

# Two new species of the primitively segmented spider genus *Songthela* from Hunan Province, China (Mesothelae, Liphistiidae)

Dengqing Li<sup>1</sup>, Fengxiang Liu<sup>2</sup>, Daiqin Li<sup>3</sup>, Xin Xu<sup>1</sup>

**1** College of Life Sciences, Hunan Normal University, Changsha, Hunan 410081, China **2** State Key Laboratory of Biocatalysis and Enzyme Engineering, and Centre for Behavioural Ecology and Evolution (CBEE), School of Life Sciences, Hubei University, 368 Youyi Road, Wuhan 430062, Hubei Province, China **3** Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, Singapore 117543, Singapore

Corresponding author: Xin Xu ([xuxin\\_09@163.com](mailto:xuxin_09@163.com)); Daiqin Li ([dbslidq@nus.edu.sg](mailto:dbslidq@nus.edu.sg))

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## Abstract

This study reports two new species of the primitively segmented spider genus *Songthela* from Hunan Province, China, based on morphological characters: *S. huangyang* **sp. nov.** (♂♀), *S. xiangnan* **sp. nov.** (♂♀). Additional material also facilitates a more accurate description of *S. goulouensis* (Yin, 2001) with the first description of the male. Nucleotide data for the barcoding gene, cytochrome c oxidase subunit I (COI), is also provided for these three species.

## Keywords

Araneae, COI, morphology, *Songthela*, taxonomy

## Introduction

In spite of being a species-poor lineage, the primitively segmented spider family Liphistiidae has recently received much attention (e.g., Xu et al. 2015a, b, 2016, 2017a, 2019; Schwendinger 2017; Aung et al. 2019; Schwendinger et al. 2019) because of its pivotal position in the spider tree of life (Platnick and Gertsch 1976; Xu et al. 2015b).

As the sole sister to all other extant spiders, Liphistiidae bears unique plesiomorphies such as the presence of abdominal tergites and the spinnerets located ventrally, in the middle of the abdomen (Bristowe 1975; Haupt 2003; Schwendinger and Ono 2011; Xu et al. 2015a, b, 2016, 2019). Extant liphistiids are confined to East and Southeast Asia where most species are highly endemic (Bristowe 1975; Haupt 2003; Xu et al. 2017a, b; World Spider Catalog 2020). Liphistiidae currently contains 135 species in eight genera (World Spider Catalog 2020). *Heptathela* Kishida, 1923 (Xu et al. 2019), *Ganthela* Xu & Kuntner, 2015 (Xu et al. 2015c) and *Ryuthela* Haupt, 1982 (Xu et al. 2017a) have been comprehensively reviewed, but no revision has yet been performed on the remaining five genera. During our review of the genus *Songthela* Ono, 2000 from China, we discovered several new taxa in Hunan Province.

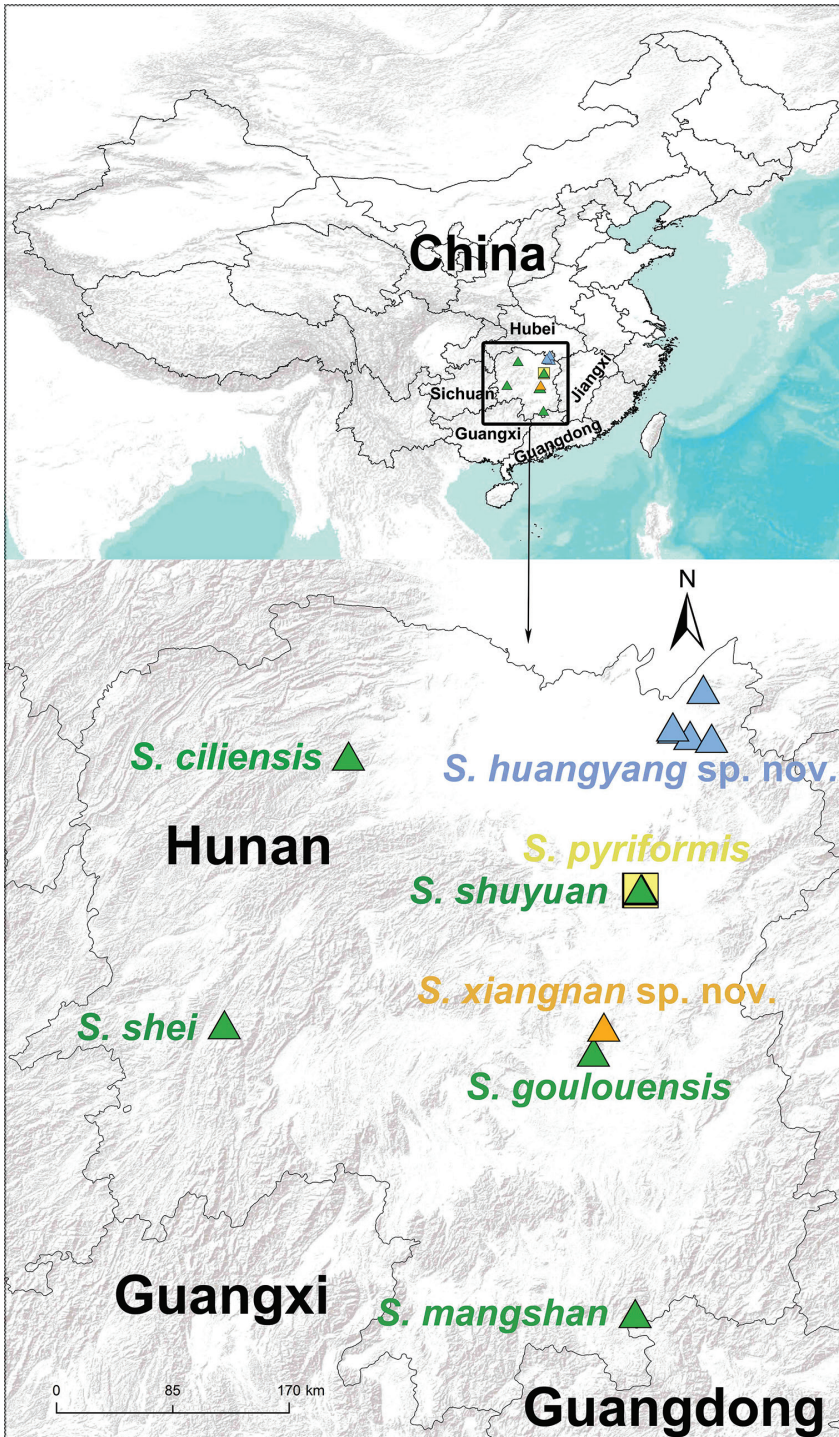
The genus *Songthela* was erected based on the type species *S. hangzhouensis* (Chen, Zhang & Zhu, 1981) using female morphology by Ono (2000), but considered as a synonym of *Sinothela* Haupt, 2003 by Haupt (2003) based on male palp morphology. In 2011, Schwendinger and Ono synonymized *Songthela* with *Heptathela* due to the lack of diagnostic characters (Schwendinger and Ono 2011). However, Xu and colleagues recently recovered *Songthela* by integrating molecular data with morphological characters (Xu et al. 2015a). Currently, *Songthela* consists of 14 described species, mostly from southern China, but also including *S. sapana* (Ono, 2010) from northern Vietnam (World Spider Catalog 2020).

Until now, six *Songthela* species have been reported from Hunan Province: *S. ciliensis* (Yin, Tang & Xu, 2003), *S. goulouensis* (Yin, 2001), *S. mangshan* (Bao, Yin & Xu, 2003), *S. pyriformis* Li, Liu & Xu, 2019, *S. shei* (Xu & Yin, 2001), and *S. shuyuan* Li, Liu & Xu, 2019 (Fig. 1). In this study, we describe two new *Songthela* species collected in Hunan Province based on male and female genital morphology. We also provide the COI GenBank accession numbers of the holotypes of the two new species for future identification. In addition, the species *S. goulouensis* was firstly diagnosed and described based on female morphology, and one specimen was found to bear two sets of female genitalia, named as “didymous phenomenon” (Yin 2001). However, Schwendinger and Ono (2011) attributed the “didymous phenomenon” to the duality of receptacular clusters. The same phenomenon was also reported in the purseweb spider family Atypidae (Li et al. 2018). To resolve this issue, we examined the types of *S. goulouensis* and provide its redescription.

## Material and methods

All specimens were collected from Hunan Province, China (Fig. 1). Subadult males/females were brought back to the laboratory and reared to adulthood. The right four legs of adults were removed, preserved in 100% ethanol, and stored at  $-80^{\circ}\text{C}$  for molecular work, and the remains were kept in 80% ethanol for morphological examination. The specimens were photographed using a digital camera MC170 HD mounted on Leica M205C stereomicroscope. The soft tissues of female genitalia were dissolved using 10 mg/ml trypase (Bomei Biotech Company, Hefei, Anhui, China) for at least





**Figure 1.** Map showing the localities of eight *Songthela* species that currently are distributed in Hunan Province, China. The distributions of two new species are indicated in blue and orange solid triangles, and the type localities of six known species are indicated in green solid triangles as well as yellow solid square.

three hours at the room temperature. Male and female genitalia were then photographed using the digital camera CCD mounted on an Olympus BX53 compound microscope. All the holotypes and voucher specimens were deposited at the College of Life Sciences, Hunan Normal University (HNU), Changsha, China.

Four female types of *S. goulouensis* deposited in Hunan Normal University were also examined. All the vouchers lacked the specimen codes, which were also not indicated in the original description of Yin (2001). To ease the description, each type specimen was assigned a code, the lectotype was designated, *S. goulouensis* was then redescribed using the newly collected male and female specimens at the same locality, and these types were also photographed for comparison. The COI GenBank accession number of this species using these specimens is also provided.

All measurements are given in millimeters, leg and palp measurements are given in the following order: total leg length (femur + patella + tibia + metatarsus + tarsus), total palp length (femur + patella + tibia + tarsus).

Abbreviations used:

<b>ALE</b>	anterior lateral eyes;	<b>OL</b>	opisthosoma length;
<b>AME</b>	anterior median eyes;	<b>OW</b>	opisthosoma width;
<b>BL</b>	body length;	<b>PC</b>	paracymbium;
<b>CL</b>	carapace length;	<b>PLE</b>	posterior lateral eyes;
<b>Co</b>	conductor;	<b>PME</b>	posterior median eyes;
<b>CT</b>	contrategulum;	<b>RC</b>	receptacular cluster;
<b>CW</b>	carapace width;	<b>T</b>	tegulum.
<b>E</b>	embolus;		

The total genomic DNA was extracted from spider legs using the Animal Genomic DNA Isolation Kit (Kangwei Biotech, Beijing, China). The primer pair LCO1490/HCO2198 (Folmer et al. 1994) was used for amplification of COI. The PCR reaction protocol was initial denaturation at 95 °C for 5 min; 35 cycles of denaturation at 95 °C for 1 min, annealing at 40 °C for 1 min, and elongation at 72 °C for 30s; and final extension at 72 °C for 7 min (Xu et al. 2015c). The PCR reactions had a total volume of 25 µl, consisting of 12.5 µl of 2×Taq or 2×Es MasterMix (KangWei Biotech, Beijing, China), 1 µl of each forward and reverse 10 µM primer, 1 µl of genomic DNA, and 9.5 µl of double-distilled H<sub>2</sub>O. The PCR products were visualized by agarose gel electrophoresis (1% agarose). PCR products were purified and sequenced at Tsingke Biotechnology Company (Changsha, China).

## Taxonomy

### Genus *Songthela* Ono, 2000

**Type species.** *Heptathela hangzhouensis* Chen, Zhang & Zhu, 1981.

**Diagnosis.** *Songthela* males can be distinguished from those of all other heptatheline genera by the conductor with the proximal portion relatively narrow, the distal portion with one or two apical spines (Figs 3B, E, 5B, E, 7B, E); by the distal of the embolus slightly sclerotized, with a wide and flat opening (Figs 3C, D, 5A, D, 7A, D); and by the contrategulum with a serrate margin (Figs 3C, D, 5A, D, G, 7A, D, G). *Songthela* females differ from those of all other heptatheline genera by four receptacular clusters with smooth surface, the median ones with relatively long sturdy genital stalks, four receptacular clusters along the anterior margin of the bursa copulatrix or the lateral ones situated dorsolaterally (Figs 3H–J, 5H, 8A–D, 8I–L, 9A–D).

**Distribution.** China and northern Vietnam.

***Songthela huangyang* sp. nov.**

<http://zoobank.org/DA8D876A-C5CA-44A3-A206-0DA36251D59D>

Figures 2, 3

**Type material. Holotype:** CHINA·1 ♂; Hunan Province, Yueyang City, Huangyang Group; 29.26°N, 113.15°E; alt. 85 m; 26 Jun. 2018; D. Li, F.X. Liu, X. Xu, D.Q. Li leg.; XUX–2018–081 (matured on 22 September 2018 at HNU).

**Paratypes:** CHINA·1 ♂, 2 ♀♀; same data as for holotype; XUX–2018–080, 082, XUX–2018–083 (matured on 20 October 2018 at HNU)·1 ♂; Hunan Province, Yueyang City, Linxiang City, Xiacaojiachong Village; 29.51°N, 113.35°E; alt. 89 m; 24 Jun. 2018; D. Li, F.X. Liu, X. Xu, D.Q. Li leg.; XUX–2018–056 (matured on 20 October 2018 at HNU)·1 ♀; Hunan Province, Yueyang City, Yueyang County, Gangkou Town, Gangkou Village; 29.18°N, 113.40°E; alt. 21 m; 25 Jun. 2018; D. Li, F.X. Liu, X. Xu, D.Q. Li leg.; XUX–2018–059·1 ♂; Hunan Province, Yueyang City, Yueyang County, Gangkou Town, Yishan Village; 29.20°N, 113.26°E; alt. 55 m; 25 Jun. 2018; D. Li, F.X. Liu, X. Xu, D.Q. Li leg.; XUX–2018–077 (matured on 20 October 2018 at HNU).

**Diagnosis.** Males of *S. huangyang* sp. nov. resemble those of *S. ciliensis*, *S. mangshan* and *S. pyriformis* by the conductor with one apical spine, but can be distinguished from *S. ciliensis* and *S. mangshan* by the narrow base of the conductor (Fig. 3B, E); from *S. pyriformis* by the thinner conductor apical spine, the contrategulum with the densely denticulate margin, and the narrower tegulum (Fig. 3D–G); from the other *Songthela* species by the conductor base narrow with one apical spine (Fig. 3B, E); and by the narrower tegulum (Fig. 3F). Females of *S. huangyang* sp. nov. differ from those of other *Songthela* species by four receptacular clusters along the anterior margin of the bursa copulatrix, and the median pairs with obscure slender genital stalks (Fig. 3I, J, L, M).

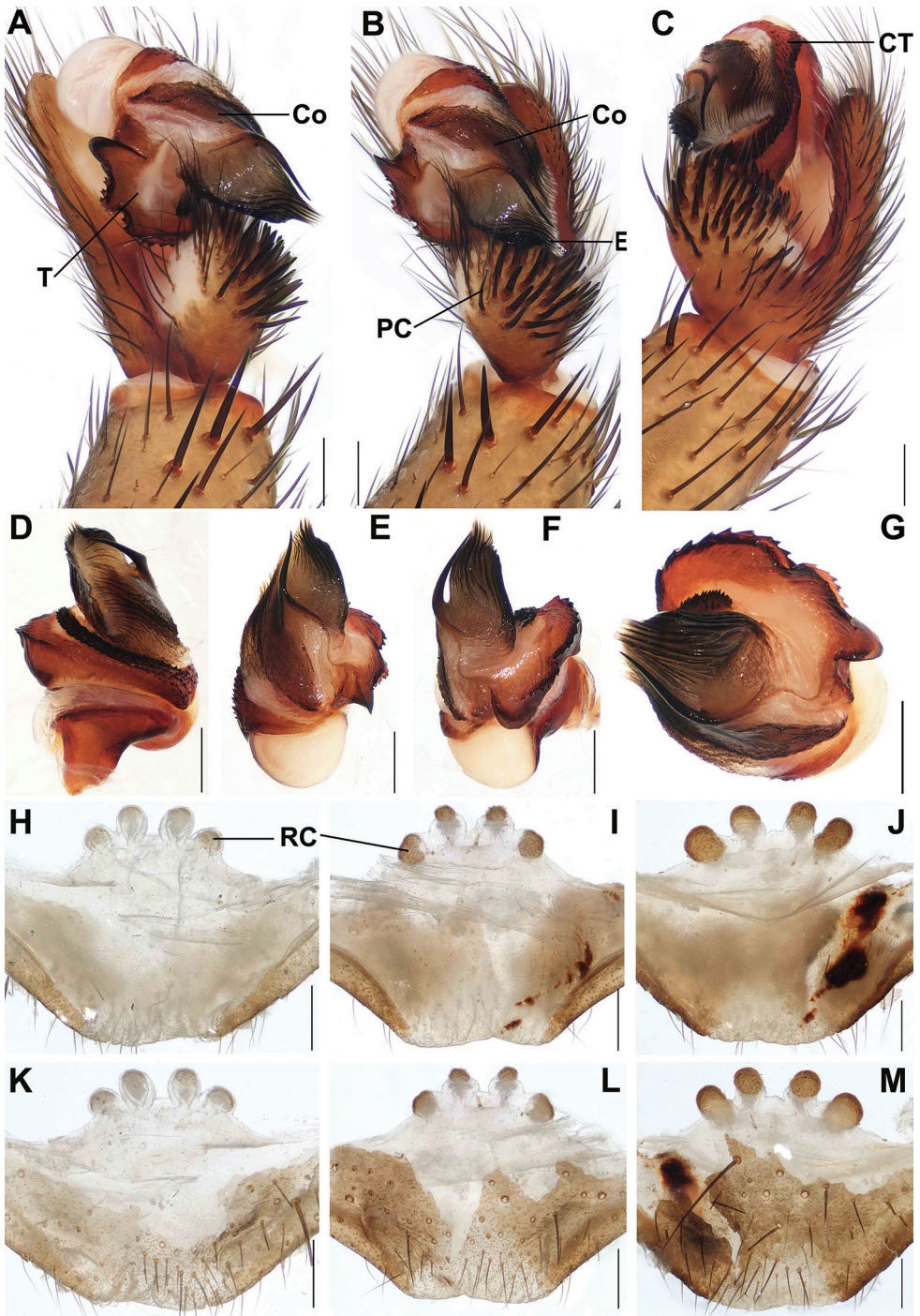
**Description. Male** (holotype; Fig. 2E). Carapace black brown and opisthosoma light brown in alcohol; fourth to sixth tergite yellow brown, remaining tergites dark brown; sternum narrow, much longer than wide; few fine pointed hairs running over ocular area; chelicerae robust with promargin of cheliceral groove with 12 denticles of variable size; legs with sturdy hairs and spines; opisthosoma with 12 tergites, the second to fifth tergite larger than remaining ones and fourth the largest; eight spinnerets.





**Figure 2.** Microhabitat and general somatic morphology of *Songthela huangyang* sp. nov. (XUX–2018–082, female; XUX–2018–083, male) **A** microhabitat **B, C** the trapdoor with the door closed and open **D, E** dorsal view. Scale bar: 3 mm (**D**).





**Figure 3.** Male and female genital anatomy of *Songthela huangyang* sp. nov. **A, D** palp prolateral view **B, E** palp ventral view **C, F** palp retrolateral view **G** palp distal view **H–J** vulva dorsal view **K–M** vulva ventral view **A–C** XUX–2018–081 (holotype) **D–G** XUX–2018–083 **H, K** XUX–2018–059 **I, L** XUX–2018–080 **J, M** XUX–2018–082. Scale bars: 0.3 mm (**A–M**).

Measurements: BL 9.29, CL 4.33, CW 3.94, OL 4.73, OW 2.79; ALE > PLE > PME > AME; leg I 14.73 (4.09 + 1.86 + 2.94 + 3.79 + 2.05), leg II 15.03 (4.10 + 1.81 + 2.83 + 4.02 + 2.27), leg III 16.36 (4.21 + 1.84 + 2.96 + 4.73 + 2.62), leg IV 21.05 (5.14 + 2.05 + 3.97 + 6.45 + 3.44).

**Palp.** Paracymbium with numerous setae and spines on the tip (Fig. 3A–C); contrategulum with a densely denticulate margin (Fig. 3D); tegulum narrow with a serrate marginal apophysis and a finger-like terminal apophysis (Fig. 3F, G); conductor situated ventro-proximally from the embolus, its base narrow and fused with embolus, distal portion free, and sharply narrowing to a apical spine (Fig. 3A, B, E); embolus with a wide and flat opening (Fig. 3C, D).

**Female** (XUX–2018–082; Fig. 2D). Carapace red brown and opisthosoma brown in alcohol; fourth to sixth tergite grey and brown, remaining tergites dark brown; sternum narrow, much longer than wide; few fine pointed hairs running over ocular area; chelicerae robust with promargin of cheliceral groove with eleven denticles; legs with sturdy hairs and spines; opisthosoma with 12 tergites, the second to fifth tergite larger than remaining ones and fourth the largest; eight spinnerets. Measurements: BL 14.15, CL 5.97, CW 5.46, OL 7.73, OW 6.55; ALE > PLE > PME > AME; palp 11.05 (3.64 + 2.07 + 2.47 + 2.87), leg I 12.80 (3.95 + 2.33 + 2.47 + 2.61 + 1.44), leg II 12.40 (3.67 + 2.26 + 2.28 + 2.66 + 1.53), leg III 12.91 (3.53 + 2.31 + 2.26 + 3.13 + 1.68), leg IV 18.24 (4.76 + 2.67 + 3.31 + 5.03 + 2.47).

**Female genitalia.** Four receptacular clusters along the anterior margin of the bursa copulatrix, the median pair with obscure slender genital stalks, smaller than or similar to the lateral ones; the lateral receptacular clusters without genital stalks (Fig. 3H–M); the posterior part of the genital area inverted trapezoid (Fig. 3H–M).

**Variation.** Males and females vary in body size. The range of measurements in males as follows ( $N = 4$ ): BL 9.29–10.78, CL 4.33–5.07, CW 3.94–5.02, OL 4.43–4.73, OW 2.77–3.11; females ( $N = 3$ ): BL 9.23–14.15, CL 3.55–5.97, CW 4.01–5.46, OL 5.36–7.73, OW 4.44–6.55. In addition, female genitalia show slight intraspecific variation: the genital stalks of the median pair are slender (Fig. 3I, J, L, M), or four receptacular clusters are slightly sclerotized, perhaps because of the early stage of maturity of the specimen (Fig. 3H, K); or the genital stalks of the median pair have the obscure ribbed distal portion (Fig. 3I, L).

**Etymology.** The species epithet, a noun in apposition, refers to the type locality.

**Distribution.** Hunan (Yueyang) Province, China.

**GenBank accession number.** Holotype (XUX–2018–081): MT102213.

### *Songthela xiangnan* sp. nov.

<http://zoobank.org/C1546A27-6E26-4271-8457-91CA59E072A9>

Figures 4, 5

**Type material. Holotype:** CHINA: 1 ♂; Hunan Province, Hengyang City, Mt. Heng, Xiangnan Temple; 27.28°N, 112.69°E; alt. 959 m; 18 Aug. 2011; F.X. Liu, X. Xu, R. Xiao leg.; XUX–2011–063.





**Figure 4.** Microhabitat and general somatic morphology of *Songthela xiangnan* sp. nov. (XUX-2011-071, female; XUX-2011-063, male) **A** microhabitat **B, C** the trapdoor with the door closed and open **D, E** dorsal view. Scale bars: 3 mm (**D, E**).



