (SEMC, 1); same, except "rock pools, 7.vii.2010, VZ10-0707-01A" (SEMC, 3, including DNA voucher specimen SLE 444); "6°57.904'N, 66°36.392'W, 51 m, Outcrop ca. 15 Km NE. of los Pijiguaos, detritus flotation, 9.vii.2010, leg. Short & Tellez, VZ10-0709-01B" (SEMC, 1); "7°29'47.3"N, 65°51'44.8"W, 45 m, 2 Km E. of Río Cuchivero, rock outcrop seeps, 6.viii.2008, leg. A. Short, M. García, L. Joly, AS-08-075" (SEMC, 1).

Differential diagnosis. *Primocerus pijiguaense* can be differentiated by the presence of sharply impressed elytral punctures, with serial punctures not differentiated (e.g., they look similar to the ground punctures). It is very similar to *P. maipure*, from which it can be distinguished by the dorsal keel on the apical region of the median lobe and the widely rounded outer margins of the apical region of the parameres (Fig. 14G, H; apical region of median lobe simple, non-keeled, and oblique and rather angulate outer margins of the apical region of the parameres in *P. maipure*, Fig. 14E, F).

Description. Body length 2.6–3.1 mm, width 0.9–1.7 mm. Body elongate oval, strongly convex (Fig. 12F). General coloration dark brown. Elytra with ground punc-

tures sharply marked; serial punctures not differentiated (similar to ground punctation). Posterior elevation of mesoventrite with simple, very lowly raised curved transverse ridge. Metafemora with hydrofuge pubescence limited to anterodorsal surface. Apex of fifth abdominal ventrite rounded. Aedeagus (Fig. 14G, H) with basal piece nearly 1.2 × longer than parameres; parameres nearly as long as median lobe, in lateral view with base perpendicular to longitudinal axis of aedeagus; outer margin of apical region of parameres widely rounded; apical region of median lobe with well-developed dorsal carina.

Etymology. Named after Los Pijiguaos, the type locality for the species.

Distribution. *Primocerus pijiguaense* has been collected at Los Pijiguaos and a few other localities north from it, at elevations between 45 and 80 m (Fig. 15A).

Remarks. All collections of this species were made either on small seepages over granite outcrops, or in small rock pools that had formed on the outcrops (e.g., Fig. 16B).

Primocerus semipubescens sp. nov.

http://zoobank.org/C28EAF39-DCD6-402C-9A0D-9107CB092407
Figs 13G–I, 15B

Type material. Holotype (♂): "GUYANA: Region VIII/ 5°17.823'N, 59°50.000'W; 684 m/ Ayanganna Airstrip, trail from Blackwater Creek Camp to Potaro River/ small forested creek with lots of detritus/ 20.iii.2014; leg. A. Short/ GY14-0320-01A" (CBDG). **Paratypes (1): GUYANA: Region VIII:** same data as holotype (SEMC, DNA voucher SLE 1079).

Differential diagnosis. *Primocerus semipubescens* can be recognized by the presence of sharply impressed elytral punctures, with serial punctures well differentiated (larger and deeper than remainder punctures), longitudinally aligned to form elytral striae. It can be differentiated by the hydrofuge pubescence of the metafemora covering less than basal half of the anterior surface (covering at least basal 3/4 in *P. petilus* and *P. striatolatus*).

Description. Body length 3.7 mm, width 2.0 mm. Body elongate oval, strongly convex (Fig. 13G, H). General coloration dark brown. Elytra with ground punctures sharply marked, and well-defined rows of serial punctures (forming elytral striae); elytral striae not impressed along elytra. Posterior elevation of mesoventrite with simple transverse ridge. Metafemora with hydrofuge pubescence covering less than basal half of anterior surface (Fig. 13I). Apex of fifth abdominal ventrite truncate.

Etymology. Named from the Latin word *semis*, meaning half, combined with the word *pubescens*, in reference to the hydrofuge pubescence covering only half of the anterior surface of the metafemora in this species.

Distribution. *Primocerus semipubescens* has only been collected around the Ayanganna airstrip in Guyana, 684–687 m in elevation (Fig. 15B).

Remarks. The known specimens were collected along the margins of a sandy creek that had lots of detritus.

***Primocerus striatolatus* sp. nov.**
http://zoobank.org/84459890-D0C8-4B48-8711-BFA9E440185D
Figs 13D–F, 14K, 15B

Type material. Holotype (♂): "SURINAME: Sipaliwini District/ 2°58'36.7782"N, 55°24'40.986"W; 400 m/ Camp 4 (high) Kasikasima; White Rock/ seepage area on trail; 24.iii.2012/ leg. A. Short; SR12-0324-01B" (NZCS). **Paratypes (1): SURINAME: Sipaliwini District:** Same data as holotype (SEMC, 1).