**Paratypes:** CHINA·2 ♀♀; same data as for holotype; XUX–2011–070, 071.

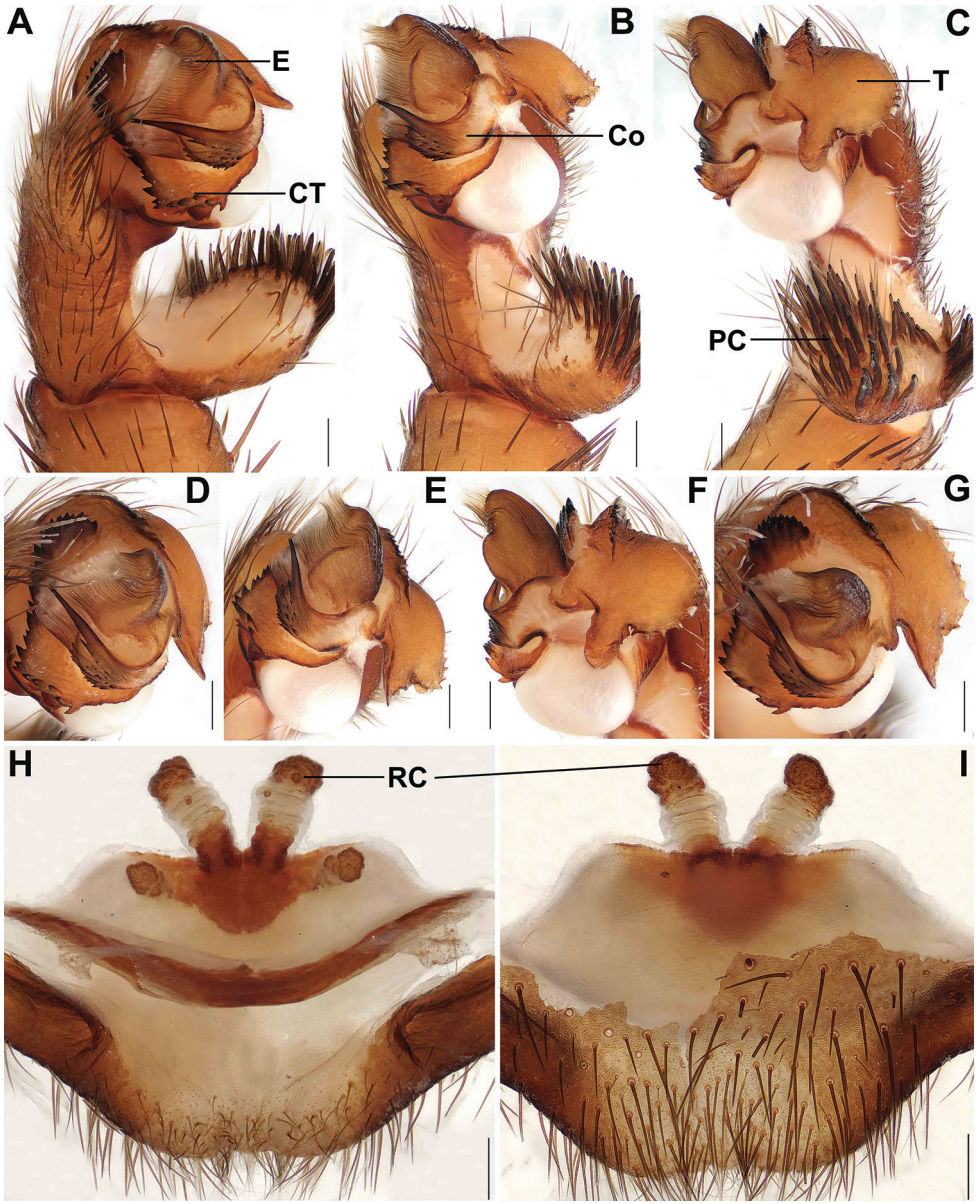
**Diagnosis.** Male of *S. xiangnan* sp. nov. resembles that of *S. pluma*, but can be distinguished from the latter by the conductor with two apical spines, the longer spine with a bifid apex (Fig. 5A, B, D, E, G), by the contrategulum with only one dentate margin and with a small apophysis located proximally (Fig. 5A, B, D, E), and by the tegulum with a finger-like terminal apophysis in retrolateral view (Fig. 5C, F); from that of other *Songthela* species by the central part of the conductor with several short spines, the blade-shaped conductor spine with a bifid apex (Fig. 5A, B, D, E, G). Females of *S. xiangnan* sp. nov. differ from those of *S. pluma* by the longer genital stalks of the median receptacular clusters (Fig. 5H), and the smaller lateral receptacular clusters with obscure genital stalks (Fig. 5H); from those of other *Songthela* species by the median receptacular clusters with longer and trachea-shaped genital stalks, obviously larger than the lateral ones, the lateral receptacular clusters with obscure genital stalks, situated slightly dorsolaterally (Fig. 5H).

**Description. Male** (holotype; Fig. 4E). Carapace yellow with several short hairs on the margin; opisthosoma light brown; tergites yellowish-brown; sternum narrow; few fine pointed hairs running over ocular area; chelicerae robust with promargin of cheliceral groove with 12 denticles; legs with sturdy hairs and spines; opisthosoma with 12 tergites, the second to fifth tergite larger than remaining ones and third the largest; six spinnerets. Measurements: BL 10.80, CL 5.51, CW 5.48, OL 5.18, OW 4.10; ALE > PLE > PME > AME; leg I 20.24 (5.77 + 2.43 + 4.41 + 5.34 + 2.29), leg II 20.51 (5.63 + 2.43 + 4.28 + 5.69 + 2.48), leg III 21.83 (5.45 + 2.49 + 4.32 + 6.71 + 2.86), leg IV 28.2 (7.15 + 2.74 + 5.79 + 8.97 + 3.55).

**Palp.** Prolateral side of paracymbium unpigmented and unsclerotized, with numerous setae and spines on the tip (Fig. 5A); contrategulum with serrate margin and with a small apophysis located proximally (Fig. 5A, B, D, E); tegulum with a dentate marginal apophysis and the dorsal extension of terminal apophysis, and a long finger-like terminal apophysis in retrolateral view (Fig. 5C, F); conductor base wide and fused with embolus, unsmooth middle portion covered with several short spines, a long blade-shaped spine with a bifid apex and a short spine basally (Fig. 5A, B, D, E); embolus with a flat opening in distal portion and ridged apophysis in middle ventral portion (Fig. 5A–G).

**Female** (XUX–2011–070; Fig. 4D). Carapace yellow brown with several hairs on the margin; opisthosoma brown; fourth to sixth tergite light brown with some brown flecks, remaining tergites dark brown; sternum narrow; few fine pointed hairs running over ocular area; chelicerae robust with promargin of cheliceral groove with 12 denticles; legs with sturdy hairs and spines; opisthosoma with 12 tergites, the second to fifth tergite larger than remaining ones and fourth the largest; six spinnerets. Measurements: BL 14.31, CL 6.44, CW 5.94, OL 7.04, OW 6.18; ALE > PLE > PME > AME; palp 12.59 (4.35 + 2.31 + 2.64 + 3.29), leg I 14.28 (4.64 + 2.52 + 2.78 + 2.80 + 1.54), leg II 13.76 (4.25 + 2.42 + 2.52 + 3.00 + 1.57), leg III 14.32 (4.08 + 2.44 + 2.53 + 3.41 + 1.86), leg IV 20.37 (5.72 + 2.94 + 3.74 + 5.30 + 2.67).

**Female genitalia.** The median pair of the receptacular clusters along the anterior margin of the bursa copulatrix, with long, trachea-shaped and slightly ventral-tilted



**Figure 5.** Male and female genital anatomy of *Songthela xiangnan* sp. nov. **A, D** palp prolateral view **B, E** palp ventral view **C, F** palp retrolateral view **G** palp distal view **H** vulva dorsal view **I** vulva ventral view **A–G** XUX–2011–063 (holotype) **H–I** XUX–2011–070. Scale bars: 0.3 mm (**A–I**).

genital stalks close to each other basally but separated from each other distally; the middle receptacular clusters obviously larger than the lateral ones; the lateral receptacular clusters with obscure genital stalks, situated slightly dorsolaterally (Fig. 5H, I); the anterior margin of the bursa copulatrix trapezoid (Fig. 5H, I).

**Variation.** The range of measurements in females as follows ( $N = 2$ ): BL 12.56–14.31, CL 6.26–6.44, CW 5.67–5.94, OL 5.78–7.04, OW 4.65–6.18.

**Etymology.** The species epithet, a noun in apposition, refers to the type locality.

**Distribution.** Hunan (Hengyang) Province, China.

**GenBank accession number. Holotype:** XUX–2011–063: MT102212.

### *Songthela goulouensis* (Yin, 2001)

Figures 6–9

*Heptathela goulouensis* Yin, 2001: 297 (♀♀, from Gouloufeng, Hengyang City, Hunan Province, China, collected by X.J. Peng on 1 August 1997; deposited in HNU, examined); Yin 2001: 2; Yin et al. 2012: 114;

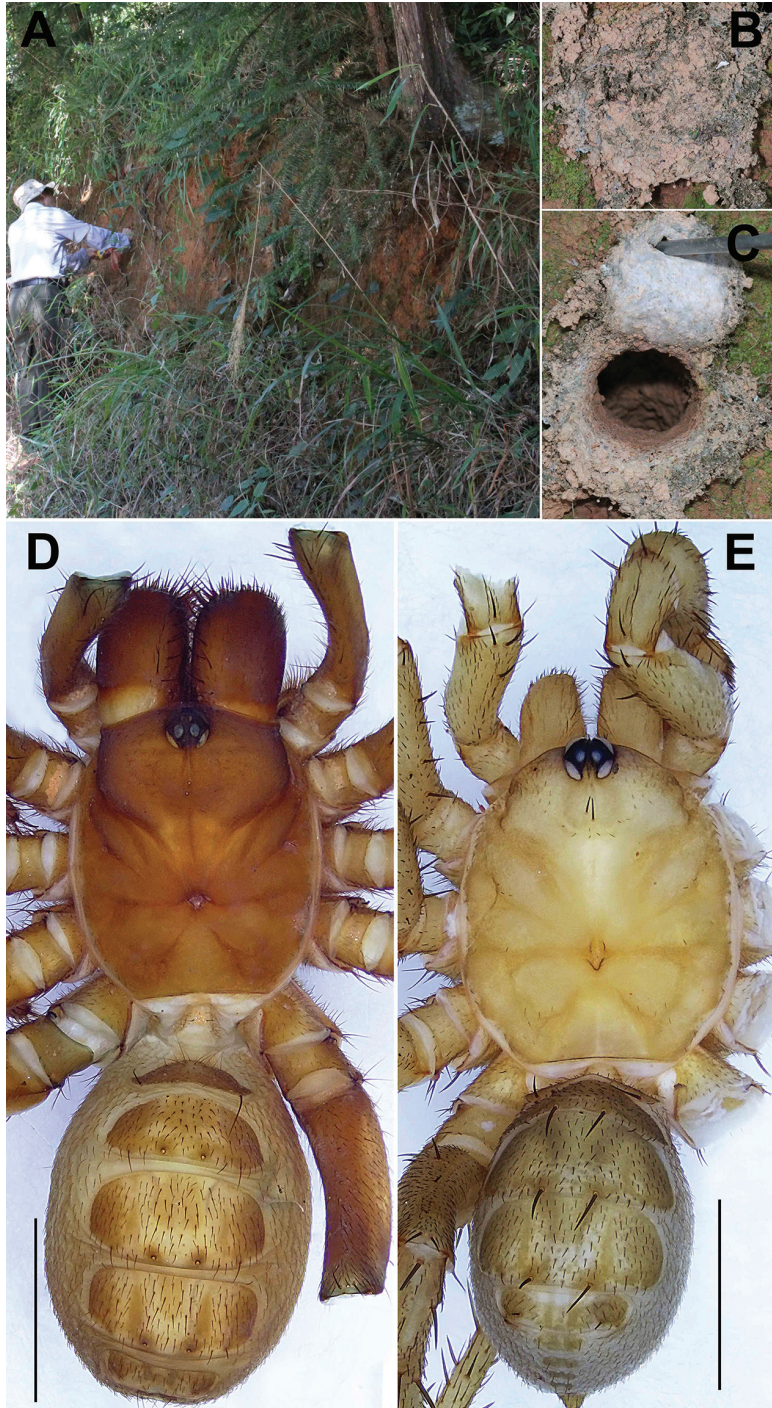
*Songthela goulouensis* Xu et al., 2015: 141.

**Material examined.** CHINA-2 ♂♂, 11 ♀♀; Hunan Province, Hengyang City, Gouloufeng, nearby Yuwang Hotel; 27.12°N, 112.63°E; alt. 609–637 m; 20 Aug. 2011; F.X. Liu, X. Xu, R. Xiao leg.; XUX–2011–093, 095, 096, 098, 099, 100, 104, 105, 106, 108, 109, 110, 110A.5 ♀♀; Hunan Province, Hengyang City, Gouloufeng; 27.12°N, 112.62°E; alt. 556–558 m; 20 Aug. 2011; F.X. Liu, X. Xu, R. Xiao leg.; XUX–2011–111, 113 to 116; 4 ♀♀; Hunan Province, Hengyang City, Gouloufeng; alt. 1500 m; 1 Aug. 1997; X.J. Peng leg.; GL–1997–001 (lectotype) to 004.

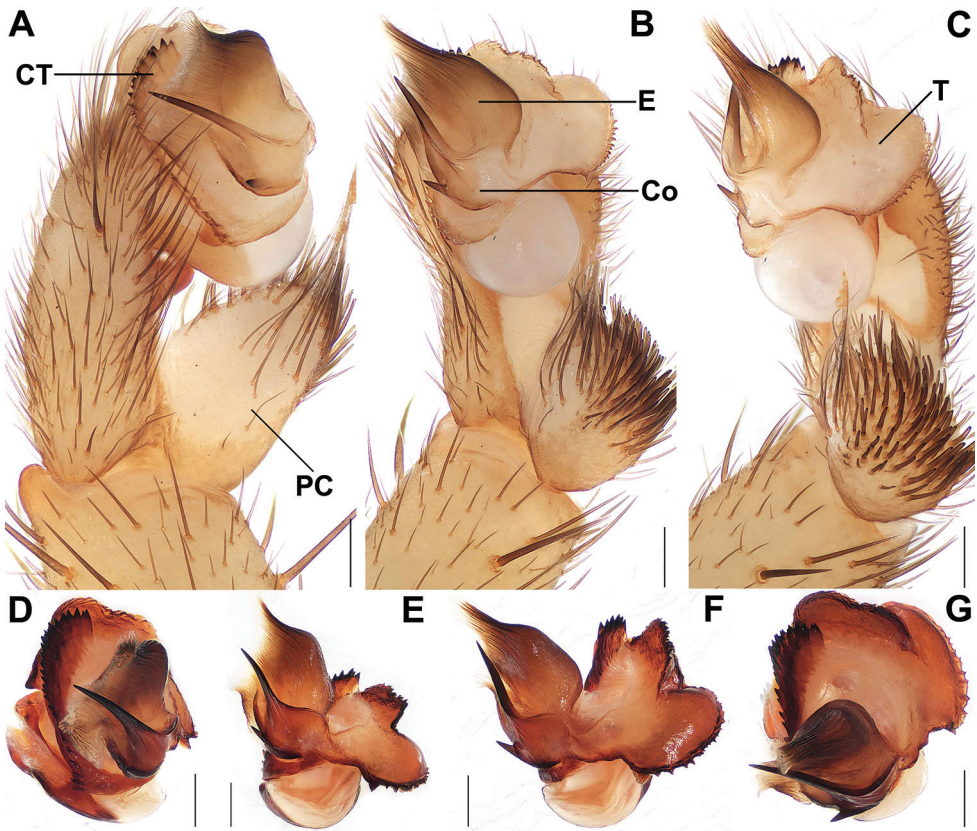
**Diagnosis.** Males of *S. goulouensis* resemble those of *S. hangzhouensis* by the conductor with two spines, but can be distinguished from the latter by the shorter spine located near the conductor margin, the longer spine extended over the embolus opening margin (Fig. 7A, B, D, E), and by the tegulum with a smaller terminal apophysis in retrolateral view (Fig. 7C, F); from *S. shuyuan* by the conductor with a narrower base and a longer apical spine (Fig. 7B, E), by the embolus with a slightly curved distal margin (Fig. 7A–E), and by the tegulum with a smaller terminal apophysis in retrolateral view (Fig. 7C, F); from those of the other *Songthela* species by the smooth conductor with two apical spines (Fig. 7A–G). Females of *S. goulouensis* differ from those of the other *Songthela* species by the median receptacular clusters located at the two peaks of the anterior margin of the bursa copulatrix, with obvious genital stalks, the lateral ones situated dorsolaterally, close to the base of the middle genital stalks, with obscure genital stalks (Figs 8A–D, 8I–L, 9A–D).

**Description. Male** (XUX–2011–110A; Fig. 6E). Carapace light yellow with several hairs on the margin; opisthosoma light brown; fourth to sixth tergite brown with some light brown flecks, remaining tergites brown; sternum narrow; few fine pointed hairs running over ocular area; chelicerae robust with promargin of cheliceral groove with eleven denticles; legs with sturdy hairs and spines; opisthosoma with 12 tergites, the second to fifth tergite larger than remaining ones and fourth the largest; seven spinnerets. Measurements: BL 9.67, CL 4.58, CW 4.33, OL 4.73, OW 3.33; ALE > PLE > PME > AME; leg I 14.53 (4.03 + 1.91 + 2.93 + 3.60 + 2.06), leg II 14.81 (3.75 +





**Figure 6.** Microhabitat and general somatic morphology of *Songthela goulouensis* (GL-1997-001, female; XUX-2011-110A, male) **A** microhabitat **B, C** the trapdoor with the door closed and open **D, E** dorsal view. Scale bars: 3 mm (**D, E**).



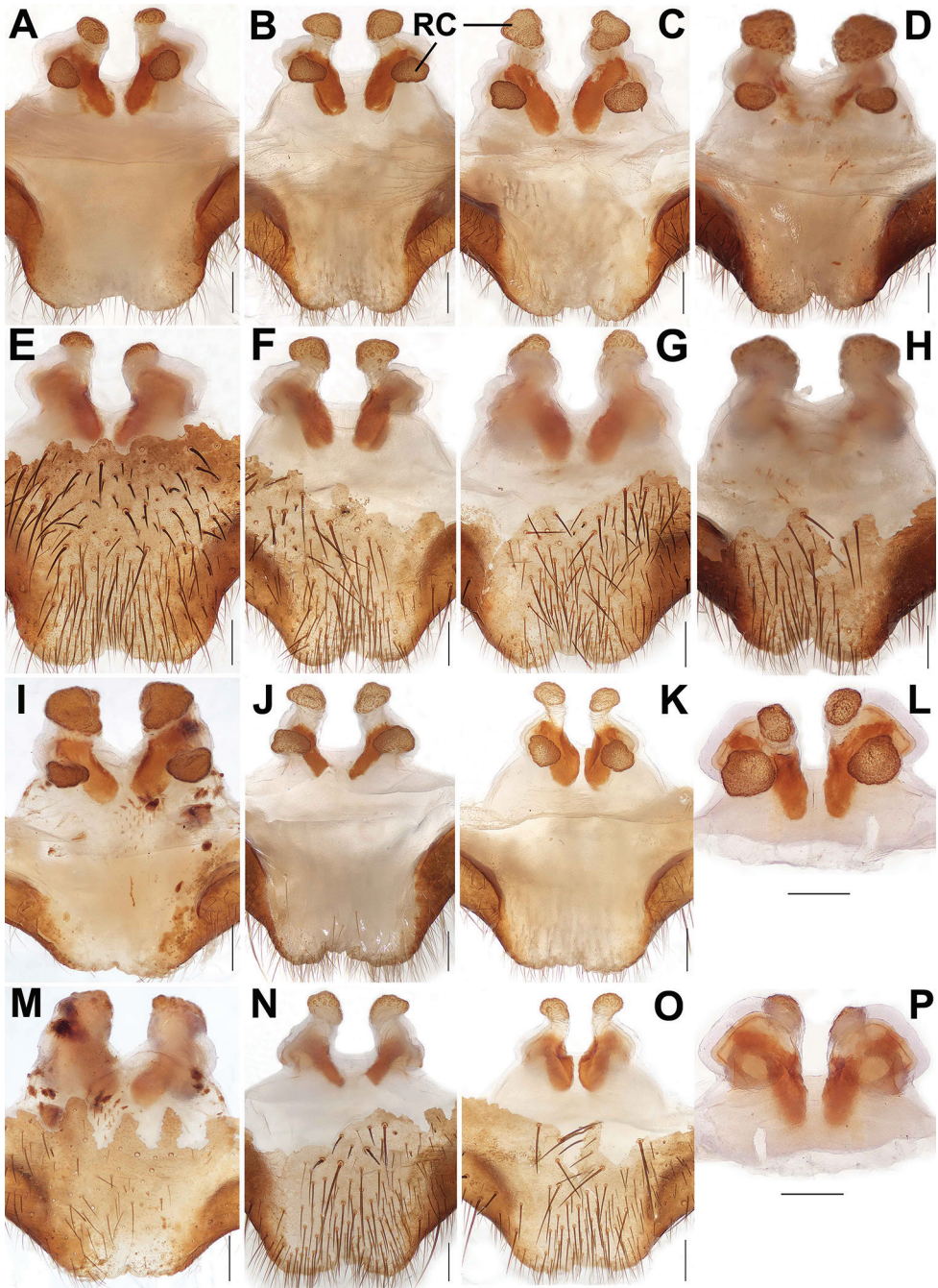
**Figure 7.** Male genital anatomy of *Songthela goulouensis* **A, D** palp prolateral view **B, E** palp ventral view **C, F** palp retrolateral view **G** palp distal view **A–C** XUX–2011–110A **D–G** XUX–2011–098. Scale bars: 0.3 mm (**A–G**).

1.86 + 2.89 + 3.97 + 2.34), leg III 16.25 (3.80 + 1.87 + 2.94 + 4.81 + 2.83), leg IV 21.50 (4.72 + 2.24 + 4.10 + 6.87 + 3.57).

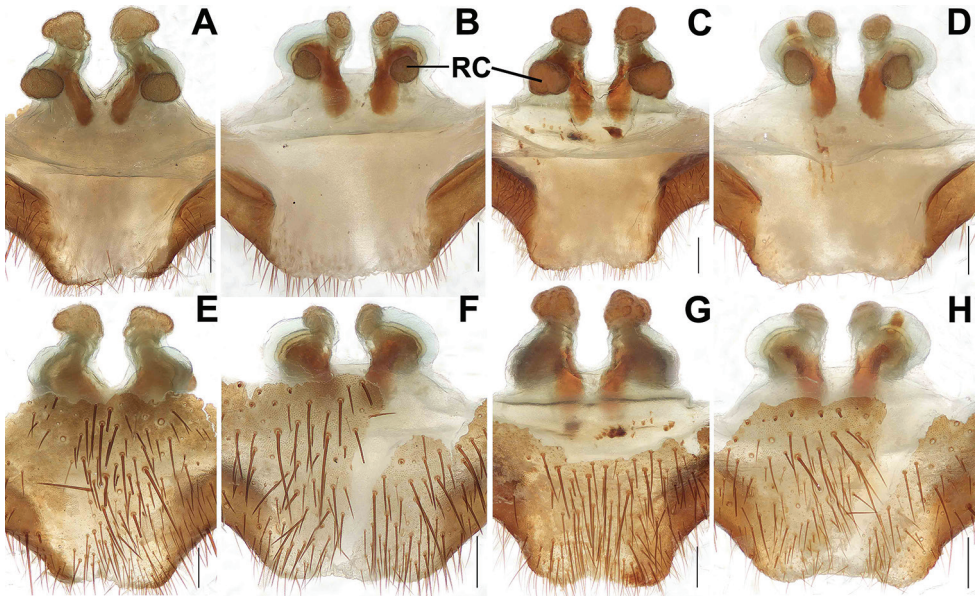
**Palp.** Paracymbium unpigmented and unsclerotized in prolateral view, with numerous setae and spines on the tip (Fig. 7A); contrategulum with serrate margin (Fig. 7A, D, G); tegulum with a dentate marginal apophysis and the dorsal extension of terminal apophysis, and with a small terminal apophysis in retrolateral view (Fig. 7C, F); the smooth conductor base fused with embolus, with two free apical spines, the short one located at the one third of the conductor and close to the conductor margin, the long one extended over the embolus opening (Fig. 7A, B, D, E); embolus distal margin slightly curved, with a wide and flat opening (Fig. 7A–F).

**Female** (XUX–2011–095; Fig. 6D). Carapace dark yellow with several hairs on the margin; opisthosoma light brown; fourth to eighth tergite light brown with some brown flecks, remaining tergites dark brown; sternum narrow; few fine pointed hairs





**Figure 8.** Female genital anatomy of *Songthela goulouensis* **A–D, I–L** vulva dorsal view **E–H, M–P** vulva ventral view **A, E** XUX–2011–093 **B, F** XUX–2011–095 **C, G** XUX–2011–099 **D, H** XUX–2011–114 **I, M** XUX–2011–104 **J, N** XUX–2011–115 **K, O** XUX–2011–106 **L, P** XUX–2011–109. Scale bars: 0.3 mm (**A–P**).



**Figure 9.** Female genital anatomy of *Songthela goulouensis* **A–D** vulva dorsal view **E–H** vulva ventral view **A, E** GL-1997-002 **B, F** GL-1997-001 (lectotype) **C, G** GL-1997-003 **D, H** GL-1997-004. Scale bars: 0.3 mm (**A–H**).

running over ocular area; chelicerae robust with promargin of cheliceral groove with eleven denticles of variable size; legs with sturdy hairs and spines; opisthosoma with 12 tergites, the second to fifth tergite larger than remaining ones and fourth the largest; seven spinnerets. Measurements: BL 12.30, CL 5.99, CW 5.25, OL 5.67, OW 4.08; ALE > PLE > PME > AME; palp 9.02 (2.91 + 1.05 + 2.18 + 2.88), leg I 11.03 (3.50 + 1.33 + 2.44 + 2.16 + 1.60), leg II 11.11 (3.48 + 1.48 + 2.11 + 2.24 + 1.80), leg III 11.62 (3.22 + 1.41 + 2.17 + 2.96 + 1.86), leg IV 15.92 (4.46 + 1.79 + 2.83 + 4.42 + 2.42).

**Female genitalia.** The middle pair of the receptacular clusters along the two peaks of the anterior margin of the bursa copulatrix, with obvious genital stalks, the middle receptacular clusters slightly larger or smaller than the lateral ones; the lateral receptacular clusters with obscure genital stalks, situated slightly dorsolaterally, close to the base of the middle genital stalks (Figs 8A–P, 9A–H); the posterior margin of the genital area W-shaped or slightly incurved at the center (Figs 8A–P, 9A–H).

**Variation.** Males and females vary in body size. The range of measurements in males as follows ( $N=2$ ): BL 9.67–9.82, CL 4.58–4.91, CW 4.33–4.54, OL 4.64–4.73, OW 3.30–3.33. Females ( $N=20$ ): BL 10.77–14.39, CL 4.68–6.69, CW 4.01–5.92, OL 5.30–7.78, OW 3.52–5.92. In addition, female genitalia show intraspecific variation: the membrane outside the middle genital stalks thick and obvious (Figs 8A–C, 8E–G, L, P, 9B, D, F, H), or thin and obscure (Fig 8J, K, N, O); the posterior margin of the genital area obviously incurved at the center (Fig. 8A–H, J, N), or obscurely incurved at the center (Figs 8I, K, M, O, 9A, C, D, E, G, H); the middle genital stalks inclined to each other (Figs 8B, D, J, 9A, B), or the short middle genital stalks parallel



to each other (Figs 8C, I, L, 9C, D), or one middle genital stalk relatively straight and the other one relatively tilted (Fig. 8A, K); the four receptacular clusters similar size (Figs 8A, B, J, K, 9C, D), or the middle ones larger than the lateral ones (Figs 8C, D, I, 9A), or the middle pair smaller than the lateral pair (Figs 8L, 9B).

**Remarks.** To confirm whether the specimens we collected are *S. goulouensis*, we attempted DNA extraction on the type specimens, unsuccessfully. We could therefore not assess genetic distances between the four type specimens and the 16 specimens that we had collected. In addition, after closely examining and comparing the types with the original descriptions of Yin (2001), we could not ensure which specimen was used as the holotype to describe the species by Yin (2001). Thus, we assigned a unique code to each specimen (i.e., GL-1997-001 to GL-1997-004) and designated GL-1997-001 as the lectotype. The female genital morphology of all four types was also photographed and presented in Figure 9 for future identification and comparison. Nevertheless, we treat all the specimens as conspecific with *S. goulouensis* for the following reasons: (1) Yin (2001) only described the females, but wrongly described and recognized the genital stalks. After closely examining and comparing the female types with the newly collected females, we found that all the females have comparable morphology, despite considerable intraspecific variation, as is typical of female genitalia in other liphistiids (Xu et al. 2017, 2019): four receptacular clusters similarly sized (Figs 8A, B, J, K, 9C, D) or the middle ones slightly larger than lateral ones (Figs 8C, D, I, 9A) or the middle ones smaller than lateral ones (Figs 8L, 9B), and the middle ones with obvious genital stalks, along the two peaks of the anterior margin of the bursa copulatrix, the lateral ones with obscure genital stalks, situated dorsolaterally, close to the base of the middle genital stalks (Figs 8A–P, 9A–H); (2) the intraspecific genetic distance using K2P model among nine newly collected specimens is very small, 0–0.59% (unpublished data); (3) the specimens (males and females) were collected adjacent to the type locality (Gouloufeng) of *S. goulouensis* (Yin 2001).

**Distribution.** Hunan (Hengyang) Province, China.

**GenBank accession number.** XUX-2011-110A: MT102211.

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# A new species of *Tachycines* Adelung, 1902 (Orthoptera, Rhaphidophoridae, Aemodogryllinae, Aemodogryllini) from karst caves in Guizhou, China

Xulin Zhou<sup>1,2</sup>, Weicheng Yang<sup>1,2</sup>

**1** School of Life Sciences, Guizhou Normal University, Guiyang, Guizhou 550031, China **2** Institute of Karst Caves, Guizhou Normal University, Guiyang, Guizhou 550031, China

Corresponding author: Weicheng Yang ([yangweicheng0908@sina.com](mailto:yangweicheng0908@sina.com))

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## Abstract

*Tachycines* (*Gymnaeta*) *trapezialis* **sp. nov.** (梯形裸灶蝻) is described with specimens collected from Diaosiyuan and Sanjiaoshan caves in Ziyun County, Guizhou, China. The unique trapezoidal shape of the epiphallus in males and the subgenital plate in females, which separate the new taxon from its congeners, are illustrated.

## Keywords

Orthoptera, *Tachycines* (*Gymnaeta*), Ziyun

## Introduction

During scientific expeditions to the proposed Ziyun Nature Reserve for Hume's pheasant (*Syrnaticus humiae*) in Ziyun County, Guizhou, China, nymphs and adults of a new species were collected in Diaosiyuan and Sanjiaoshan caves in Ziyun County, Guizhou, China, in June and October of 2019.

These specimens were found to belong to the subgenus *Gymnaeta* Adelung, 1902 in the genus *Tachycines* Adelung, 1902 and *Tachycines* (*Gymnaeta*) *trapezialis* sp. nov. is described herein. Nine valid species of the subgenus have been recorded from Guizhou Province, i.e. *Tachycines* (*Gymnaeta*) *ferrecaecus* (Gorochov, Rampini & Di Russo, 2006), *Tachycines* (*Gymnaeta*) *proximus* (Gorochov, Rampini & Di Russo, 2006), *Tachycines* (*Gymnaeta*) *chenhui* (Rampini & Di Russo, 2008), *Tachycines* (*Gymnaeta*) *latellai* (Rampini & Di Russo, 2008), *Tachycines* (*Gymnaeta*) *zorzini* (Rampini & Di Russo, 2008), *Tachycines* (*Gymnaeta*) *solida* (Gorochov, Rampini & Di Russo, 2006), *Tachycines* (*Gymnaeta*) *borutzkyi* (Gorochov, 1994), *Tachycines* (*Gymnaeta*) *dispar* (Qin, Liu & Li, 2019) and *Tachycines* (*Gymnaeta*) *lalinus* (Feng, Huang & Luo, 2019) (Gorochov, 1994; Gorochov et al. 2006; Rampini et al. 2008; Feng et al. 2019; Qin et al. 2019). Six of them have been found in caves of Guizhou (Gorochov et al. 2006; Rampini et al. 2008; Wen. 2018; Feng et al. 2019).

## Materials and methods

All specimens used in this study were preserved in 75% ethanol. Details of the morphology were studied under an Olympus SZ61 stereomicroscope. Male genitalia were preserved in mixture solution of ethanol and glycerin. Photographs were taken by an Olympus DP22 digital camera and processed with Adobe Photoshop CS6.

All specimens are deposited in the Institute of Karst Caves, Guizhou Normal University, Guizhou Province, China (IKCGZNU). The morphological terminology follows Qin et al. (2019).

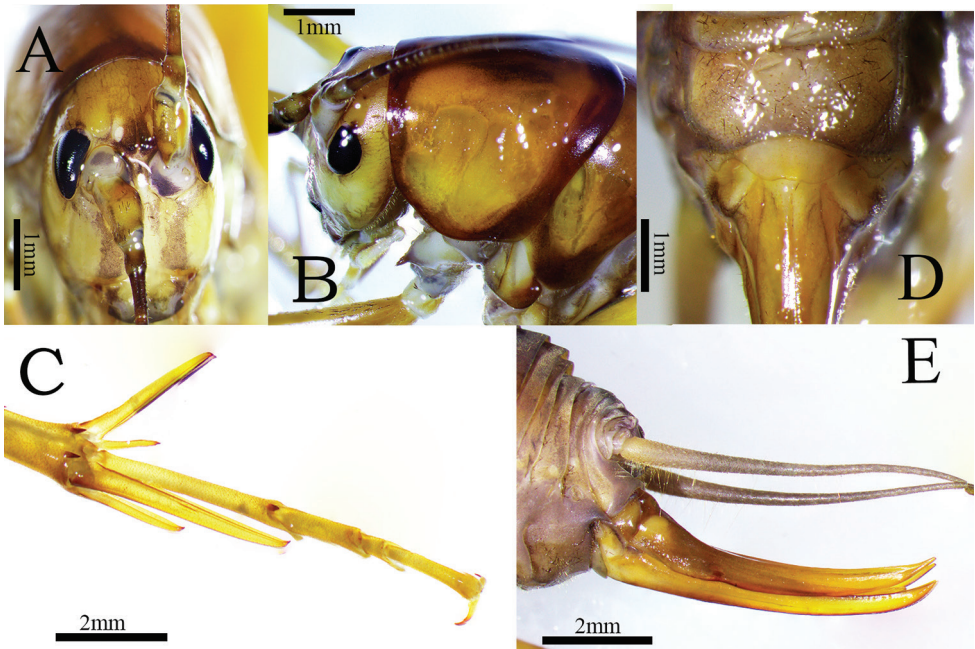
## Taxonomy

### *Tachycines* (*Gymnaeta*) *trapezialis* sp. nov.

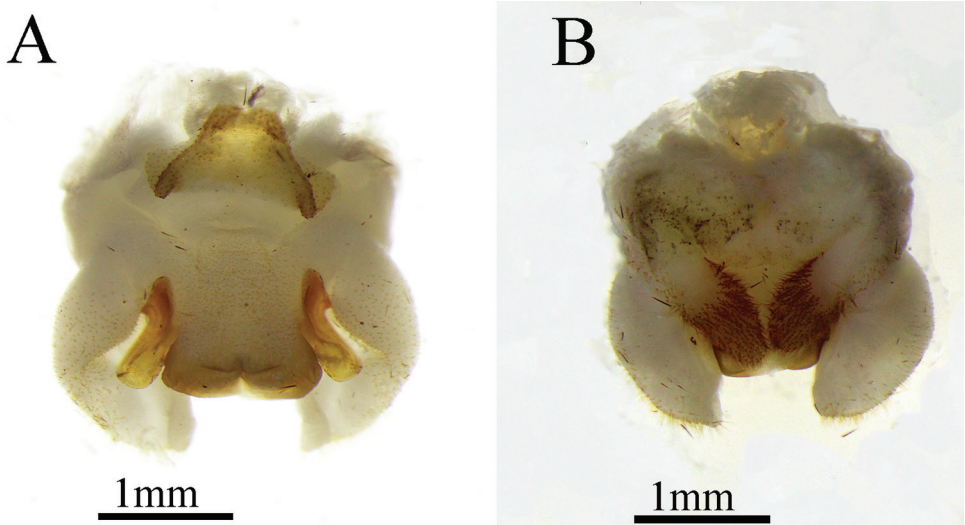
<http://zoobank.org/00CE3ED0-336F-46C9-9BFD-AB3FB447CA6E>

Figures 1–6

**Diagnosis.** This new species is very similar to *T. (G.) lushuicus* Qin, Liu & Li, 2019, *T. (G.) parvus* Qin, Liu & Li, 2019, and *T. (G.) bifurcatus* Gorochov, 2010, but differs from them in having the epiphallus of the male genitalia trapezoidal, without upper and lower deep notches and the hind tibia provided with 54–60 spines on each side for the new species. In *T. (G.) lushuicus* Qin, Liu & Li, 2019, the epiphallus of the male genitalia has an upper deep notch, and the hind tibia above has 61–67 spines on each side. In *T. (G.) parvus* Qin, Liu & Li, 2019, the epiphallus of the male genitalia has an upper and lower deep notch, and the female subgenital plate is triangular. In *T. (G.) bifurcatus* Gorochov, 2010, the epiphallus is strongly transverse, with a slightly

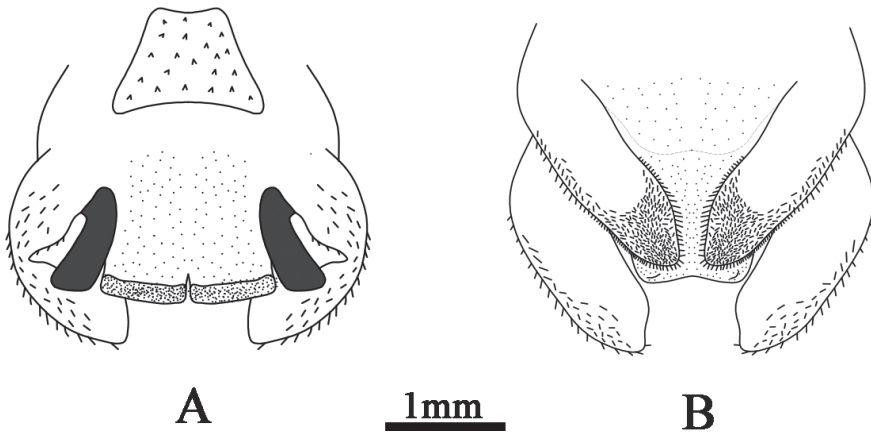


**Figure 1.** *Tachycines (Gymnaeta) trapezialis* sp. nov. **A** male; head and pronotum, dorsal view **B** male; head and pronotum, lateral view **C** male; hind tarsus in dorsal view **D** female, subgenital plate in ventral view **E** ovipositor in lateral view.



**Figure 2.** *Tachycines (Gymnaeta) trapezialis* sp. nov., male genitalia **A** dorsal view **B** ventral view.





**Figure 3.** Illustration of male genitalia **A** dorsal view **B** ventral view.



**Figure 4.** *Tachycines (Gymnaeta) trapezialis* sp. nov. nymphs from Diaosiyang Cave **A** male **B** female.

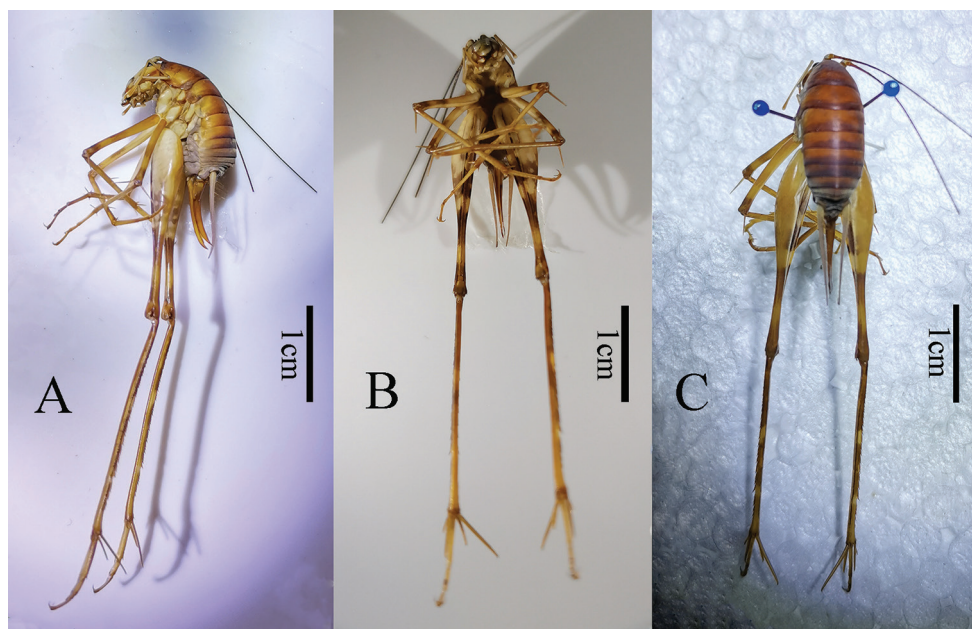
notched upper part and medial projections on the lower part, and with a pair of large, almost oval lateral sclerites in males.

**Type locality.** *Holotype*, 1♂, Diaosiyang Cave, Ziyun County, Guizhou, 25°35.06'N, 106°12.32'E, 1110–1120 m alt., October 2, 2019, collected by Xulin Zhou; *paratypes*, 1♀, same data as holotype.

**Specimens examined.** Diaosiyang Cave, Ziyun County, Guizhou Province: nymphs 11♂♂ 10♀♀, June 10, 2019, collected by Xulin Zhou, Juan Liao and Yi Du; 13♂♂ 9♀♀, October 2, 2019, collected by Xulin Zhou, Haixia Luo, Panpan Ren, Meizhen Deng and Suqin Zhao. Sanjiaoshan Cave, Ziyun County, Guizhou Province: 2♀♀, 25°35.35'N, 106°12.31'E, 1109m alt., October 2, 2019, collected by Xulin Zhou, Haixia Luo, Panpan Ren, Meizhen Deng and Suqin Zhao.



**Figure 5.** Holotype. *Tachycines (Gymnaeta) trapezialis* sp. nov. (male habitus) **A** lateral view **B** ventral view **C** dorsal view.



**Figure 6.** *Tachycines (Gymnaeta) trapezialis* sp. nov. (female habitus) **A** lateral view **B** ventral view **C** dorsal view.

**Description. Male.** Body medium-sized (Fig 5). Vertex divided into two conical tubercles (Fig. 1A, B). Ommateum normal, not reduced; ocelli visible. Legs elongate and slender; fore femur about 1.6–1.8 times longer than the pronotum, ventrally un-



**Figure 7.** The entrance of Diaosiyan Cave (photographed by Yi Du from Luga village, Ziyun County, Guizhou).

armed, internal genicular lobe with a small spine; external genicular lobe with one elongate movable spur; ventral side of fore tibiae with two external spurs and two internal spurs. Mid femur ventrally unarmed, internal, and external genicular lobes with one elongate movable spur respectively; ventral side of mid tibiae with one external spur and one internal spur. Hind femur without spines ventrally; hind tibiae with 55–60 outer spines and 54–58 inner spines, arranged in groups. Supra-internal spurs of hind tibiae not exceeding ventral apex of hind tarsus (Fig. 1C). Hind tarsus keeled ventrally and with one dorsal apical spine. Male genitalia with trapezoidal epiphallus, lateral sclerites and median process divided at apical fourth (Figs 2A, B, 3A, B).

**Female.** Other characters are similar to male (Fig. 6). Subgenital plate wider than long and with three lobes; median lobe large and nearly trapezoid with apex transverse, paired lateral lobes small and nearly triangular with blunt apex (Fig. 1D). Ovipositor (Fig. 1E) shorter than half the length of hind femur.



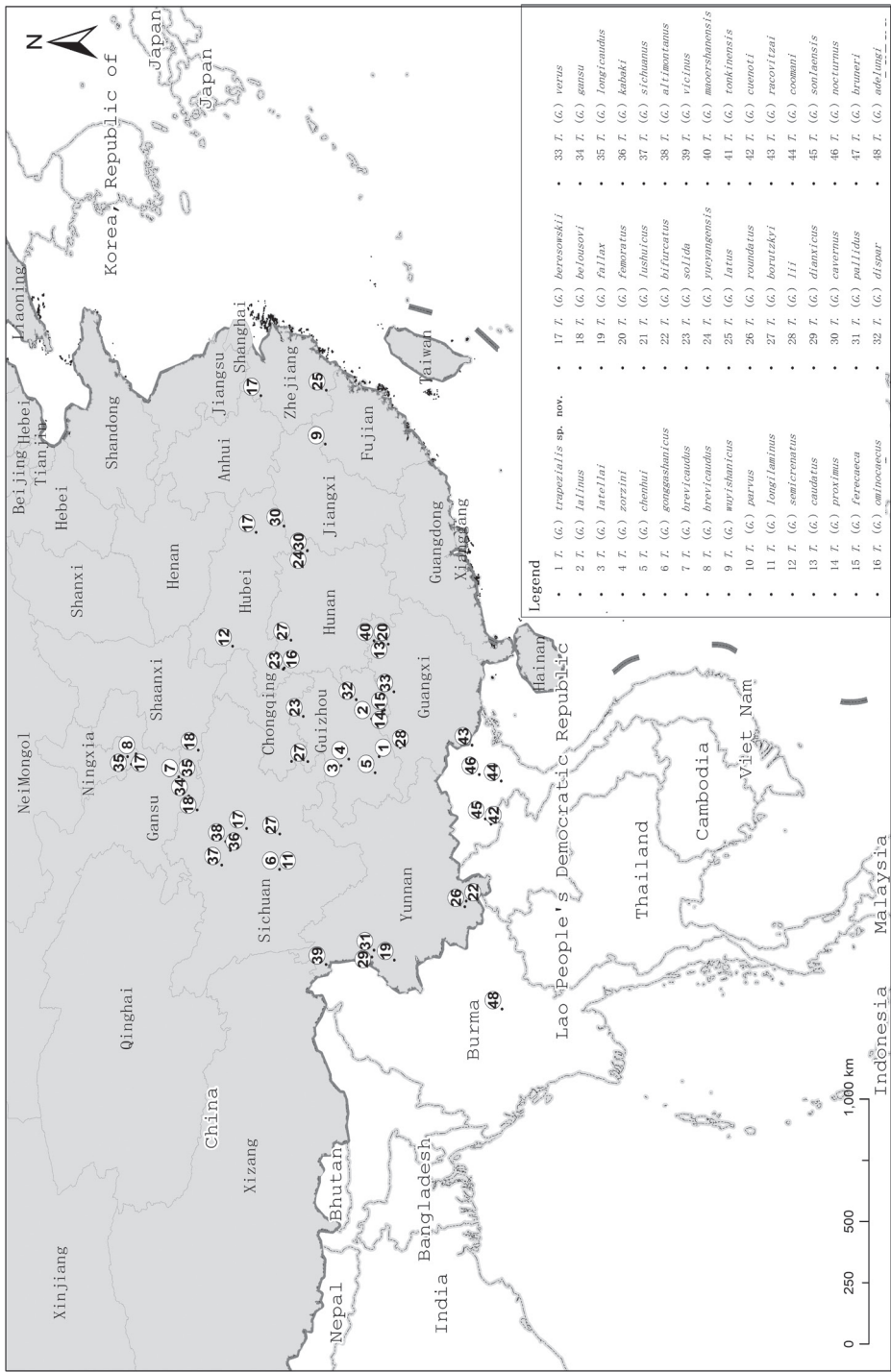


Figure 8. Distribution map for species of *Tachycines*, subgenus *Gymnaeta*.

**Coloration.** Body brown. Frons with two dark longitudinal bands (Fig. 1A). Pronotum and mesonotum margins dark brown. Apexes of abdominal tergites dark brown. Hind femur with darkish stripes laterally.

**Measurements (mm).** Body ♂16.2–17.6, ♀14.8–17.9; pronotum ♂6.3–6.6, ♀6.1–6.4; fore femur ♂10.8–11.3, ♀10.3–11.3; hind femur ♂16.3–17.6, ♀21.1–22.4; ovipositor 8.1–9.2.

**Etymology.** The name refers to trapezoidal epiphallus in males.

**Habitat.** Individuals of the new species live in groups in subtropical karst caves (Figs 4, 7).

**Distribution.** Guizhou, China.

## Discussion

Species distribution of the subgenus (Fig. 8) presents a complexity which may reflect the degree of troglomorphy and parapatry distribution. Many species of this subgenus were found both inside and outside of cave. Eyes of these species vary from fully developed to reduced or absent, as in the totally blind *T. (G.) omninoecaecus*. The geographical distribution pattern might be explained by the evolutionary scenario of zones of secondary admixture following epigeal dispersal among lineages diverged from allopatry, as proposed by Ketmaier et al. (2013).

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# New and little-known species of the genus *Sphecodes* Latreille (Hymenoptera, Halictidae) from Southeast Asia

Yulia V. Astafurova<sup>1</sup>, Maxim Yu. Proshchalykin<sup>2</sup>, Maximilian Schwarz<sup>3</sup>

**1** Zoological Institute, Russian Academy of Sciences, Universitetskaya Nab., 1, Saint Petersburg 199034, Russia

**2** Federal Scientific Centre for East Asian Terrestrial Biodiversity, Far Eastern Branch of Russian Academy of Sciences, Vladivostok 690022, Russia **3** A-4052, Anselden, Austria

Corresponding author: Maxim Yu. Proshchalykin ([proshchalikin@biosoil.ru](mailto:proshchalikin@biosoil.ru))

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## Abstract

The available information about the cleptoparasitic bees of the genus *Sphecodes* in Southeast Asia is summarized. Thirty-one species are currently known from this area. Four new species are described: *Sphecodes discoverlifei* Astafurova & Proshchalykin, **sp. nov.** (Laos), *S. engeli* Astafurova & Proshchalykin, **sp. nov.** (Laos, Vietnam), *S. ilyadadaria* Astafurova, **sp. nov.** (Indonesia), and *S. pseudoredivivus* Astafurova & Proshchalykin, **sp. nov.** (Laos). Nine species are newly recorded from South East Asia: *S. chaprensis* Blüthgen, 1927 (Laos), *S. howardi* Cockerell, 1922 (Malaysia, Myanmar, Thailand), *S. kershawi* Perkins, 1921 (Indonesia, Malaysia, Myanmar, Thailand), *S. laticeps* Meyer, 1920 (Thailand, Vietnam), *S. montanus* Smith, 1879 (Laos), *S. sauteri* Meyer, 1925 (Laos), *S. sikkimensis* Blüthgen, 1927 (Laos, Myanmar), *S. simlaensis* Blüthgen, 1924 (Laos), and *S. turneri* Cockerell, 1916 (Laos). Based on type specimens, new synonymies have been proposed for *Sphecodes kershawi* Perkins, 1921 = *S. javanensis* Blüthgen, 1927, **syn. nov.**; *S. simlaensis* Blüthgen, 1924 = *S. simlaellus* Blüthgen, 1927, **syn. nov.**; *S. laticeps* Meyer, 1920 = *S. biroi mariae* Cockerell, 1930, **syn. nov.** Lectotypes are designated for *Sphecodes biroi* Friese, 1909, *S. simlaellus* Blüthgen, 1927, and *S. laticeps* Meyer, 1920. The female of *Sphecodes sauteri* Meyer, 1925, and the male of *S. turneri* Cockerell, 1916 are described for the first time.

## Keywords

Anthophila, Apiformes, cleptoparasites, fauna, lectotype, taxonomy, distribution

## Introduction

In recent years significant progress has been made towards a better knowledge of the species of *Sphecodes* Latreille from central and northern Asia (Astafurova and Proshchalykin 2014, 2015a, b, c, 2017a, b, 2018; Astafurova et al. 2015, 2018a, b, c, d, 2019). The purpose of this review is to improve our knowledge of the taxonomy and distribution of *Sphecodes* in Southeast Asia (Fig. 1) as an essential foundation for advancing biogeographical investigations in the Oriental Region.