Differential diagnosis. *Primocerus striatolatus* can be recognized by the presence of sharply impressed elytral punctures, with serial punctures well differentiated (larger and deeper than remainder punctures), longitudinally aligned to form elytral striae. It is similar to *P. semipubescens*, from which it can be differentiated by the hydrofuge pubescence of the metafemora covering basal 3/4 of the anterior surface (covering less than basal half in *P. semipubescens*). It is also very similar to *P. petilus*, from which it can be differentiated by the elytral striae IX and X clearly impressed along their entire length (Fig. 13E; elytral striae IX and X undefined along their basal fourth in *P. petilus*, Fig. 13B).

Description. Body length 3.1 mm, width 1.6 mm. Body elongate oval, strongly convex (Fig. 13D, E). General coloration dark brown. Elytra with ground punctures sharply marked, and well-defined rows of serial punctures (forming elytral striae); elytral striae very slightly impressed along posterior half of elytra. Posterior elevation of mesoventrite with simple, curved, transverse ridge. Metafemora with hydrofuge pubescence covering basal 4/5 of anterior surface. Apex of fifth abdominal ventrite rounded. Aedeagus (Fig. 14K) with basal piece nearly as long as parameres; parameres nearly as long as median lobe (median lobe inserted further into basal piece, thus appearing shorter than parameres); apex of parameres rounded; apex of median lobe rounded.

Etymology. Named from the word *stria*, combined with the Latin word *latus* meaning broad, in reference to the comparatively broad shape of the body and the clearly defined elytral striae in this species.

Distribution. *Primocerus striatolatus* has only been collected at one locality in the Kasikasima region in Suriname, at an elevation of 400 m (Fig. 15B).

Remarks. Collected on a forested seepage that had lots of detritus.

Key to the genera of New World Acidocerinae (modified from Girón and Short 2018)

1 Eyes absent. Known only from a cave in Ecuador ..... ***Troglochares***
– Eyes present **2**
2 Eyes completely divided into dorsal and ventral sections by a lateral projection of frons. Size small (<3 mm) ..... ***Quadriops***
– Eyes not divided into dorsal and ventral sections by frons. Size variable **3**

3 Labrum concealed by clypeus, elytral margins broadly explanate. Body extremely dorsoventrally compressed ..... ***Helobata***

– Labrum not concealed by clypeus elytral margins not or at most weakly explanate. Body form variable but rarely dorsoventrally compressed **4**

4 Elytra with distinctly impressed sutural striae. Only Neotropical region **5**

– Elytra without sutural striae. Both Neotropical and Nearctic **6**

5 Posterior elevation of the mesoventrite either flat, broadly elevated or with a longitudinal elevation. Gonopore distinct and present ..... ***Chasmogenus***

– Posterior elevation of the mesoventrite with a transverse curved ridge, either sharp or reduced, or with a sharp, pyramidal (triangular) spine-like projection. Gonopore absent ..... ***Primocerus***

6 Prosternum with strongly elevated median carina ..... ***Crucisternum***

– Prosternum not or only very slightly carinate or at most tectiform medially 7

7 Elytral systematic punctures very distinct, distinctly larger than surrounding ground punctation, forming five longitudinal rows along each elytron. Antennae with nine antennomeres **8**

– Elytral systematic punctures indistinct, usually blending with surrounding ground punctation. Antennae with eight or nine antennomeres **9**

8 Metafemora mostly glabrous, with only few scattered setae on anterior surface ..... ***Ephydrolithus***

– Metafemora at most glabrous along apical third ..... ***Katasophistes***

9 Antennae with eight antennomeres. Size small (< 3 mm) **10**

– Antennae with nine antennomeres. Size variable but almost always > 3 mm ... **12**

10 Anterior surfaces of metafemora mostly glabrous ..... ***Tobochares***

– Anterior surfaces of metafemora densely covered by hydrofuge pubescence along basal three fourths **11**

11 Body form circular, rounded. Size very small (1.9–2.3 mm) ..... ***Globulosis***

– Body form ovoid, parallel sided. Size exceedingly small (1.1–1.5 mm) ..... ***Nanosaphes***

12 Fifth ventrite entire, without apical emargination or truncation. Maxillary palps shorter than the width of the head ..... ***Radicitus***

– Fifth ventrite with apical emargination. Maxillary palps as long or longer than the width of the head **13**

13 Head subquadrate; eyes relatively small, separated by a distance nearly 6.5 × the maximum width of an eye; mentum and submentum roughly punctate; pubescence covering abdominal ventrites composed of long golden setae; ventral surface of tarsomeres 1–4 densely setose ..... ***Aulonochares***

– Head trapezoid; eyes moderate in size, separated by a distance nearly 4 × the maximum width of an eye; mentum obliquely strigate, submentum smooth to shallowly punctate; pubescence covering abdominal ventrites composed of short setae; ventral surface of tarsomeres 1–4 only with paired rows of denticles ..... ***Helochares***

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One school name needs to be corrected:

Page 51:

1 *CAS Key Laboratory of Forest Ecology and Management, Institute of Applied Ecology, Shenyang, 110016, China.*
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The correct one should be:

1 *CAS Key Laboratory of Forest Ecology and Management, Institute of Applied Ecology, Shenyang, 110016, China.*
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