Southeast Asia is composed of eleven countries of impressive diversity in habitats and landscapes: Brunei, Myanmar (Burma), Cambodia, East Timor, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam (Fig. 1). This region has one of the highest concentrations of endemic species on Earth (Myers et al. 2000; Sloan et al. 2014; Sing et al. 2016) but knowledge of its bee fauna other than the relatively well-studied highly eusocial hive bees (Apini and Meliponini) remains very limited and inaccessible (Ascher et al. 2016). Currently 975 Southeast Asian species of Halictidae from fifteen genera are recognized as valid (Ascher and Pickering 2019), but the taxonomy and distribution of these species requires much additional study. We begin here with reference to the genus *Sphecodes* Latreille.

The first information on the genus *Sphecodes* from Southeast Asia was published by Bingham (1897), who record *S. apicatus* Smith [= *S. gibbus* (Linnaeus)] from the Pegu Hills, Burma (= Myanmar). But it is obvious that this is a misidentification and the record actually refers to another large *Sphecodes* species. *Sphecodes brunneipes* Friese, 1914 was the first species of the genus *Sphecodes* described from Southeast Asia (Indonesia) and since then eleven additional species have been described from this area by Cockerell 1915, 1919, 1930 (four species), Blüthgen 1924, 1927 (four species), and Meyer 1925 (three species), with only seven of them still valid (current data). Until now there has been no review published on Southeast Asian *Sphecodes* and all information on the distribution of the 17 known species was only available on the Discover Life website (Ascher and Pickering 2019).

In the present paper, based on a comprehensive study of specimens (including primary types) held in various collections, we report additional records of 21 species, with four species described as new and nine species recorded from Southeast Asia for the first time, resulting in a total number of 31 *Sphecodes* species known from this region (Table 1). The genus *Sphecodes* has not yet been documented from Brunei, Cambodia, and East Timor although it is probable that this cosmopolitan genus is present in these countries and it is only a matter of time before the fauna is sampled and recorded.

In addition, we describe the female of *Sphecodes sauteri* Meyer, 1925, and the male of *S. turneri* Cockerell, 1916 for the first time, propose new synonymies for three specific names (*S. kershawi* Perkins, 1921 = *S. javanensis* Blüthgen, 1927, syn. nov.; *S. laticeps* Meyer, 1920 = *S. biroi mariae* Cockerell, 1930, syn. nov.; *S. simlaensis* Blüthgen, 1924 = *S. simlaellus* Blüthgen, 1927, syn. nov.), and designate lectotypes for *Sphecodes biroi* Friese, 1909, *S. laticeps* Meyer, 1920, and *S. simlaellus* Blüthgen, 1927 in order to clarify the status and diagnosis of type specimens.



**Figure 1.** Map of Southeast Asia.

## Materials and methods

The results presented in this paper are based on 77 specimens collected in Southeast Asia and currently housed in the Natural History Museum (London, UK, **NHMUK**); National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (**USNM**), the Zoological Institute, Russian Academy of Sciences (St. Petersburg, Russia, **ZISP**); Museum für Naturkunde der Humboldt Universität zu Berlin, Germany (**ZMHB**), Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany (**SDEI**), Zoologische Staatssammlung, München, Germany (**ZSM**), Hungarian Natural History Museum, Budapest, Hungary (**HNHM**), Oberösterreichisches Landesmuseum, Biologiezentrum, Linz, Austria (**OLBL**) and the personal collection of Maximilian Schwarz (Ansfelden, Austria, **PCMS**).

Morphological terminology follows that of Engel (2001) and Michener (2007). The ventral surface of some flagellomeres bear a distinctive patch of sensilla trichodea A (sensu Årgent and Svensson 1982), which we refer to as ‘tyloids’, easily observable under the microscope. Abbreviations F, T, and S are used for flagellomere, metasomal

**Table 1.** Checklist of the *Sphecodes* species of Southeast Asia including distribution by countries.

Species	Southeast Asia							
	Indonesia	Laos	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
No. collecting sites	7	4	8	3	3	–	3	4
No. bees examined	11	16	11	3	6	–	22	8
1 <i>S. bakeri</i> Cockerell	●				○●			
2 <i>S. binghami</i> Blüthgen			●	○				
3 <i>S. biroi</i> Friese	○●		●		○		●	
4 <i>S. bischoffi</i> Blüthgen	○			○				
5 <i>S. brunneipes</i> Friese	○●							
6 <i>S. chaprensis</i> Blüthgen		●						
7 <i>S. discoverlifei</i> Astafurova & Proshchalykin, sp. nov.		●						
8 <i>S. distinctus</i> Meyer							●	○
9 <i>S. duplex</i> Blüthgen	○●		●			○		
10 <i>S. engeli</i> Astafurova & Proshchalykin, sp. nov.		●						●
11 <i>S. fumipennis</i> Smith		●		○				
12 <i>S. howardi</i> Cockerell			●	●			●	
13 <i>S. ihyadadaria</i> Astafurova, sp. nov.	●							
14 <i>S. insularis</i> Smith	○							
15 <i>S. javanicus</i> Friese	○							
16 <i>S. kershawi</i> Perkins	○●		●	●			●	
17 <i>S. laticeps</i> Meyer							○	●
18 <i>S. luzonicus</i> Blüthgen					○			
19 <i>S. malayensis</i> Blüthgen			○					
20 <i>S. montanus</i> Smith		●						
21 <i>S. pseudoredivivus</i> Astafurova & Proshchalykin, sp. nov.		●						
22 <i>S. redivivus</i> Blüthgen	○							
23 <i>S. rotundiceps</i> Cockerell					○			
24 <i>S. samarensis</i> Blüthgen	●		●		○			
25 <i>S. sauteri</i> Meyer		●						
26 <i>S. sibuyanensis</i> Cockerell					○			
27 <i>S. sikkimensis</i> Blüthgen		●		●				
28 <i>S. simlaensis</i> Blüthgen		●						
29 <i>S. tertius</i> Blüthgen				○				
30 <i>S. tristellus</i> Cockerell					○			
31 <i>S. turneri</i> Cockerell		●						
<b>Total:</b>	11	10	7	7	7	1	5	3

Circle – published records (Cockerell 1919, 1925, 1930, Meyer 1920, 1925, Blüthgen 1924, 1927, Ascher and Pickering 2019); black circle – current data. Genus *Sphecodes* are not known in Brunei, Cambodia, and East Timor.

tergum and metasomal sternum respectively. The density of integumental punctures is described using the following formula: puncture diameter (in  $\mu\text{m}$ ) / ratio of distance between punctures to average puncture diameter, e.g., 15–20  $\mu\text{m}$  / 0.5–1.5. Integumental sculpture other than distinctive surface punctation is described following Harris (1979): areolate – coarse, contiguous punctures; reticulate – superficially net-like or network of raised lines; rugose – irregular, nonparallel, wrinkled raised lines (rugae); rugulose – minutely rugose; strigate – narrow, transverse or longitudinal streaks (strigae), variety of parallel lineations; tessellate – regular network of shallow grooves with flat interspaces.

Specimens were studied with a Leica M205A stereomicroscope and photographs taken with a combination of stereomicroscope (Olympus SZX10) and digital camera (Olympus OM-D and Canon EOS70D). Final images are stacked composites using Helicon Focus 6. All images were post-processed for contrast and brightness using Adobe Photoshop.

New distributional records are noted with an asterisk (\*).

## Taxonomy

### List of species

#### *Sphecodes bakeri* Cockerell, 1915

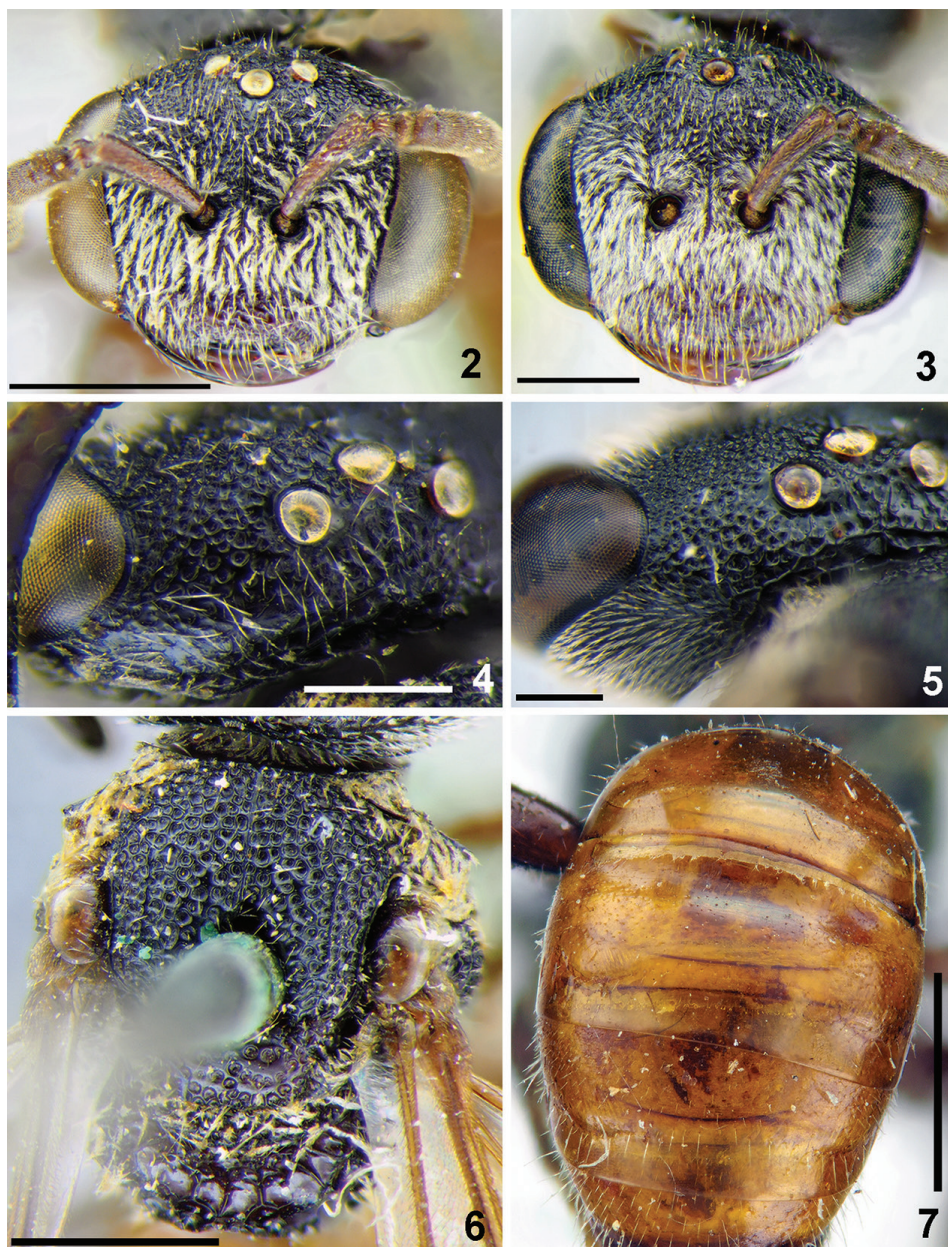
Figures 3, 5

*Sphecodes bakeri* Cockerell, 1915: 489, ♀ (holotype: ♀, Philippines, Dapitan, Mindanao, Baker leg.; USNM, <http://n2t.net/ark:/65665/34c597e0b-f31f-4bd8-82fb-e3e6a1379222>).

**Diagnosis.** Structurally and sculpturally this species is very similar to the male of *Sphecodes samarensis* Blüthgen, 1927 and the female of *S. duplex* Blüthgen, 1927, but from the first species it differs by weakly developed antennal tyloids (versus tyloids covering large part of ventral flagellar surface in *S. samarensis*) and from the second species by the ocello-ocular area (Fig. 5) having entirely confluent punctures (versus the ocello-ocular area with narrow shiny interspaces in *S. duplex*, Fig. 4).

**Descriptive notes.** Wings with weak yellow-brownish darkening; hind wing with angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with eight hamuli. Lateral preoccipital carina present. **Female.** Total body length 6–8 mm. Head strongly transverse in front view, ca. 1.3 times as wide as long (Fig. 3); vertex weakly elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; labrum trapezoidal, 0.6 times as long as basal width; face and ocello-ocular area with confluent punctures; paraocular and supraclypeal areas with adpressed white pubescence obscuring integument, gena with sparser pubescence. Mesoscutum and mesoscutellum areolate-punctate (30–50 µm); propodeal triangle (metapostnotum) and lateral parts of propodeum with longitudinal wrinkles and smooth shiny interspaces between them; mesepisternum reticulate-rugose. Metasomal terga almost impunctate, sometimes with a few fine punctures, red; pygidial plate widely rounded apically, 1.2–1.4 times as wide as metabasitarsus. **Male.** Total body length 5.5–6.5 mm. Head transverse, ca. 1.15 times as wide as long; vertex weakly elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; tyloids weakly developed, narrowly linear as seen in lateral view; F2 1.6 times as long as wide; F3 = F4, 1.2–1.3 times as long as wide; face (below and





**Figures 2–7.** *Sphecodes duplex* Blüthgen (2, 4, 6, 7), *S. bakeri* Cockerell (3, 5), females **2, 3** head, frontal view **4, 5** vertex, dorso-lateral view **6** mesosoma, dorsal view **7** T1–T3, dorsal view. Scale bars: 1.0 mm (**2, 3, 6, 7**), 0.5 mm (**4, 5**).

above the antennal sockets) with adpressed white pubescence obscuring integument. Mesoscutum and mesoscutellum areolate-punctate; propodeum and mesepisternum as in the female. Metasomal terga finely punctate (15–20  $\mu\text{m}$  / 1–3); marginal zones

impunctate; T1–T3 red; gonocoxite dorsally without impression; gonostylus short, apically broadened.

**Material examined.** INDONESIA: 1 ♀, NE Sulawesi, 47 km WSW Kotamobagu, Dumoga-Bone N. Pk., Toraut, 211 m, VII.1985, G.R. Else (NHMUK 013380350); PHILIPPINES: 1 ♂, Dapitan, Mindano, Baker leg. [*Sphec. bakeri* Ckll., Blüthgen det.] (ZMHB); 1 ♀, Kolambugan, Mindanao, Baker leg. [*Sphec. bakeri* Ckll., Blüthgen det.] (ZMHB).

**Published records.** Cockerell 1915: 489 (Philippines); Blüthgen 1927: 74 (Philippines); Ascher and Pickering 2019 (Philippines).

**Distribution.** \*Indonesia, Philippines.

### *Sphecodes binghami* Blüthgen, 1924

Figures 8–11

*Sphecodes binghami* Blüthgen, 1924: 497, ♀ (holotype: ♀, Myanmar, Pegu Hill, 3.89, coll. Bingham; NHMUK 010576231; examined).

**Diagnosis.** The female of this species resembles *Sphecodes takaensis* Blüthgen, 1927 owing to a similar structure, sculpture and coloration of the body, but it differs from this species by the square F3 (as long as wide), the entirely areolate vertex and the wider pygidial plate which is as wide as metabasitarsus (in *S. takaensis* F3 0.7–0.8 times as long as wide; vertex with small shiny impunctate spots near ocelli; pygidial plate narrower than metabasitarsus).

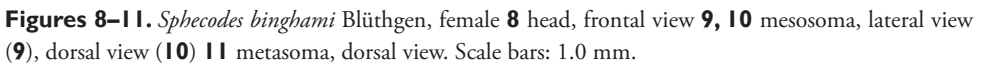
**Descriptive notes.** Wings with brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 80°, costal margin with eight or nine hamuli. Lateral preoccipital carina present. **Female.** Total body length 8–9 mm. Head (Fig. 8) transverse, ca. 1.25 times as wide as long; vertex weakly elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; labrum trapezoidal, 0.45 times as long as basal width; face and vertex areolate-punctate; paraocular (below and above the antennal sockets), supraclypeal areas and gena with adpressed white pubescence obscuring integument. Mesoscutum and mesoscutellum (Fig. 10) densely punctate (40–75 µm), medially with punctures separated by at most 1–2 puncture diameters, becoming confluent peripherally; propodeal triangle (metapostnotum) and mesepisternum (Fig. 9) reticulate-rugose. Metasoma red (Fig. 11); T1 on disc and marginal zone finely and densely punctate (10–15 µm / 0.5–3), remaining terga more coarsely punctate (10–25 µm) with impunctate and smooth marginal zones; pygidial plate dull, widely rounded apically, as wide as metabasitarsus. **Male** unknown.

**Material examined.** MALAYSIA: 1 ♀, Malaya, S. Batu Feringgi, Panang, 4.VIII.1955, H.T. Pagden (NHMUK 013380344).

**Published records.** Blüthgen 1924: 497 (Myanmar).

**Distribution.** \*Malaysia, Myanmar.





## Figures 12–21

*Sphecodes biroi* Friese, 1909 (nec Meyer, 1925): 181, ♀, ♂ (lectotype (**designed here**): ♂, N. Guinea, Biro 1899 // Sattelberg, Huon-Golf. // *Sphecodes biroi* Fiese det., 1908, ♂ // Type // Lectotypus, *Sphecodes biroi* Friese, 1909, design. Asta-

furova et Proshchalykin, 2020 <red label>), Fig. 16; Paralectotype: ♀, the same label (Fig. 16); HNHM, examined.

*Sphecodes transversus* Cockerell, 1919: 556, ♀ (holotype: ♀, Philippines, Luzon, Mt Makiling, Baker leg.; USNM, <http://n2t.net/ark:/65665/372106fa4-0a44-4b85-812d-254423957856>). Synonymized by Blüthgen 1927: 79.

*Sphecodes latifrons* Cockerell, 1919: 556, ♂ (holotype: ♂, Philippines, Luzon, Baguio, Benguet, Baker leg.; USNM, <http://n2t.net/ark:/65665/3ed6e3af8-0ca2-4dac-a230-436c053d6475>). Synonymized by Blüthgen 1927: 79.

*Sphecodes abnormis* Perkins, 1921: 10–11, ♂ (holotype: ♂, “East Indies”; ?). Synonymized by Blüthgen 1927: 79.

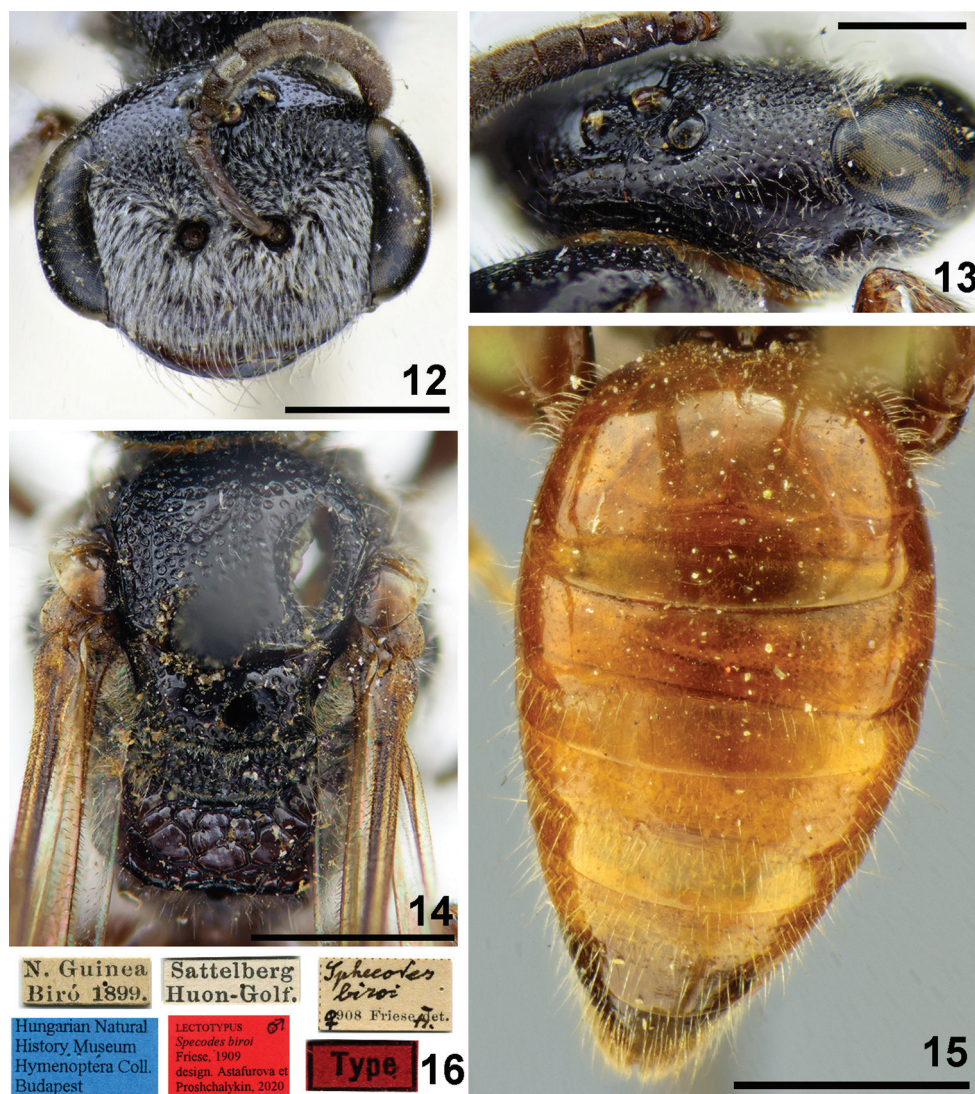
*Sphecodes amboinensis* Meyer, 1925: 11, ♂ (syntypes: 4 ♂♂, Indonesia, Amboina, 1998, Biro leg.; HNHM). Synonymized by Blüthgen 1927: 79.

*Sphecodes bischoffi* Meyer, 1925 (nom. praeocc., nec *S. bischoffi* Blüthgen, 1924): 11, ♂ (holotype: ♂, Indonesia, Java, Buitenzorg; ZMHB). Synonymized by Blüthgen 1927: 79.

**Diagnosis.** This species resembles *Sphecodes laticeps* Meyer, 1920 in having a similar structure, sculpture and coloration of the body, including the shape of the male genitalia. However, the male differs in the size of tyloids which usually cover the entire ventral flagellar surface or sometimes with a small glabrous spot on basal flagellomeres (versus antennae with well-developed medial glabrous spot on ventral surface of flagellomeres in *S. laticeps*); females are challenging to distinguish, but *S. laticeps* has T2 usually more distinctly punctate.

**Descriptive notes.** Wings with weak yellow-brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 80°, costal margin with seven hamuli. Lateral preoccipital carina present. **Female.** Total body length 6.5–7.5 mm. Head (Fig. 12) strongly transverse, ca. 1.3 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus 1–1.5 times lateral ocellar diameter as seen in frontal view; labrum trapezoidal, 0.6 times as long as basal width; vertex (Fig. 13) with shiny interspaces between shallow punctures (approximately a puncture diameter); paraocular (below the antennal sockets) and supraclipeal areas with adpressed white pubescence obscuring integument, clypeus and gena with sparser pubescence. Mesoscutum and mesoscutellum (Fig. 14) mostly with confluent punctures (30–40 µm) and medially with a few shiny interspaces at most 1–2 puncture diameters; propodeal triangle (metapostnotum) roughly reticulate-rugose (sculpture forming 1–2 rows of large deep cells); mesepisternum reticulate-rugose. Metasomal T1 impunctate or with a few tiny punctures (Fig. 15), T2 medially impunctate or with tiny and sparse punctures, but coarser and denser on lateral parts (10–15 µm / 2–4); marginal zones impunctate; pygidial plate as wide as metabasitarsus; T1 and T2 red, T3 and T4 red or dark. **Male.** Total body length 6–7 mm. Head transverse (Fig. 18), ca. 1.2 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus 1–1.5 times lateral ocellar diameter as seen in frontal view; antennae attain posterior margin of mesoscutum, F2 1.4–1.5 times as long as wide; tyloids well developed, covering entire ventral and lateral fla-

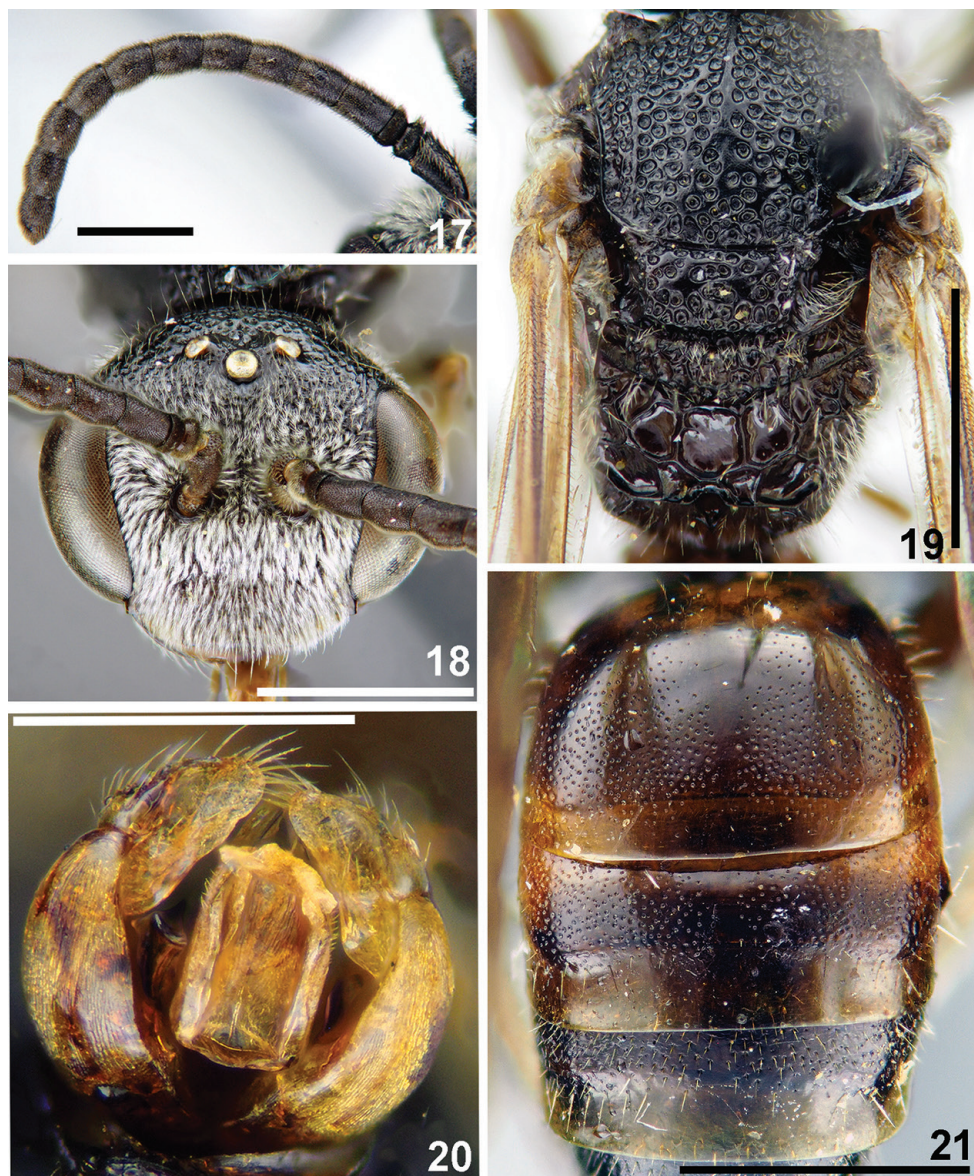




**Figures 12–16.** *Sphecoides biroi* Friese, female, paralectotype **12** head, frontal view **13** vertex, dorso-lateral view **14** mesosoma, dorsal view **15** metasoma, dorsal view **16** labels. Scale bars: 1.0 mm (**12**, **14**, **15**), 0.5 mm (**13**).

gellar surfaces (Fig. 17). Mesoscutum and mesoscutellum (Fig. 19) mostly areolate with a few shiny interspaces at most a puncture diameter; propodeal triangle roughly reticulate-rugose (sculpture forming one or two rows of large deep cells); lateral parts of propodeum rugose with large smooth shiny interspaces. Metasomal terga (Fig. 21) with fine and relatively dense punctures (10–15  $\mu\text{m}$  / 1–3), punctures more visible in specimens with darker terga; T1–T3 red or brownish; gonocoxite dorsally without impression; gonostylus as on Fig. 20.





**Figures 17–21.** *Sphecodes biroi* Friese, male **17** antennae, lateral view **18** head, frontal view **19** mesosoma, dorsal view **20** genitalia, dorsal view **21** T1–T3, dorsal view. Scale bars: 1.0 mm (**17–19, 21**), 0.5 mm (**20**).

**Material examined.** MALAYSIA: 1 ♂, Malaya, Kuala Lumpur, 17.XI.1929, H.T. Pagden (NHMUK 013380438); 1 ♀, idem, Batu Road, 19.VII.1936, H.T. Pagden (NHMUK 013380348); 1 ♂, Perak Gerik env., 26–28.II.2000, K. Denes jun. (OLBL/PCMS); 3 ♂♂, Perak Bukit Larut, 23–25.II.2000, K. Denes jun. (OLBL/PCMS); INDONESIA: 1 ♀, NE Sulawesi, 47 km WSW Kotamobagu, Dumoga-Bone N. Pk., Toraut, 211 m, VII.1985, G.R. Else (NHMUK 013380352); 1 ♂, North Sumatra,

Brastagi, 76 km S Medan, 3.III–1.IV.1996, S. Becvar (OLBL/PCMS); THAILAND: 2 ♀♀, 2 ♂♂, Nan, MaeCharim NPEingang, 18°36'N, 100°58'E, 206 m, 13–22.V.2012, E. & J. Holzschuh (OLBL/PCMS); 1 ♂, Phuket Island, Main Harn, 1–5.II.2018, J. Halada (OLBL/PCMS); 1 ♂, Chumphon prov., 27.III–14.IV.1996, 9°48'N, 98°47'E, P. Prudek (OLBL/PCMS); SRI LANKA: ♂, Sri Lanka, Gal. Dist., Kanneliya Section, Sinharaja, 2–5.X.1980, K. Krombein et al. leg. (USNM) (S. Sakagami det as. "*Sphecodes lankensis*" – unpublished manuscript name).

**Published records.** Cockerell 1919: 556 (Philippines, as *S. transversus* and *S. latifrons*); Meyer 1920: 230 (Philippines, as *S. insularis*); 1925: 11 (Indonesia, as *S. bischoffi*); Perkins, 1921: 10 (East India, as *S. abnormis*); Ascher and Pickering 2019 (Indonesia, Philippines).

**Distribution.** Indonesia, \*Malaysia, Philippines, \*Thailand, India, Sri Lanka, New Guinea.

**Remarks.** Records of this species in Thailand (Ascher and Pickering 2019) refer to *Sphecodes biroi mariae* Cockerell, 1930 = *S. laticeps* Meyer, 1920 (see below).

### *Sphecodes brunneipes* Friese, 1914

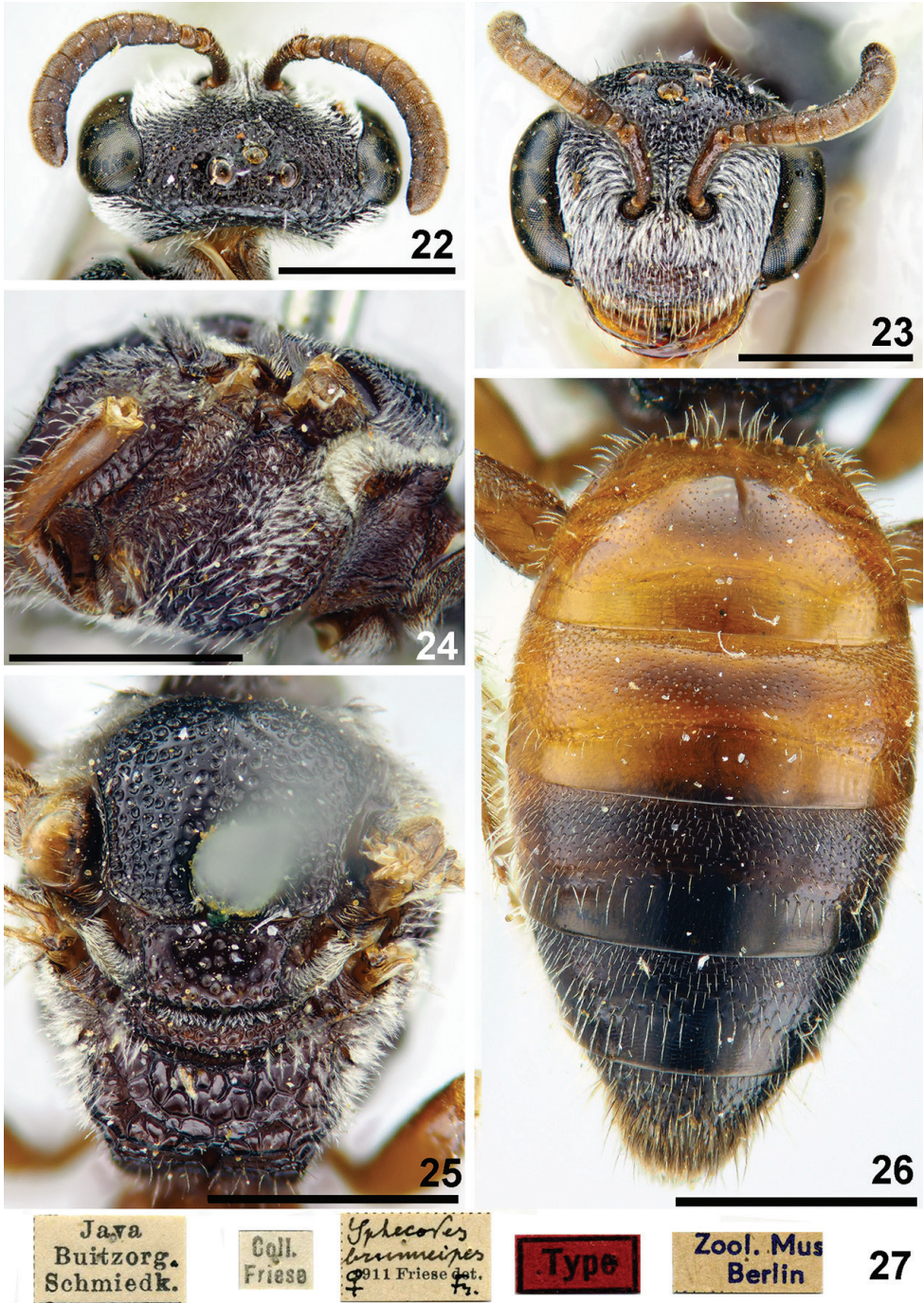
Figures 22–27

*Sphecodes brunneipes* Friese, 1914: 14, ♀ (holotype: ♀, Indonesia, Java, Buitzotg. Schmiedek. leg., Coll. Friese; ZMHB; examined, Fig. 27).

**Diagnosis.** Unlike other species with simple mandibles in the female, this species has a preoccipital carina and a weakly curved basal vein in hind wing.

**Descriptive notes.** Wings with brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with seven hamuli. Lateral and dorsal preoccipital carina present. **Female.** Total body length 6–7 mm. Head (Fig. 23) strongly transverse, ca. 1.25 times as wide as long; vertex weakly elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; F1 and F2 strongly transverse, 0.5 times as long as wide; F3 0.8 times as long as wide; face with confluent punctures, ocello-ocular area with dense punctures separated by at most a puncture diameter (Fig. 22); paraocular and supraclypeal areas with adpressed white pubescence obscuring integument. Gena with dense pubescence. Mesoscutum and mesoscutellum (Fig. 25) coarsely and densely punctate (25–50 µm), the punctures separated by at most two puncture diameters; mesepisternum reticulate-rugose (Fig. 24); propodeal triangle (metapostnotum) coarsely reticulate-rugose, lateral parts of propodeum with fine wrinkles (strigose). Metasomal terga definitely punctate (Fig. 26), finely on T1 (ca. 10 µm) and more coarsely on the remaining terga (10–25 µm); marginal zones impunctate; T1 and T2 red, coloration of T3 and T4 variable; pygidial plate dull, widely rounded apically, 1.4 times as wide as metabasitarsus. **Male** unknown.





**Figures 22–27.** *Sphecodes brunneipes* Friese, female, holotype **22, 23** head, dorsal view (**22**), frontal view (**23**) **24, 25** mesosoma, lateral view (**24**), dorsal view (**25**) **26** metasoma, dorsal view **27** labels. Scale bars: 1.0 mm.



**Published records.** Friese 1914: 14 (Indonesia); Ascher and Pickering 2019 (Indonesia).

**Material examined.** INDONESIA: 2 ♀♀, Lombok, near Senggigi, 18.V.2012, M. Mokrousov (ZISP).

**Distribution.** Indonesia.

### *Sphecodes chaprensis* Blüthgen, 1927

Figures 28–33

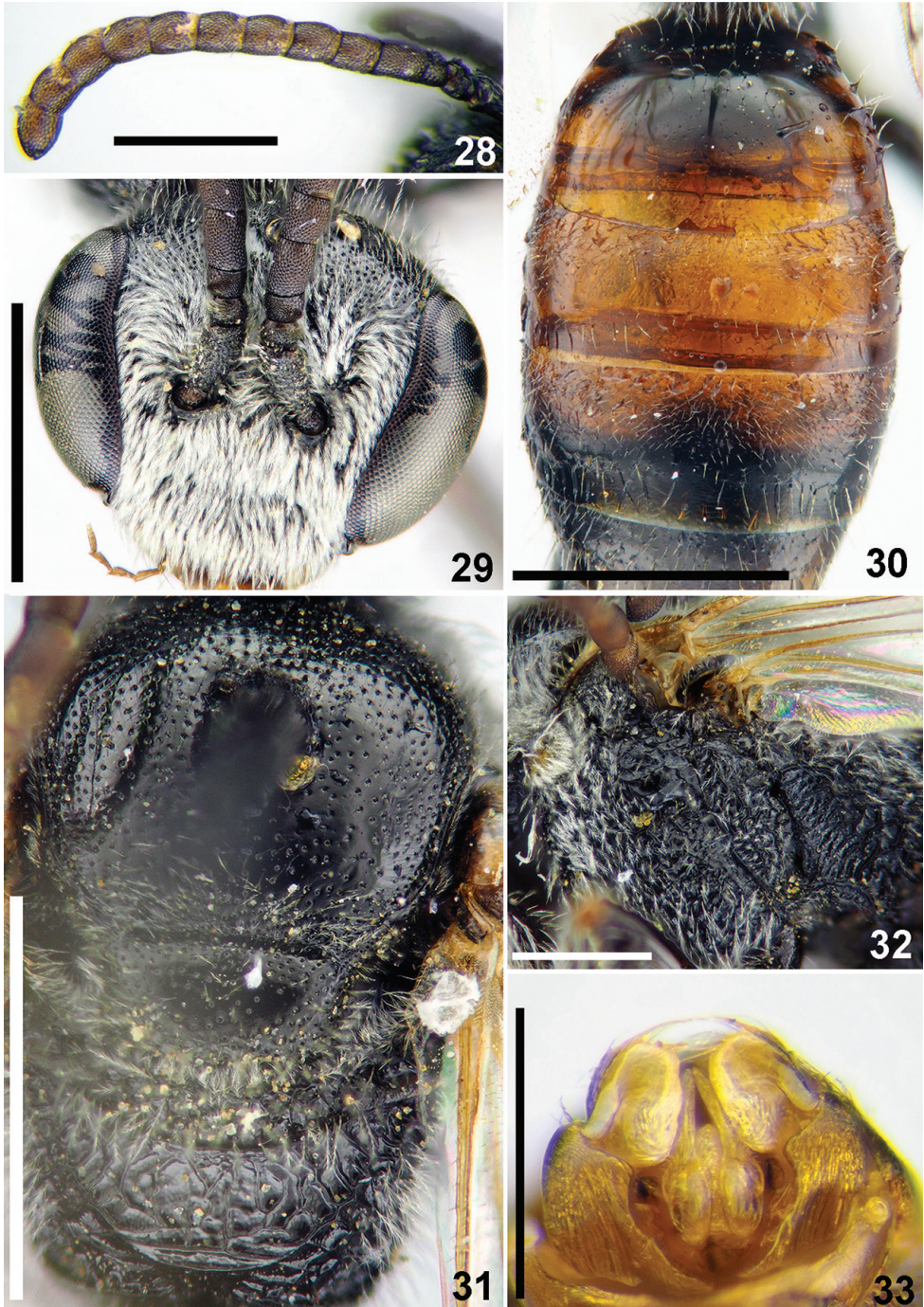
*Sphecodes chaprensis* Blüthgen, 1927: 96–98, Fig. 30, ♂ (holotype: ♂, India, Chapra, Bengal, Mackenzie, B.M. TYPE HYM. 17a564; NHMUK 013380323; examined).

**Diagnosis.** This species resembles *Sphecodes shillongensis* Blüthgen, 1927 and *S. simlaensis* Blüthgen, 1924, sharing a similar structure and sculpture of the body, including weakly developed antennal tyloids, a densely punctate mesoscutum and scarcely punctate metasomal terga. The species differs from *S. simlaensis* in having dense facial pubescence obscuring integument above the antennal sockets; from *S. shillongensis* it differs by shorter antennae with flagellomeres (from F3 onward) ca. 1.1–1.2 times as long as wide (versus 1.3) and shape of the gonostylus with a large membranous part.

**Descriptive notes.** Wings hyaline; hind wing with angle between basal (M) and cubital (Cu) veins almost 90°, costal margin with six or seven hamuli. Preoccipital carina absent. **Male.** Total body length 4.5–5.5 mm. Head transverse, ca. 1.15 times as wide as long (Fig. 29); vertex not elevated as seen in frontal view; antennae (Fig. 28) short, attaining posterior margin of mesoscutum, F1 0.7 times as long as wide, F2 1.3–1.4 times as long as wide, remaining flagellomeres ca. 1.1–1.2 as long as wide; tyloids weakly developed, at most semicircular across basal 1/4 of ventral surfaces of last flagellomeres (Fig. 28); ocello-ocular area with minute punctures separated by at most a puncture diameter; face above and below the antennal sockets with adpressed white pubescence obscuring integument. Gena with sparser pubescence. Mesoscutum and mesoscutellum (Fig. 31) finely punctate, sparser medially (15–20 µm / 0.5–3), becoming denser peripherally; mesepisternum and hypoepimeral area rugose (Fig. 32); propodeal triangle (metapostnotum) shining, with coarse longitudinal-winding wrinkles; remaining surfaces of propodeum rugose to reticulate-rugose. Metasomal terga scarcely punctate (Fig. 30); T1 almost impunctate, with a few minute punctures; remaining terga basally with tiny setae pores; marginal zones impunctate; T1 (apically) and T2 red, coloration of T3 variable; gonocoxite dorsally with impression; gonostylus as on Fig. 33. **Female** unknown.

**Material examined.** LAOS: 1 ♂, Phongsaly prov., 21°44'N, 102°12'E, Ban Natsa, 9–17.V.2004, 550 m, P. Pacholatko (OLBL/PCMS).

**Distribution.** \*Laos, India (Bihar).



**Figures 28–33.** *Sphecodes chaprensis* Blüthgen, male **28** antennae, lateral view **29** head, frontal view **30** T1–T3, dorsal view **31** mesosoma, dorsal view **32** mesepisternum and hypoepimeral area, lateral view **33** genitalia, dorsal view. Scale bars: 1.0 mm (**29–31**), 0.5 mm (**28, 32, 33**).

***Sphecodes discoverliffei* Astafurova & Proshchalykin, sp. nov.**

<http://zoobank.org/94551AB3-C22B-4561-B1B7-B81C82C1D90A>

Figures 34–45

**Type material.** *Holotype*: ♂, Laos, Phongsaly prov., Phongsaly env., 21°41'N, 102°06'E, 1500 m, 1–30.VI.2003, P. Pacholatko (PCMS), Fig. 42. *Paratypes*: 2 ♂♂, the same label as for holotype, but VI.2003 (PCMS/ZISP); 2 ♀♀, the same label as for holotype, but 28.V–20.VI.2003, V. Kuban (PCMS/ZISP).

**Diagnosis.** Among the oriental species lacking a preoccipital carina and with five or six hamuli in hind wing the male of the new species is recognizable by having tyloids covering the entire ventral and lateral flagellar surfaces and also in the shape of the gonostylus which has an elongate membranous part; the female is similar to *Sphecodes tantalus* Nurse, 1903 by combination of the strongly transverse head, the metafemur strongly enlarged in proximal half, the mesoscutum with relatively sparse punctures, the impunctate T1, the narrow pygidial plate and the reddish metasoma, but it differs by not having an elevated vertex as seen in frontal view (in *S. tantalus* distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter).

**Description.** Wings hyaline, weak yellowish with light brown stigma and yellowish veins; hind wing with the angle between basal (M) and cubital (Cu) veins 90°, costal margin with five hamuli. Preoccipital carina absent. **Female.** Total body length 6.0–6.5 mm (Fig. 35), fore wing 4.6–4.9 mm. Head black (Fig. 43); strongly transverse, ca. 1.3 times as wide as long; vertex not elevated as seen in frontal view; distance from top of head to upper margin of a lateral ocellus ca. two lateral ocellar diameters as seen in dorsal view; F1 0.8 times as long as wide, F2 0.9 times as long as wide, remaining flagellomeres 1.0–1.1 times as long as wide; labrum trapezoidal, 0.7 times as long as basal width; face densely punctate, with punctures separated by at most a puncture diameter; ocello-ocular area and gena with tiny setae pores (5–10 µm) separated by a few puncture diameters; face and gena with sparser pubescence, not obscuring integument. Mesosoma black, legs brownish with yellowish tarsi; mesoscutum and mesoscutellum (Fig. 44) with relatively sparse punctures (15–25 µm / 1–4) becoming denser peripherally; metafemur strongly enlarged in proximal half, maximum width 0.4 times its length; hypoepimeral area and mesepisternum rugose; propodeal triangle (metapostnotum) with coarse longitudinal wrinkles and shining interspaces (Fig. 44); lateral parts of propodeum coarsely reticulate-rugose. Metasomal T1 impunctate; remaining terga with a few minute setae pores (Fig. 45); marginal zones impunctate; T1–T4 mostly red, remaining terga red-brownish; pygidial plate dull, pointed apically, narrow, 0.6 times as wide as metabasitarsus. Sterna finely tessellate with dense shallow setae pores.

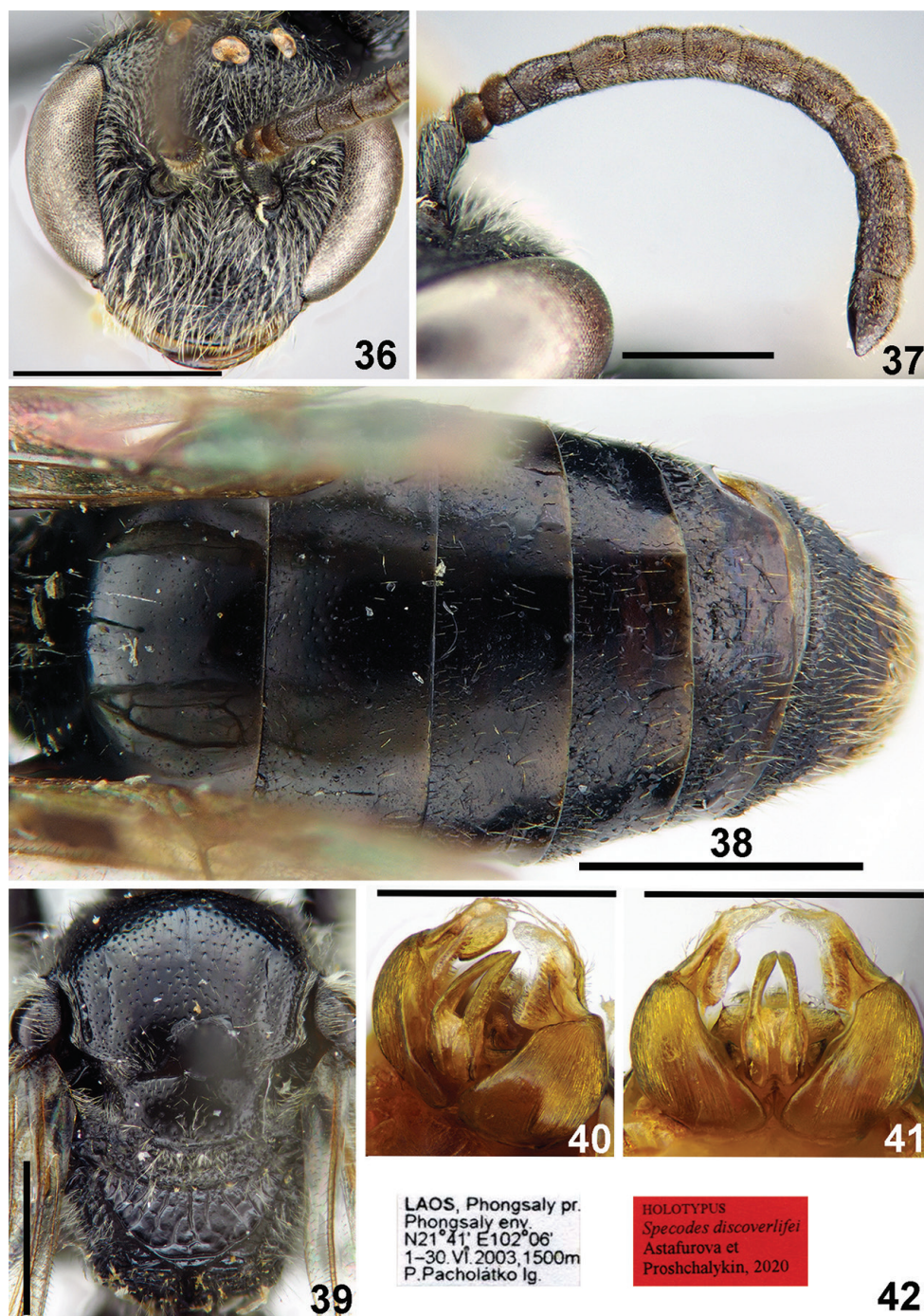
**Male.** Total body length 6–7 mm (Fig. 34), fore wing 4.5–5.0 mm. Head black (Fig. 36), transverse, ca. 1.2 times as wide as long; vertex not elevated as seen in frontal view and distance from top of head to upper margin of a lateral ocellus approximately two lateral ocellar diameters as seen in dorsal view; antenna short (Fig. 37), reaching posterior half of mesoscutum, F1 0.6 times as long as wide, F2 1.3–1.4 times as long as wide, remaining flagellomeres 1.1–1.2 times as long as wide; tyloids covering entire ventral and lateral flagellar surfaces; face densely punctate, the punctures separated by





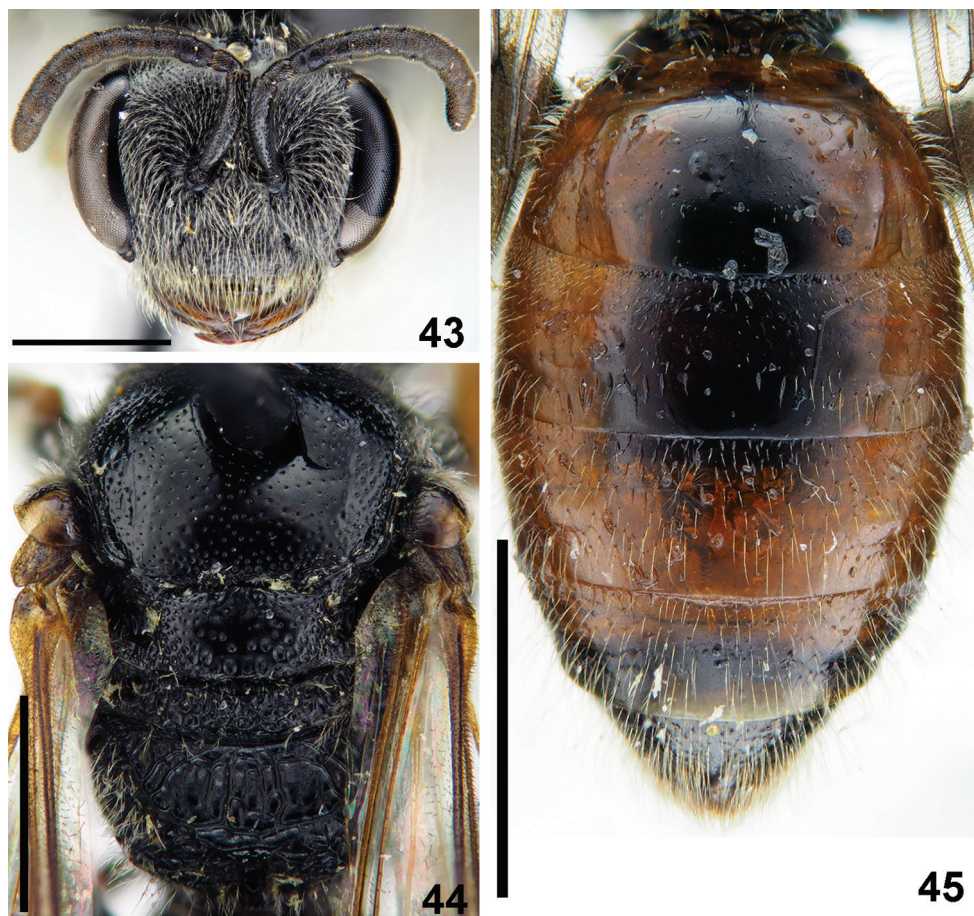
**Figures 34, 35.** *Sphecodes discoverlifei* Astafurova & Proshchalykin, sp. nov. **34** holotype, male, lateral view **35** paratype, female, lateral view. Scale bars: 1.0 mm.

at most a half puncture diameter; ocello-ocular area and gena more sparsely punctate with punctures separated by approximately a puncture diameter; face and gena with sparser pubescence, not obscuring integument. Mesosoma black, tibia (partially) and tarsi yellow; mesoscutum (Fig. 39) irregularly punctate, with confluent punctures peripherally and sparser medially (15–25  $\mu\text{m}$  / 1–4); mesoscutellum coarsely punctate (20–40  $\mu\text{m}$ ) with punctures separated by at most a puncture diameter; hypoepimeral area and mesepisternum reticulate-rugose; propodeal triangle with coarse longitudinal wrinkles and shiny interspaces; lateral part of propodeum coarsely reticulate-rugose. Metasoma dark brownish (Fig. 38); terga almost impunctate with a few minute punc-



**Figures 36–42.** *Sphecodes discoverlifei* Astafurova & Proshchalykin, sp. nov., male, holotype **36** head, frontal view **37** antennae, lateral view **38** metasoma, dorsal view **39** mesosoma, dorsal view **40, 41** genitalia, dorso-lateral view (**40**), dorsal view (**41**) **42** labels. Scale bars: 1.0 mm (**36–39**), 0.5 mm (**40, 41**).





**Figures 43–45.** *Sphecodes discoverlifei* Astafurova & Proshchalykin, sp. nov., female, paratype **43** head, frontal view **44** mesosoma, dorsal view **45** metasoma, dorsal view. Scale bars: 1.0 mm.

tures; sterna with sparse setae pores; gonocoxite dorsally with impression; gonostylus with elongate membranous part (Figs 40, 41).

**Etymology.** This species is dedicated to name of the website <https://www.discoverlife.org> (creators are J.S. Ascher and J. Pickering), in recognition of its contribution to knowledge of bee biodiversity.

**Distribution.** Only known from the type locality in Laos.

### *Sphecodes distinctus* Meyer, 1925

Figures 46–52

*Sphecodes distinctus* Meyer, 1925: 11, ♂ (holotype: ♂, Annam, Laos [Vietnam]; HNHM, examined, Fig. 52).



**Diagnosis.** This species is similar to *Sphecodes formosanus* Cockerell, 1911 in having weakly developed tyloids, a densely punctate mesoscutum (close to areolate) and metasomal terga, but it differs in having a smaller body size (6.5–8.5 mm versus 9–10 mm), number of hamuli (seven or eight versus ten), and usually more developed tyloids (covering sometimes to basal 1/4–1/3 of distal flagellomeres compared to at most 1/5 in *S. formosanus*). Females of *S. takaensis* Blüthgen 1927, *S. howardi* and *S. binghami* are structurally and sculpturally close to the male of *S. distinctus* and it is possible that one of these is the unknown female for *S. distinctus*.

**Descriptive notes.** Wings with weak yellow-brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins almost 80°, costal margin with seven or eight hamuli. Lateral preoccipital carina present. **Male.** Total body length 6.5–8.5 mm (Fig. 46). Head transverse (Fig. 47), ca. 1.2 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus approximately an ocellar diameter as seen in frontal view; antennae (Fig. 51) reach posterior margin of mesoscutum, F2 1.6–1.7 times as long as wide, remaining flagellomeres 1.2–1.3 times as long as wide; tyloids semicircular across basal 1/7–1/3 of flagellar surfaces; face and vertex finely areolate-punctate; face (below and above the antennal sockets) and gena with adpressed white pubescence obscuring integument. Mesoscutum and mesoscutellum coarsely and densely punctate (Fig. 48), mostly with confluent punctures, but medially with interspaces approximately a puncture diameter; propodeal triangle (metapostnotum) roughly reticulate-rugose. Metasomal terga (Fig. 49) coarsely punctate (20–25 µm / 1–3); marginal zone on T1 finely punctate (impunctate along posterior margin); remaining marginal zones impunctate; T1–T4 and T5 basally red; gonocoxite dorsally without impression; gonostylus as shown in Fig. 50. **Female** unknown.

**Material examined.** THAILAND: 13 ♂♂, Nan, MaeCharim NP Eingang, 18°36'N, 100°58'E, 10–24.V.2012, E. & J. Holzschuh (OLBL/PCMS).

**Published records.** Meyer 1925: 11 (Vietnam); Ascher and Pickering 2019 (Vietnam).

**Distribution.** \*Thailand, Vietnam.

**Remarks.** Annam (type locality of *S. distinctus*) is actually located in Vietnam, not Laos as Meyer (1925: 11) pointed out.

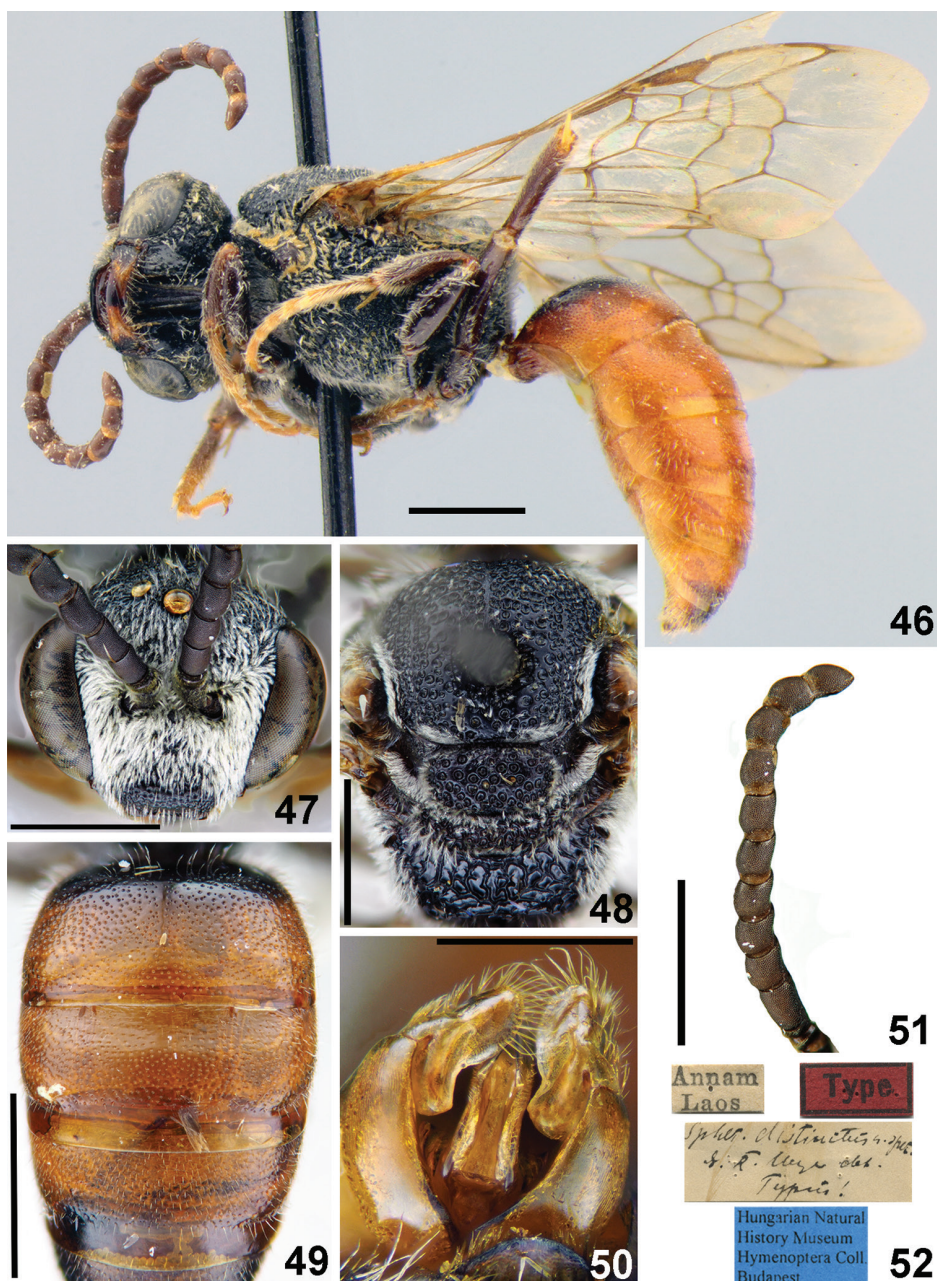
### *Sphecodes duplex* Blüthgen, 1927

Figures 2, 4, 6, 7

*Sphecodes biroi* Meyer, 1925 (nom. praeocc., nec *S. biroi* Friese, 1909): 11, ♀ (syntypes: 2 ♀♀, “Singapore [Singapore], Biró 1898 leg.”; HNHM).

*Sphecodes duplex* Blüthgen, 1927: 78, replacement name for *S. biroi* Meyer, 1925 (nec *S. biroi* Friese, 1909).

**Diagnosis.** Structurally and sculpturally this species is extremely similar to the female of *Sphecodes bakeri* Cockerell, 1915, but it differs in the ocello-ocular area (Fig. 4)



**Figures 46–52.** *Sphecodes distinctus* Meyer, male **46** Habitus, lateral view, holotype **47** head, frontal view **48** mesosoma, dorsal view **49** T1–T3, dorsal view **50** genitalia, dorsal view **51** antennae, lateral view **52** holotype labels. Scale bars: 1.0 mm (**46–49, 51**), 0.5 mm (**50**).

having shiny interspaces and T2 basally possessing fine and sparse punctures (versus ocello-ocular area with entirely confluent punctures without interspaces (Fig. 5) and T2 impunctate in *S. bakeri*).

**Descriptive notes.** Wings with yellow-brownish darkening; hind wing with angle between basal (M) and cubital (Cu) veins almost 90°, costal margin with eight hamuli. Lateral preoccipital carina present. **Female.** Total body length 5–6 mm. Head strongly transverse (Fig. 2), ca. 1.35 times as wide as long; vertex weakly elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; labrum trapezoidal, 0.6 times as long as basal width; face and ocello-ocular area with dense punctures separated by at most a half puncture diameter; paraocular and supraclypeal areas with adpressed white pubescence obscuring integument, gena with sparser pubescence. Mesoscutum and mesoscutellum (Fig. 6) areolate-punctate (30–50 µm); propodeal triangle (metapostnotum) with longitudinal wrinkles and deep large shining interspaces between them; lateral parts of propodeum with parallel wrinkles and large shining interspaces; mesepisternum reticulate-rugose. Metasomal terga red, almost impunctate (Fig. 7); T2 basally with sparse and minute (ca. 5 µm) punctures; pygidial plate 1.2 times as wide as metabasitarsus. **Male** unknown.

**Material examined.** INDONESIA: 1 ♀, Java, Buitzorg [S. *duplex* Blüthgen det.] (ZMHB); MALAYSIA: 1 ♀, Malaya, Kuala Sleh, jungle, 15.III.1936, H.T. Pagden (NHMUK 013380358).

**Published records.** Meyer 1925: 11 (Singapore); Blüthgen 1927: 78 (Indonesia); Ascher and Pickering 2019 (Singapore).

**Distribution.** Indonesia, \*Malaysia, Singapore.

**Remarks.** This species is probably the unknown female of *S. samarensis*.

### *Sphecodes engeli* Astafurova & Proshchalykin, sp. nov.

<http://zoobank.org/B2D1E20B-86FF-42AE-AE78-37A4F9EEF2D2>

Figures 53–59

**Type material.** *Holotype*: ♀, LAOS, Hua Phan Prov., Ban Saleui, Phou Pan Mts., 20°13'30"N, 103°59'26"E, 1350–1900 m, 08.V.2012, C. Holzschuh & locals (OLBL), Fig. 59. *Paratypes*: 1 ♀, the same label as for holotype, but 27–28.IV.2011 (OLBL); VIETNAM: 1 ♀, prov. Hoa Binh, Pa Co, 27–28.IV.2002, S. Belokobylskij (ZISP).

**Diagnosis.** As with members of the Palearctic *hyalinatus* species group (Astafurova and Proshchalykin 2017a), the new species has a pronotum rounded between the dorsal and lateral surfaces, but it differs in the strongly transverse head (1.3 times as wide as long) with a straight upper margin as seen in frontal view (versus head 1.2–1.25 times as wide as long with rounded vertex as seen in frontal view in species of the *hyalinatus* group).

**Description.** Wings with weak brownish darkening, veins and stigma brown; hind wing with angle between basal (M) and cubital (Cu) veins ca. 90°, costal margin with six hamuli. Preoccipital carina absent. **Female.** (holotype. Fig. 53). Total body length 7.5–8.5 mm, fore wing 6.5–7.0 mm. Head black (Fig. 55); strongly transverse, ca. 1.3 times as wide as long; vertex weakly elevated as seen in frontal





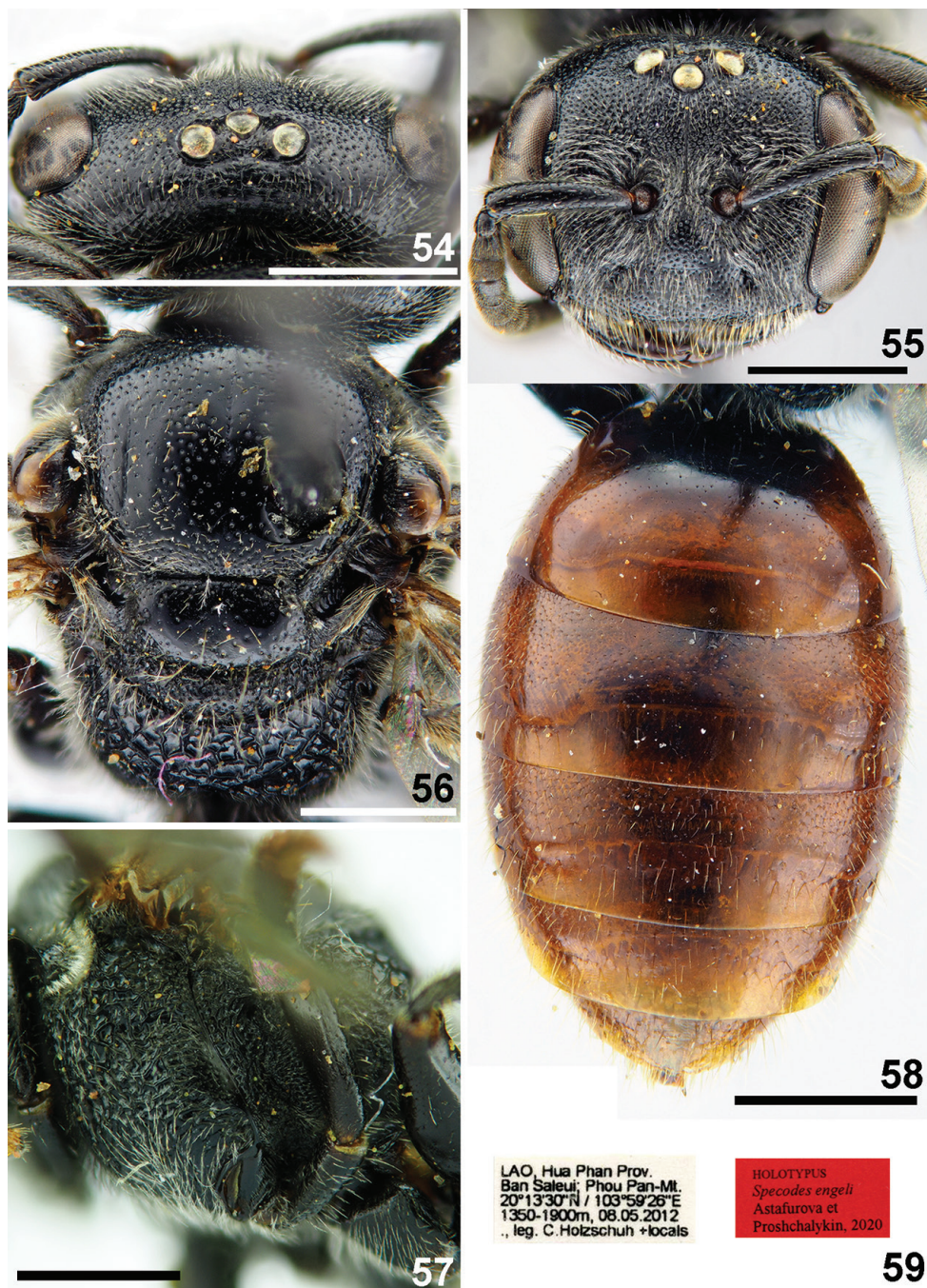
**Figure 53.** *Sphecodes engeli* Astafurova & Proshchalykin, sp. nov., female, holotype, lateral view. Scale bars: 1.0 mm.

view, distance from top of head to upper margin of a lateral ocellus approximately a half lateral ocellar diameter as seen in frontal view and ca. 2 diameters as seen in dorsal view; mandible bidentate; labrum trapezoidal, 0.7 times as long as basal width; gena wide, 1.2 times as wide as eye; clypeus medially slightly emarginated; supraclypeal area weakly bulging; clypeus and supraclypeal area with punctures (15–25  $\mu\text{m}$ ) separated by at most a puncture diameter; paraocular area and frons with confluent punctures, ocello-ocular area with punctures separated by 1–3 puncture diameters (Fig. 54), vertex behind ocelli and gena strigose; face below antennal sockets with sparse plumose setae, gena with sparse thin setae. Mesosoma black (Fig. 56); pronotum rounded between the dorsal and lateral surfaces; mesoscutum finely punctate (15–25  $\mu\text{m}$  / 1–4); mesoscutellum irregularly punctate, medially sparsely; metafe-mur enlarged in proximal half, maximum width 0.4 times its length; hypoepimeral area, mesepisternum, propodeal triangle (metapostnotum) and lateral parts of propodeum reticulate rugose (Figs 56, 57). Mesosoma (Fig. 58) sparsely punctate, T1 impunctate or with a few fine punctures; remaining terga basally with sparse and fine punctures (5–10  $\mu\text{m}$ ); marginal zones impunctate; pygidial plate dull, pointed apically, narrow, 0.6–0.7 times as wide as metabasitarsus; T1–T4 red, remaining terga red or red-brownish; sterna tessellate, with tiny and sparse shallow setae pores on S2 and coarse and dense on S3–S5.

**Male** unknown.

**Etymology.** This species is dedicated to our colleague Dr. Michael S. Engel (University of Kansas, USA), in recognition of his significant contributions to systematic entomology.

**Distribution.** Laos, Vietnam.



**Figures 54–59.** *Sphecodes engeli* Astafurova & Proshchalykin, sp. nov., female, holotype **54, 55** head, dorsal view (**54**), frontal view (**55**) **56, 57** mesosoma, dorsal view (**56**), lateral view (**57**) **58** metasoma, dorsal view **59** labels. Scale bars: 1.0 mm.



***Sphecodes fumipennis* Smith, 1853**

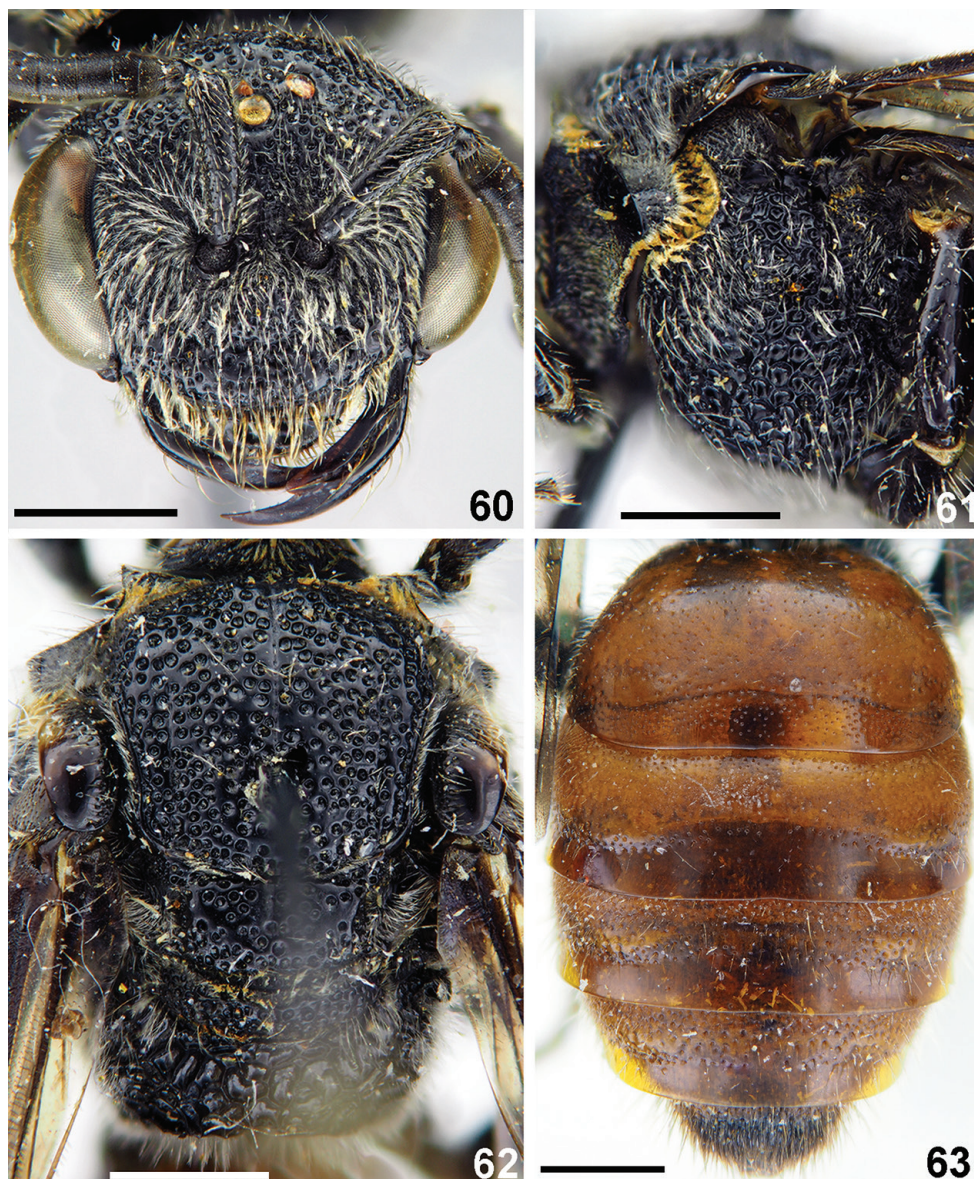
Figures 60–68

*Sphecodes fumipennis* Smith, 1853: 36, ♀ (holotype: ♀, N. India, coll. J.S. Baly; NHMUK, not examined).

**Diagnosis.** The male of this species resembles *Sphecodes assamensis* Blüthgen, 1927 in having a similar size of antennal tyloids and shape of the gonostylus, but it differs from this species by shining interspaces on vertex and mesoscutum (dull in *S. assamensis*), and the number of hamuli (ten or twelve versus eight). The female differs from other oriental species by combination of the following characters; lack of a preoccipital carina, large body length (9.5–12 mm), eleven or twelve hamuli, mesoscutum mostly punctate-areolate and vertex strongly elevated. With these characteristics the female is similar to the palaearctic *S. albilabris* (Fabricius, 1793), but it differs in a sparsely punctate T1 disc with punctures separated by 2–6 puncture diameters (versus 0.5–2 in *S. albilabris*).

**Descriptive notes.** Wings with strong brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with eleven or twelve hamuli. **Female.** Total body length 9.5–12 mm. Head (Fig. 60) transverse, 1.25 times as wide as long; vertex strongly elevated with distance from top of head to upper margin of lateral ocellus ca. two lateral ocellar diameters as seen in frontal view; supraclypeal area swollen; labrum short, semi-oval, 0.45 times as long as basal width; ocello-ocular area areolate-punctate, but vertex behind ocelli with shiny interspaces; paraocular areas and gena with relatively dense plumose pubescence although not obscuring integument. Mesoscutum and mesoscutellum (Fig. 62) mostly with confluent punctures (50–75 µm), but medially with a few interspaces at most 1–2 puncture diameters; propodeal triangle (metapostnotum) coarsely reticulate-rugose; mesepisternum (Fig. 61) areolate on an upper half to reticulate below. Metasoma (Fig. 63) red; T1 sparsely punctate (ca. 25 µm / 2–6), finer and denser on marginal zone; remaining terga more densely and coarsely punctate, but marginal zones impunctate; pygidial plate dull, 1.3–1.4 as wide as metabasitarsus. **Male.** Total body length 9.5–12 mm. Head (Fig. 64) transverse, 1.2 times as wide as long; vertex strongly elevated with the distance from top of head to upper margin of lateral ocellus more than two lateral ocellar diameters as seen in frontal view; antenna (Fig. 66) long, reaching mesoscutellum, F2 1.8 times as long as wide, remaining flagellomeres ca. 1.4–1.5 times as long as wide; tyloids weakly developed, narrowly semicircular across basal 1/8–1/7 of flagellar surfaces and narrowly linear across remainder of flagellomere as seen in lateral view. Mesoscutum and mesoscutellum (Fig. 67) mostly areolate-punctate, but medially with a few interspaces approximately a puncture diameter wide; propodeum and mesepisternum as in the female. Metasoma (Fig. 68) coarsely and densely punctate, sparser on T1 (25–35 µm / 0.5–3); marginal zones impunctate except on T1; gonocoxite dorsally without impression; gonostylus (Fig. 65) short, with small membranous part.





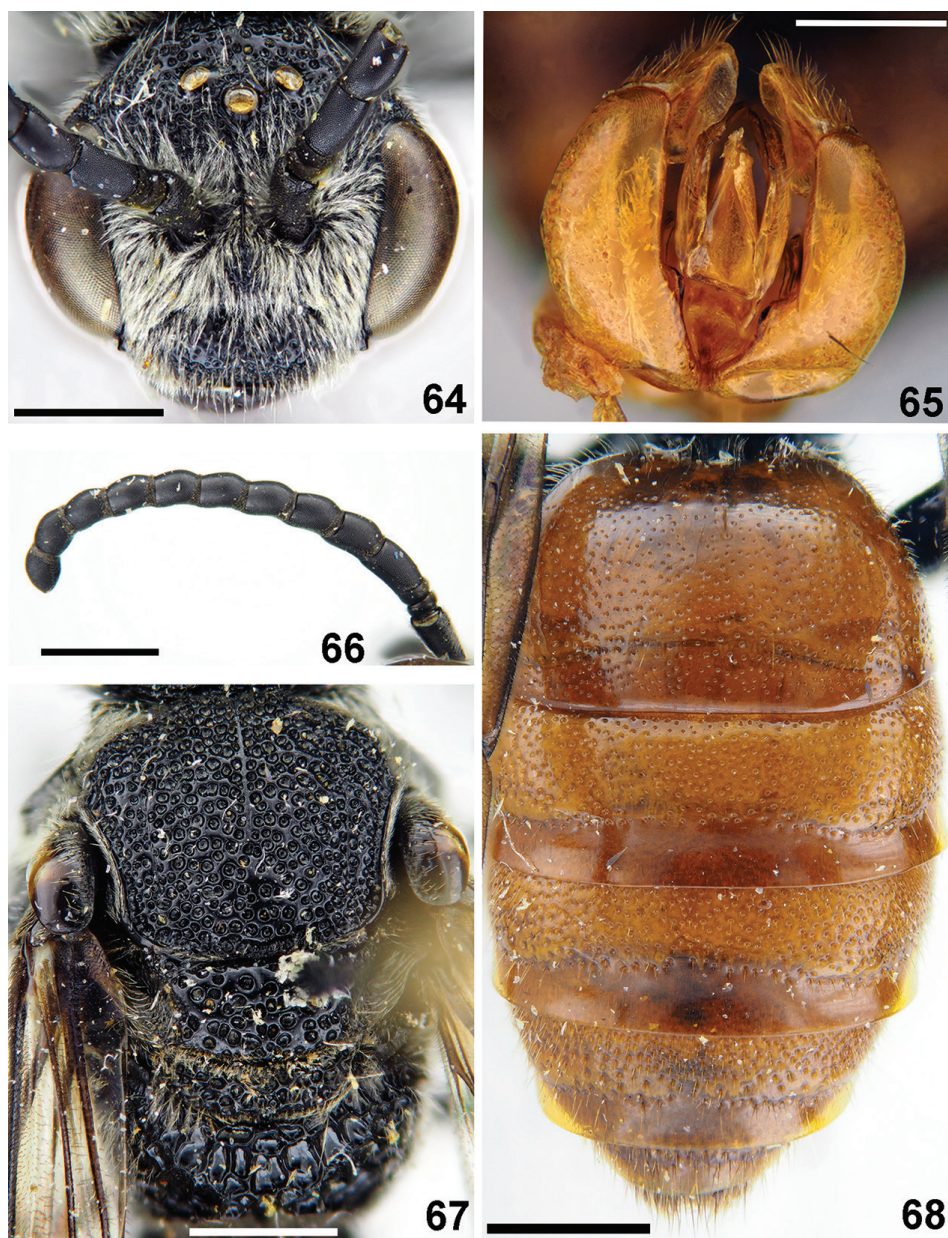
**Figures 60–63.** *Sphecodes fumipennis* Smith, female **60** head, frontal view **61, 62** mesosoma, lateral view (**61**), dorsal view (**62**) **63** metasoma, dorsal view. Scale bars: 1.0 mm.

**Material examined.** LAOS: 2 ♀♀, 1 ♂, Louang Phrabang pr., Ban Song Cha, 1200 m, V. 1999, V. Kuban (OLBL/PCMS).

**Published records.** Blüthgen 1924: 489 (Myanmar).

**Distribution.** \*Laos, Myanmar, India (Sikkim).





**Figures 64–68.** *Sphecodes fumipennis* Smith, male **64** head, frontal view **65** genitalia, dorsal view **66** antennae, lateral view **67** mesosoma, dorsal view **68** metasoma, dorsal view. Scale bars: 1.0 mm (**64**, **66**–**68**), 0.5 mm (**65**).

*Sphecodes howardi* Cockerell, 1922

Figures 69, 71

*Sphecodes howardi* Cockerell, 1922: 12, ♀ (holotype: ♀, Canton [= Guangdong], China, C.W. Howard Collection, Type No 24885USNM; USNM, <http://n2t.net/ark:/65665/3129f6c5d-578d-446f-bdc7-f59ccb6213e0>).

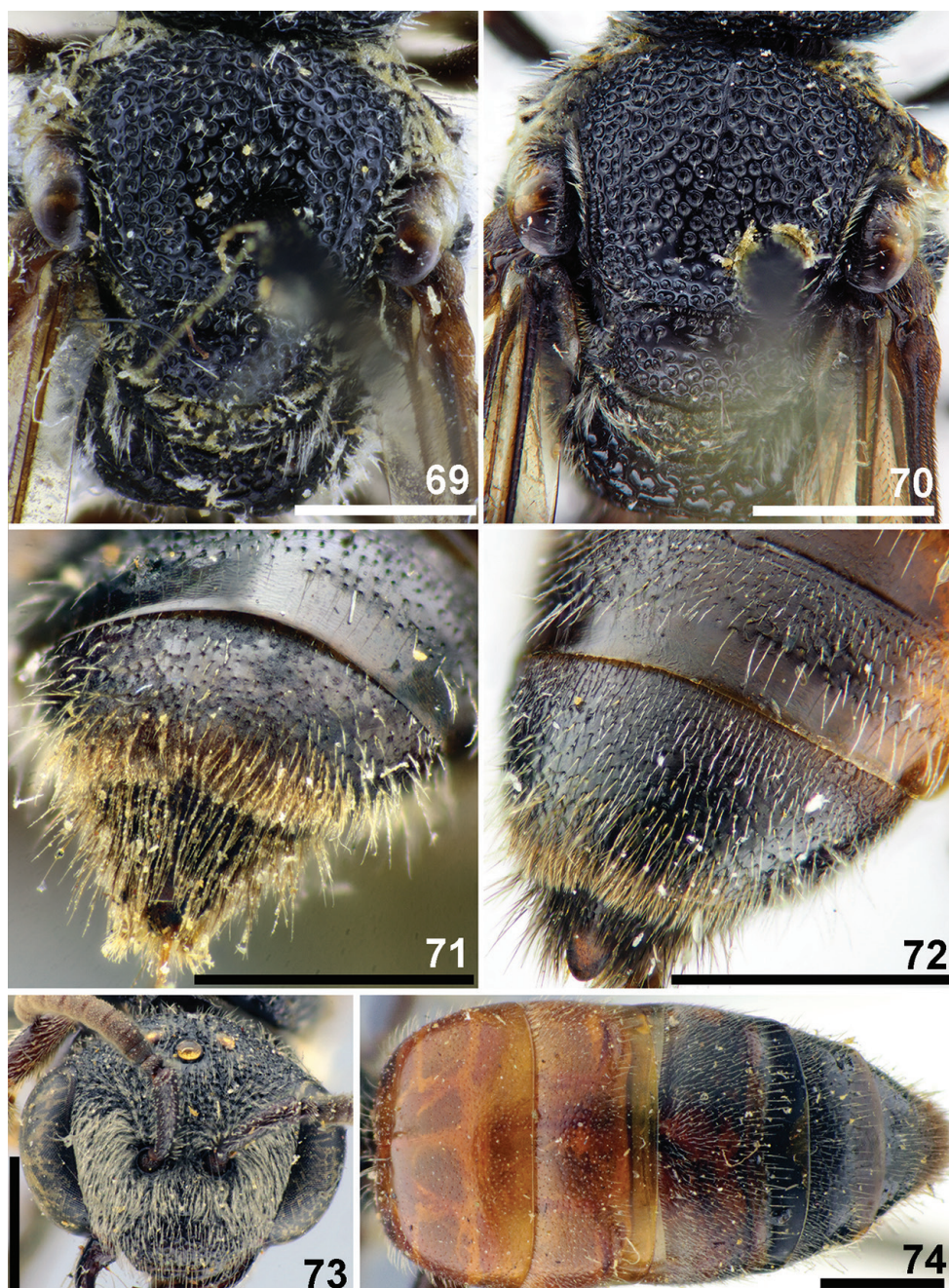
**Diagnosis.** This species is most close to *Sphecodes kershawi* and also resembles *S. formosanus* Cockerell, 1911, *S. takaensis* Blüthgen, 1927, and *S. binghami* owing to similar structure, sculpture, and coloration of the body, including a densely punctate disc and marginal zone of T1 (differences between females of these species are outlined in Table 2). Structurally and sculpturally the species is also close to *S. distinctus* and *S. sibuyanensis* Cockerell, 1925 and one of these species may possibly be the unknown male of *S. howardi*, especially *S. sibuyanensis* which has the same brown wing coloration (lighter and yellowish in *S. distinctus*).

**Descriptive notes.** Wings with brownish darkening; hind wing with angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with seven or eight hamuli. Lateral preoccipital carina present. **Female.** Total body length 8.5–9.5 mm. Head transverse, ca. 1.25 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; labrum semi-oval, 0.4 times as long as basal width; face and vertex areolate-punctate; paraocular (below and above the antennal sockets), supraclypeal areas and gena with adpressed white pubescence obscuring integument. Mesoscutum and mesoscutellum mostly with areolate punctures (40–75 µm), but medially with a few shining interspaces of approximately a puncture diameter (Fig. 69); propodeal triangle (metapostnotum) reticulate-rugose (sculpture forming

**Table 2.** Differences between females of *Sphecodes howardi*, *S. formosanus*, *S. takaensis*, *S. binghami*, and *S. kershawi*.

Characters	<i>Sphecodes</i> species				
	<i>howardi</i>	<i>formosanus</i>	<i>takaensis</i>	<i>binghami</i>	<i>kershawi</i>
F3	About as long as wide	About as long as wide	0.7–0.8 times as long as wide	About as long as wide	About as long as wide
Mesoscutum	With coarse and confluent punctures, but medially with interspaces 0.5–1.0 puncture diameter	Densely punctate with punctures separated at most a puncture diameter	With coarse and confluent punctures, but medially with interspaces 0.5–1.0 puncture diameter	With coarse and confluent punctures, but medially with interspaces 0.5–1.0 puncture diameter	Mostly areolate-punctate
T4 marginal zone	Tessellate	Smooth	Smooth	Smooth	Smooth or unclearly tessellate
Pygidial plate	Narrower than metabasitarsus	As wide as metabasitarsus	Narrower than metabasitarsus	As wide as metabasitarsus	Narrower than metabasitarsus
Number of hamuli	7–8	9–10	8	8–9	6–7
Distribution	Malaysia, Myanmar, China (Guangdong)	China (Taiwan)	China (Taiwan)	Malaysia, Myanmar	Indonesia, Malaysia, Myanmar, Thailand, China (Macao)





**Figures 69–74.** *Sphecodes howardi* Cockerell (**69, 71**), *S. kershawi* Perkins (**70, 72–74**), females **69, 70** mesosoma, dorsal view **71, 72** T4–T6, dorso-lateral **73** head, frontal view **74** metasoma, dorsal view. Scale bars: 1.0 mm.

one or two rows of large deep cells); mesepisternum reticulate-rugose. Metasomal T1 on disc and marginal zone finely and densely punctate ( $10\text{--}15\text{ }\mu\text{m}$  /  $0.5\text{--}3$ ), remaining terga similarly punctate, but with impunctate marginal zones; T4 marginal zone finely tessellate (Fig. 71); T1–T3 red, T4 variable; pygidial plate 0.7 times as wide as metabasitarsus. **Male** unknown.

**Material examined.** MALAYSIA: 1 ♀, Titi Serong Perak, 29.III.1930, H.T. Pagden (NHMUK 013380439); MYANMAR: 1 ♀, Upper Burma, Nam Tamai Valley, 3000 ft, 12.VIII.1938, R. Kaulback,  $27^{\circ}42'\text{N}$ ,  $97^{\circ}54'\text{E}$  (NHMUK 013380337); CHINA: 1 ♀, Canton, 1916–1918, H. Weigold (ZMHB).

**Distribution.** \*Malaysia, \*Myanmar, China (Guangdong).

***Sphecodes ilyadadaria* Astafurova, sp. nov.**

<http://zoobank.org/281ED4DF-FFBA-4341-A305-43A791BAD494>

Figures 75–80

**Type material.** **Holotype:** ♂, INDONESIA, West Java, Gunung Halimun N.P., Tea Plantation, Citalahab, 850 m,  $6.77607^{\circ}\text{N}$ ,  $106.85401^{\circ}\text{E}$ , 20.VIII.2004, P. Hartmann (ZSM), Fig. 75. **Paratype:** 1 ♂, the same label as for holotype (ZMS). Additional material (this



**Figure 75.** *Sphecodes ilyadadaria* Astafurova, sp. nov., male, holotype, lateral view. Scale bars: 1.0 mm.





**Figures 76–80.** *Sphecodes ilyadadaria* Astafurova, sp. nov., male, holotype **76** head, frontal view **77** antennae, lateral view **78** mesosoma, dorsal view **79** genitalia, dorsal view **80** metasoma, dorsal view. Scale bars: 1.0 mm (**76–78, 80**), 0.5 mm (**79**).



specimen was determined as belonging the new species by photos and descriptive notes): 1 ♂, NE Sulawesi, 47 km WSW Kotamobagu, Dumoga-Bone N.P., Toraut (forest edge), 211 m, V.1985, G.R. Else, NHMUK 013380345 [aff. *insularis* Astafurova det. 2019].

**Diagnosis.** The new species most closely resembles *Sphecodes insularis* Smith, 1858, from which it differs by having an areolate punctate mesoscutum (with inter-spaces between punctures up to a puncture diameter in *S. insularis*).

**Description.** Wings with weak yellow-brownish darkening, veins and stigma brown; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with seven or eight hamuli. Lateral preoccipital carina well developed. **Male.** (holotype, Fig. 75). Total body length 8.5–9.0 mm, fore wing 5.6–5.7 mm. Head black (Fig. 76); weakly transverse, ca. 1.15 times as wide as long; vertex elevated, distance from top of head to upper margin of a lateral ocellus ca. one and a half of lateral ocellar diameter as seen in frontal view and ca. two as seen in dorsal view; antenna short (Fig. 77), reaching posterior half of mesoscutum; F1 strongly transverse, 0.4 times as long as wide; remaining flagellomeres 1.2–1.3 times as long as wide; tyloids semi-oval across at most basal 1/2 of last flagellomeres; supraclypeal area weakly bulging; clypeus shining, densely punctate with the punctures (20–30 µm) separated by at most a half puncture diameter. Supraclypeal and paraocular areas dull, finely areolate-punctate (15–25 µm), but frons and vertex close to reticulate-rugose; gena shining, rugose with sparse short setae; paraocular and supraclypeal areas with dense plumose adpressed pubescence. Mesosoma black (Fig. 78); mesoscutum coarsely areolate-punctate (50–75 µm), medially closer to reticulate-rugose; mesoscutellum densely and coarsely punctate, medially with the punctures separated by at most a puncture diameter; hypoepimeral area reticulate rugose; mesepisternum and propodeal triangle (metapostnotum) roughly reticulate-rugose; mesepisternum with sparse and thin short setae; lateral parts of propodeum shining, close to striate. Metasoma (Fig. 80) distinctly punctate, T1 with minute (5–15 µm) numerous punctures; remaining terga coarsely punctate (15–25 µm / 0.5–2); marginal areas impunctate except on T1 which has fine and sparse punctures basally; sterna tessellate with shallow setae pores; gonocoxite dorsally without impression; gonostylus with triangular apical process (Fig. 79); T1–T3 and S1–S3 variable in coloration, partially red, remaining terga and sterna brownish.

**Female** unknown.

**Etymology.** The species is named after the author's daughter Darya Gayday and her husband Ilya Gayday, who recently married. It is to be treated as a noun.

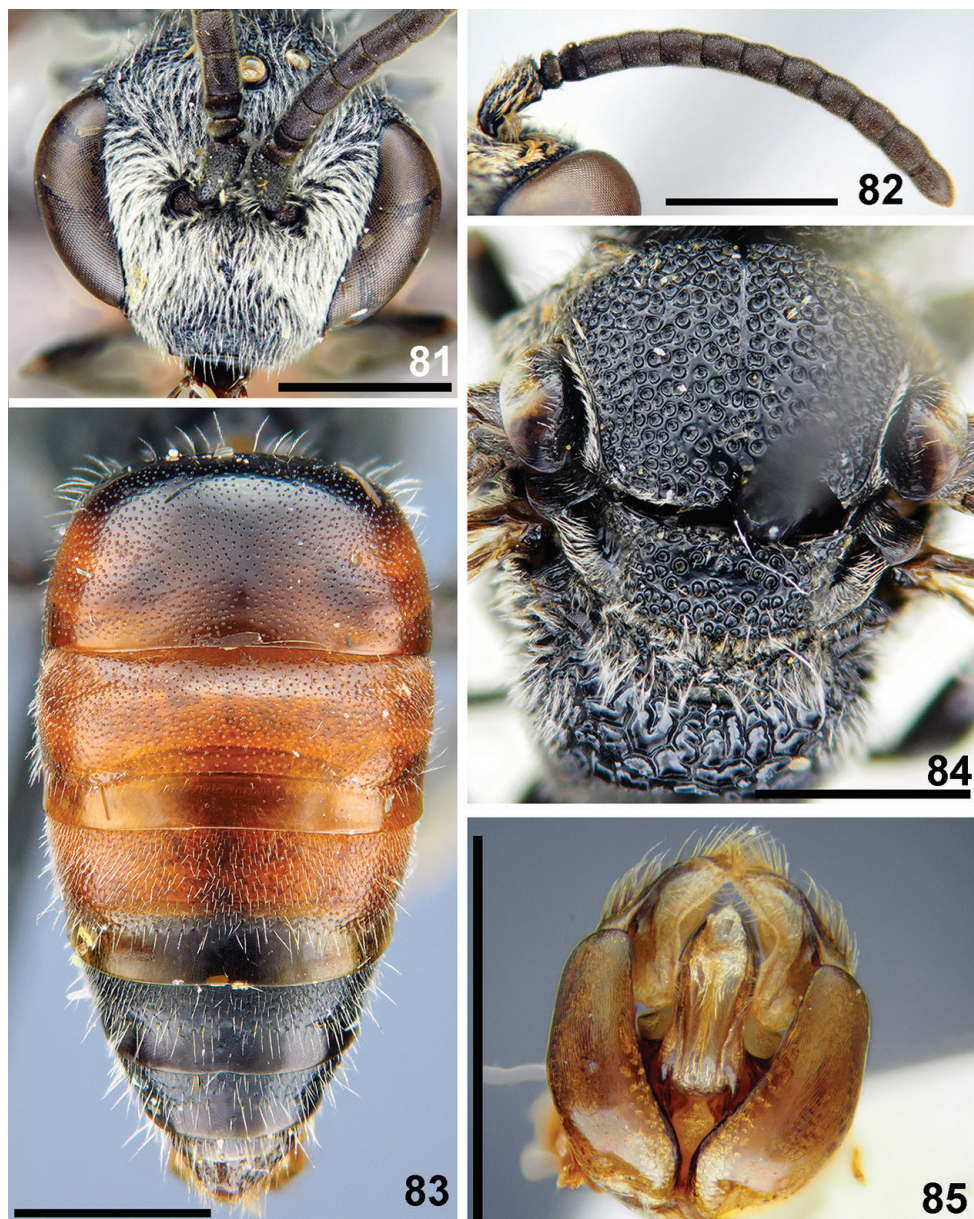
**Distribution.** Indonesia.

### *Sphecodes kershawi* Perkins, 1921

Figures 70, 72–74, 81–85

*Sphecodes kershawi* Perkins, 1921: 9, ♂ (syntypes: ♂♂, China, Macao, J.C. Kershaw leg.; NHMUK, ZMHB, examined).

*Sphecodes javanensis* Blüthgen, 1927: 69–70, ♂ (holotype: ♂, Indonesia, Java, Buitenzorg, VIII. 1920; NHMW, examined). Syn. nov.



**Figures 81–85.** *Sphecodes kershawi* Perkins, male **81** head, frontal view **82** antennae, lateral view **83** metasoma, dorsal view **84** mesosoma, dorsal view **85** genitalia, dorsal view. Scale bars: 1.0 mm.

**Diagnosis.** The male of this species is closest to *Sphecodes sibuyanensis* Cockerell, 1925 owing to similar short antennae with tyloids covering the entire ventral flagellar surface, a densely punctate metasoma (including marginal zone on T1) and in the shape of the gonostylus, with an elongate membranous part. From *S. sibuyanensis* it differs by a mostly punctate-areolate mesoscutum (versus a lot of mesoscutellar punctures

separated by 0.5–1 puncture diameter). The female is closest to *S. howardi* and is also similar to *S. formosanus*, *S. takaensis*, and *S. binghami* owing to a similar structure, sculpture and coloration of the body, including the densely punctate disc and marginal zone of T1 (differences between females of these species are outlined in Table 2).

**Descriptive notes.** Wings with strong brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with six, seven or eight hamuli. Lateral preoccipital carina present. **Female.** Total body length 7.5–8 mm. Head transverse (Fig. 73), ca. 1.2 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; labrum semi-oval, 0.5 times as long as basal width; face and vertex areolate-punctate; paraocular areas with dense adpressed white pubescence, gena with sparser pubescence not obscuring integument. Mesoscutum (Fig. 70) mostly areolate-punctate (50–75 µm) medially with a few punctures separated by at most 0.5–1 puncture diameter; mesoscutellum with confluent punctures and a few interspaces of approximately a puncture diameter. Propodeal triangle (metapostnotum) reticulate-rugose. Metasoma densely punctate (Fig. 74); T1 on disc and marginal zone finely punctate (10–15 µm / 0.5–3), remaining terga coarsely punctate (10–25 µm) with impunctate and smooth marginal zones, sometimes finely tessellate on T4 (Fig. 72); pygidial plate 0.7 times as wide as metabasitarsus; T1–T3 red. **Male.** Total body length 7–8 mm. Head transverse (Fig. 81), ca. 1.2 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus approximately a lateral ocellar diameter as seen in frontal view; antennae short (Fig. 82), not reaching mesoscutellum, F1 0.6 times as long as wide, remaining flagellomeres ca. 1.2 times as long as wide, tyloids covering entire ventral flagellar surface. Mesosomal sculpture as in female (Fig. 84). Metasomal T1 densely punctate including marginal zone (10–20 µm / 0.5–2), remaining terga with impunctate marginal zones (Fig. 83); T1–T3 red or metasoma entirely black; gonocoxite dorsally without impression; gonostylus with elongate membranous part, apically with long setae (Fig. 85).

**Material examined.** INDONESIA: 1 ♂, Ceylon, Calutara, O.S. Wickwar, 1912–189 (NHMUK 013380334); MALAYSIA: 1 ♀, Malaya, Titi Serong Perak, 27.VIII.1931, H.T. Pagden (NHMUK 013380436); MYANMAR: 1 ♀, Mali Hka Valley, Kachin Hills, 1500 ft, 15.XII.1930, F. Kingdon Ward., BM 1936–91 (NHMUK 013380338); THAILAND: 1 ♀, 2 ♂♂, Nan, MaeCharim NPEingang, 18°36'N, 100°58'E, 206 m, 10–15.V.2012, E. & J. Holzschuh (OLBL/PCMS); CHINA: 1 ♂ (syntype), Macao, J.C. Kershawi (ZMHB); 1 ♂ (syntype), Macao, J.C. Kershawi (NHMUK 013380474); 1 ♀, Macao, R.C.L. Perkins Coll., B.M. 1942–95 (NHMUK 013380470).

**Published records.** Blüthgen 1927: 69 (Indonesia, as *S. javanensis*).

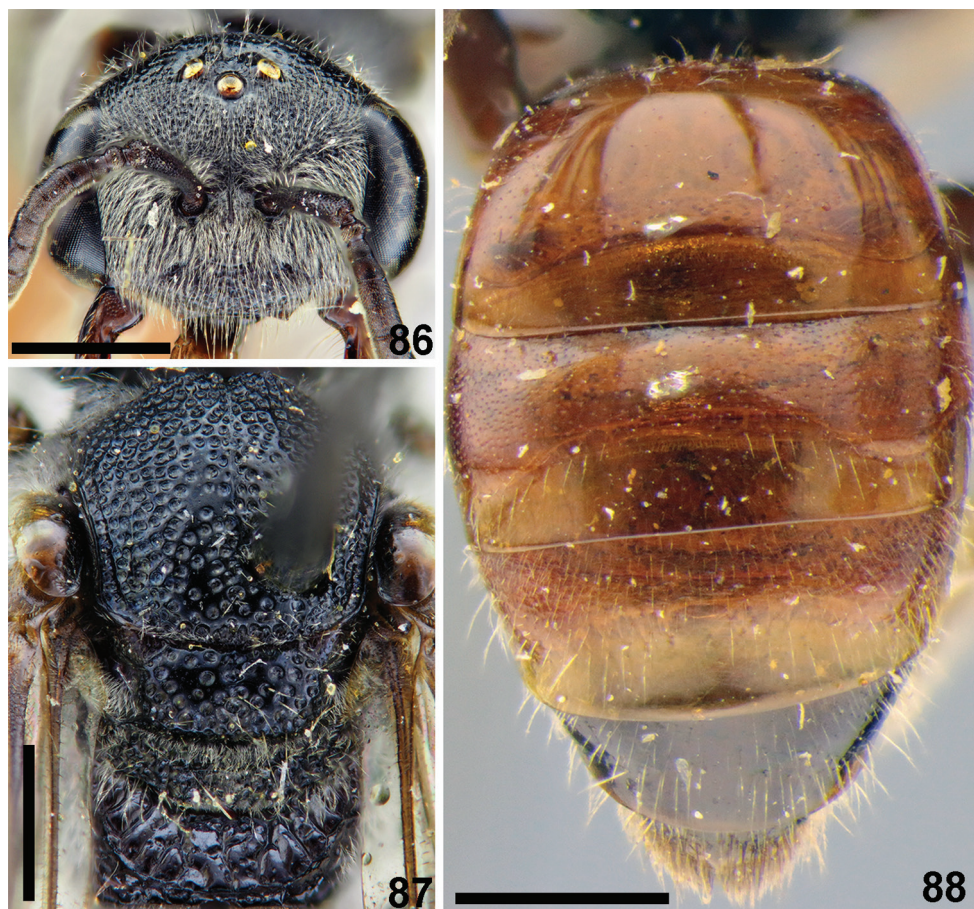
**Distribution.** Indonesia, \*Malaysia, \*Myanmar, \*Thailand, China (Macao).

### *Sphecodes laticeps* Meyer, 1920

Figures 86–93

*Sphecodes laticeps* Meyer, 1920: 121, ♀, ♂ (lectotype (designated here): ♂, Formosa, Takao, H. Sauter S.G., 8.12.09 // *Sphec. laticeps* Meyer det. n. spec., !Type // Lec-





**Figures 86–88.** *Sphecodes laticeps* Meyer, female **86** head, frontal view **87** mesosoma, dorsal view **88** metasoma, dorsal view. Scale bars: 1.0 mm.

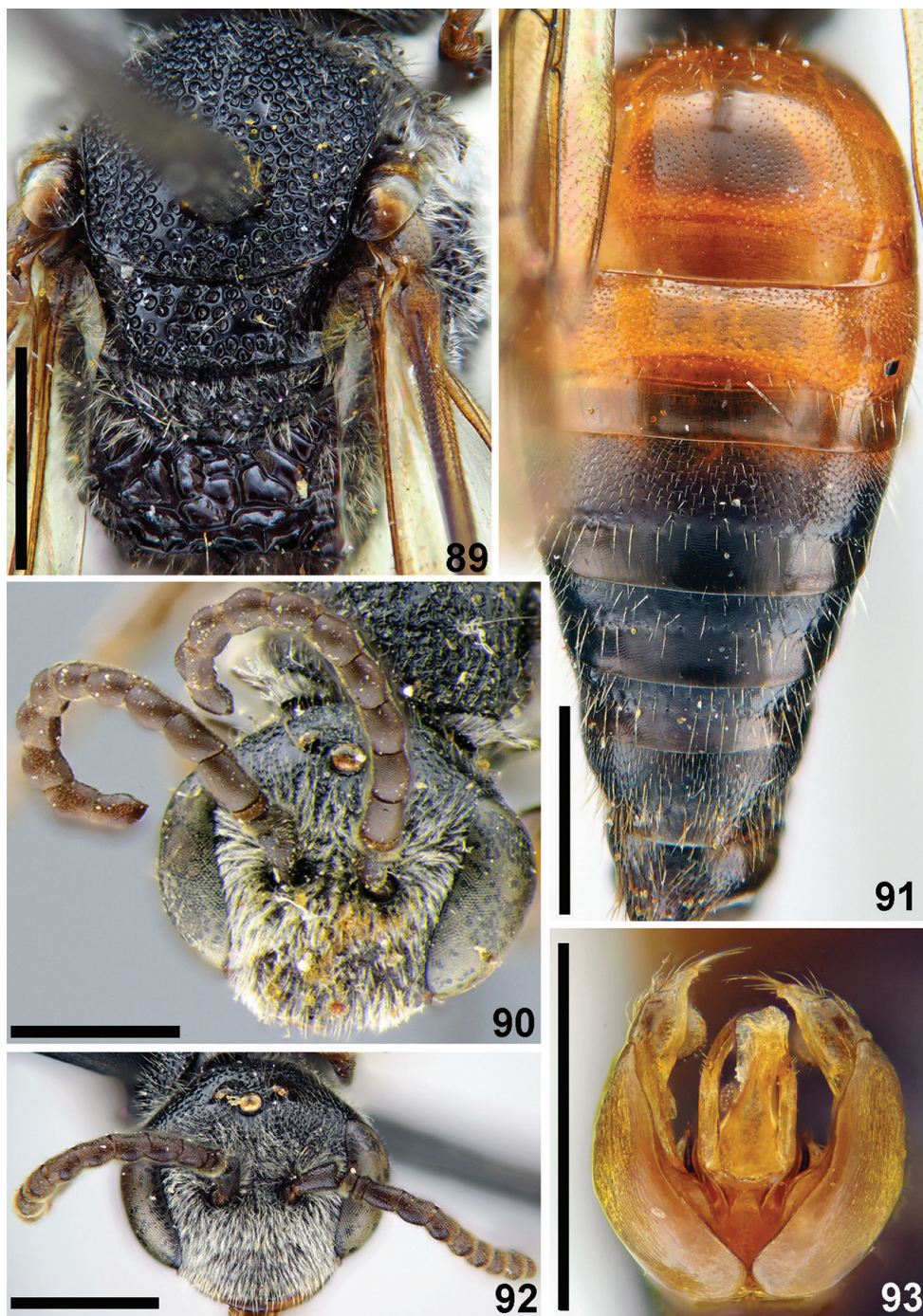
totypus, *Sphecodes laticeps* Meyer, 1920, design. Astafurova et al. 2020 <red label>; ZMHB); Paralectotypes: 2 ♀♀, Formosa, Taihorinsho, Sauter S.V., VIII. // *Sphec. laticeps* Meyer det. n. spec., Type, ZMHB, SDEI; 3 ♀♀, Taihorin, Formosa, H. Sauter, 1911 // 7.VI // *Sphec. laticeps* Meyer det. n. spec., Type; ZMHB.

*Sphecodes candidius* Meyer, 1925: 10, ♀ (holotype: ♀, Taiwan, “Lake Candidius 25./9/-10./10/ 1907”; HNHM). Synonymized by Blüthgen 1927: 85.

*Sphecodes biroï mariae* Cockerell, 1930: 162, ♂ (holotype: ♂; Thailand, “Siam, Nam, Jan. 8, 1928 (Cockerell)”; USNM, <http://n2t.net/ark:/65665/3e3daca86-a75f-458d-b994-6723b995dccc>). Syn. nov.

**Diagnosis.** This species resembles *Sphecodes biroï* Friese, 1909 and *S. samarensis* Blüthgen, 1927 owing to a similar structure, sculpture and coloration of the body, including the shape of the male gonostylus. *S. laticeps* differs from *S. samarensis* by the shining and more elevated vertex with distance from top of head to upper margin of lateral





**Figures 89–93.** *Sphecodes laticeps* Meyer, male, lectotype (90) 89 mesosoma, dorsal view 90, 92 head, frontal view 91 metasoma, dorsal view 93 genitalia, dorsal view. Scale bars: 1.0 mm.

ocellus ca. one and a half or two lateral ocellar diameters as seen in frontal view (versus dull, areolate vertex with distance from top of head to upper margin of lateral ocellus half or one ocellar diameter. The female of *S. samarensis* is unknown, but these features are suitable for both sexes). The male of *S. laticeps* differs from *S. biroi* in having less developed tyloids and a glabrous spot on the ventral surfaces of flagellomeres (versus tyloids usually covering entire ventral flagellar surface or sometimes with small non-setae spot on basal flagellomeres). The females of *S. laticeps* and *S. biroi* are difficult to distinguish, but *S. laticeps* has T2 usually more distinctly punctate.

**Descriptive notes.** Wings with brownish darkening; hind wing with angle between basal (M) and cubital (Cu) veins almost 90°, costal margin with seven hamuli. Lateral preoccipital carina present. **Female.** Total body length 7–7.5 mm. Head strongly transverse (Fig. 86), ca. 1.3 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus ca. one and a half of a lateral ocellar diameter as seen in frontal view; labrum trapezoidal, 0.6 times as long as basal width; ocello-ocular area shining with shallow punctures separated by 0.5–2 puncture diameters; face (below and above the antennal sockets) with adpressed white pubescence obscuring the paraocular and supraclypeal integuments, gena with sparser pubescence. Mesoscutum and mesoscutellum (Fig. 87) mostly with confluent punctures (30–40 µm) and medially with a few shining interspaces equal at most to one or two puncture diameters. Propodeal triangle (Fig. 87) roughly reticulate-rugose (sculpture forming one or two rows of large deep cells); mesepisternum reticulate-rugose. Metasomal T1 impunctate, T2 with minute and sparse punctures on medial part of disc, coarser and denser on lateral areas (10–15 µm / 2–4); marginal zones impunctate; pygidial plate as wide as metabasitarsus; T1–T3 red or darkish (Fig. 88). **Male.** Total body length 7–8 mm. Head transverse (Figs 90, 92), ca. 1.2 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus ca. one and a half of a lateral ocellar diameter as seen in frontal view; antennae reach posterior margin of mesoscutum, F2 1.6–1.7 times as long as wide. Tyloids well developed, covering the entire lateral flagellar surfaces and peripheral part of ventral surface (with variable in size medial glabrous spot, Figs 90, 92). Mesoscutum (Fig. 89) mostly areolate-punctate, medially with a few shining interspaces equal at most to a puncture diameter. Propodeal triangle roughly reticulate-rugose; lateral parts of propodeum rugose with large smooth shining interspaces. Metasomal terga (Fig. 91) with minutely punctate (10–15 µm), variable in density; marginal zones impunctate; T1–T3 red; gonocoxite dorsally without impression; gonostylus as on Fig. 93.

**Material examined.** VIETNAM: 4 ♂♂, Gia Prov., Lai-Contum, Tran Lap, 20 km N Buon Luoi, 22–25.XI.1988, Sharkov (ZISP); 2 ♀♀, 50 km W Thanh Hoa, 9.I.1989, B. Korotyaev (ZISP); 1 ♀, Hanoi, 30.I.1989, Yanushev (ZISP).

**Published records.** Cockerell 1930: 162 (Thailand, as *S. biroi mariae*); Ascher and Pickering 2019 (Thailand, as *S. biroi mariae*).

**Distribution.** Thailand, \*Vietnam, China (Taiwan).

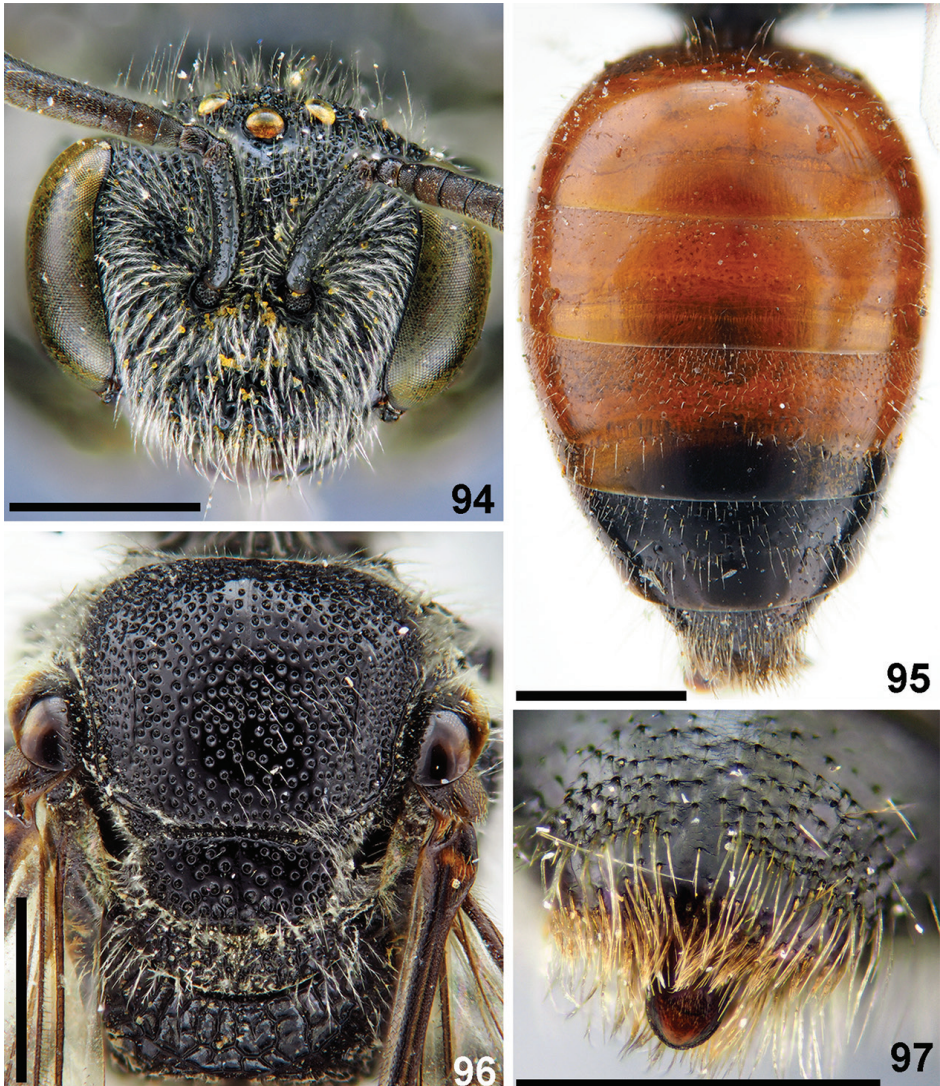


***Sphecodes montanus* Smith, 1879**

Figures 94–102

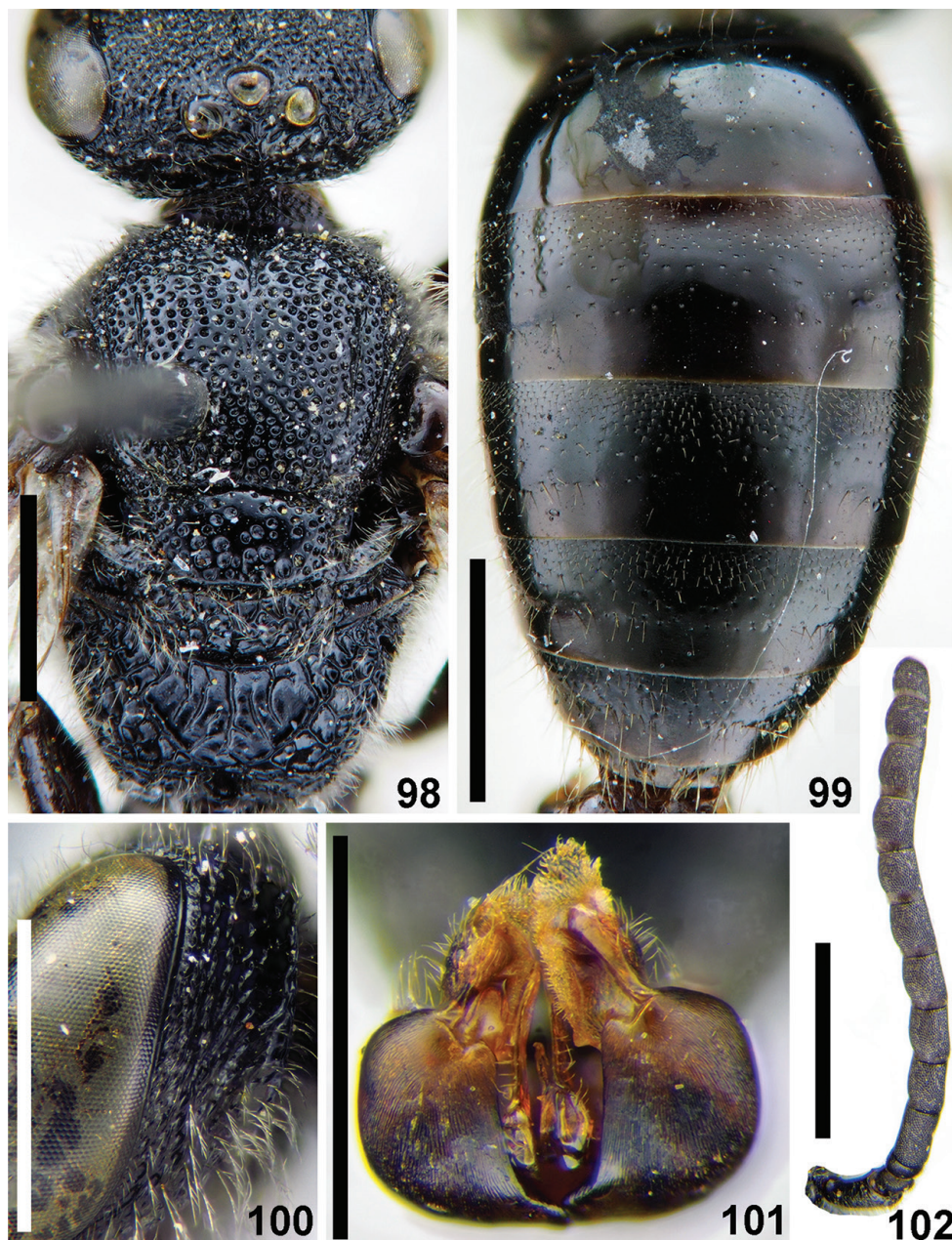
*Sphecodes montanus* Smith, 1879: 27, ♀, ♂ (syntype: ♀, Northern India, Masuri [Uttaranchal: Mussoorie], 7000 ft, B.M. Type HYM.17a549; NHMUK 013380316; examined).

**Diagnosis.** This species is closest to *Sphecodes kozlovi* Astafurova & Proshchalykin, 2015 and *S. simillimus* Smith, 1873, both displaying a similar form to the male geni-



**Figures 94–97.** *Sphecodes montanus* Smith, female **94** head, frontal view **95** metasoma, dorsal view **96** mesosoma, dorsal view **97** T5–T6, pygidial plate, dorsal view. Scale bars: 1.0 mm (**94–96**), 0.5 mm (**97**).





**Figures 98–102.** *Sphecodes montanus* Smith, male **98** head and mesosoma, dorsal view **99** metasoma, dorsal view **100** genal area and lateral preoccipital carina, lateral view **101** genitalia, dorsal view **102** antennae, lateral view. Scale bars: 1.0 mm.

talía with a large membranous section of the gonostylus (Fig. 101), a similar size of antennal tyloids and a flat vertex with longitudinal carina (in the last feature, the species is also similar to *S. pieli* Cockerell, 1931). *S. montanus* differs from these three species

by the possession of a weakly developed lateral preoccipital carina (absent in *S. kozlovi*, *S. simillimus* and *S. pieli*) and a narrower female pygidial plate which is 1.1–1.2 times as wide as metabasitarsus (versus 1.2–1.5).

**Descriptive notes.** Wings hyaline to weak brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 90°, costal margin with five or six hamuli. Vertex with longitudinal carina; lateral preoccipital carina weakly developed (Fig. 100). **Female.** Total body length 7–8 mm. Head strongly transverse (Fig. 94), ca. 1.3 times as wide as long; vertex not elevated as seen in frontal view; labrum semi-oval, 0.5 times as long as basal width; face and ocello-ocular area areolate-punctate; paraocular areas and gena with sparse pubescence. Mesoscutum and mesoscutellum (Fig. 96) densely punctate with punctures separated by at most one or two puncture diameters, becoming denser (confluent) peripherally. Propodeal triangle (metapostnotum), mesepisternum and hypoepimeral area reticulate-rugose. Metasomal T1 impunctate, T2–T4 basally with sparse minute (5–10 µm) punctures (Fig. 95); marginal zones impunctate. Pygidial plate dull, 1.1–1.2 times as wide as metabasitarsus (Fig. 97); T1–T3 red. **Male.** Total body length 7–7.5 mm. Head transverse, ca. 1.2 times as wide as long; vertex not elevated as seen in frontal view; tyloids weakly developed, semi-oval, covering (at least from F4 onward) approximately basal 1/5–1/3 of flagellomeres (Fig. 102); F2 ca. 1.8 times as long as wide. Face and ocello-ocular area areolate-punctate. Mesosomal sculpture as in female (Fig. 98). Metasoma dark (Fig. 99); T1 impunctate; remaining terga basally finely and densely punctate. Gonocoxite dorsally without impression; gonostylus large, rectangular, apically with long setae (Fig. 101).

**Material examined.** LAOS: 1 ♂, Prov. Hua Phan, Phou Pan, Umg. Ort Ban Saleui, 20°13'N, 103°59'E, 1350–1900 m, 10–14.V.2012, C. Holzschuh & locals (OLBL/PCMS).

**Distribution.** \*Laos, India (Uttaranchal Rajasthan).

***Sphecodes pseudoredivivus* Astafurova & Proshchalykin, sp. nov.**

<http://zoobank.org/1D5A1DFD-7108-4F86-8AD7-3CB1F1CCB98B>

Figures 103–109

**Type material. Holotype:** ♀, LAOS, Louang Prabang prov., 20°33'N, 102°14'E, Ban Songcha, 1200 m, 24.IV–16.V.1999 (OLBL/PCMS), Fig. 103.

**Diagnosis.** This species is sculpturally closest to *Sphecodes malayensis* Blüthgen, 1927, *S. redivivus* Blüthgen, 1927 and *S. sauteri* Meyer, 1925 (refer to diagnosis of *S. sauteri* below) and possibly is the unknown female of *S. redivivus* owing to a similar sculpture of the hypoepimeral area.

**Description. Female** (holotype, Fig. 103). Total body length 5.0 mm, fore wing 4.4 mm. Head (Fig. 104) black (except reddish antenna, yellow mouthparts and lower clypeus); transverse, ca. 1.2 times as wide as long; preoccipital carina absent; vertex weakly elevated, distance from top of head to upper margin of a lateral ocellus at most a half ocellar diameter as seen in frontal view and ca. 2 diameters as seen in dorsal view; mandibles simple; labrum short, semi-oval, 0.2 times as long as basal





**Figure 103.** *Sphecodes pseudoredivivus* Astafurova & Proshchalykin, sp. nov., female, holotype, lateral view. Scale bars: 1.0 mm.

width; F1 transverse, 0.7 times as long as wide; F2 square; F3 1.2 times as long as wide; face densely punctate ( $15\text{--}20\text{ }\mu\text{m}$  /  $0.5\text{--}1.5$ ); ocello-ocular area (Fig. 105) and gena shiny, sparsely punctate (ca.  $10\text{ }\mu\text{m}$  /  $1\text{--}3$ ); paraocular and supraclypeal areas with relatively dense plumose setae, but not obscuring integument; gena with sparse thin pubescence.

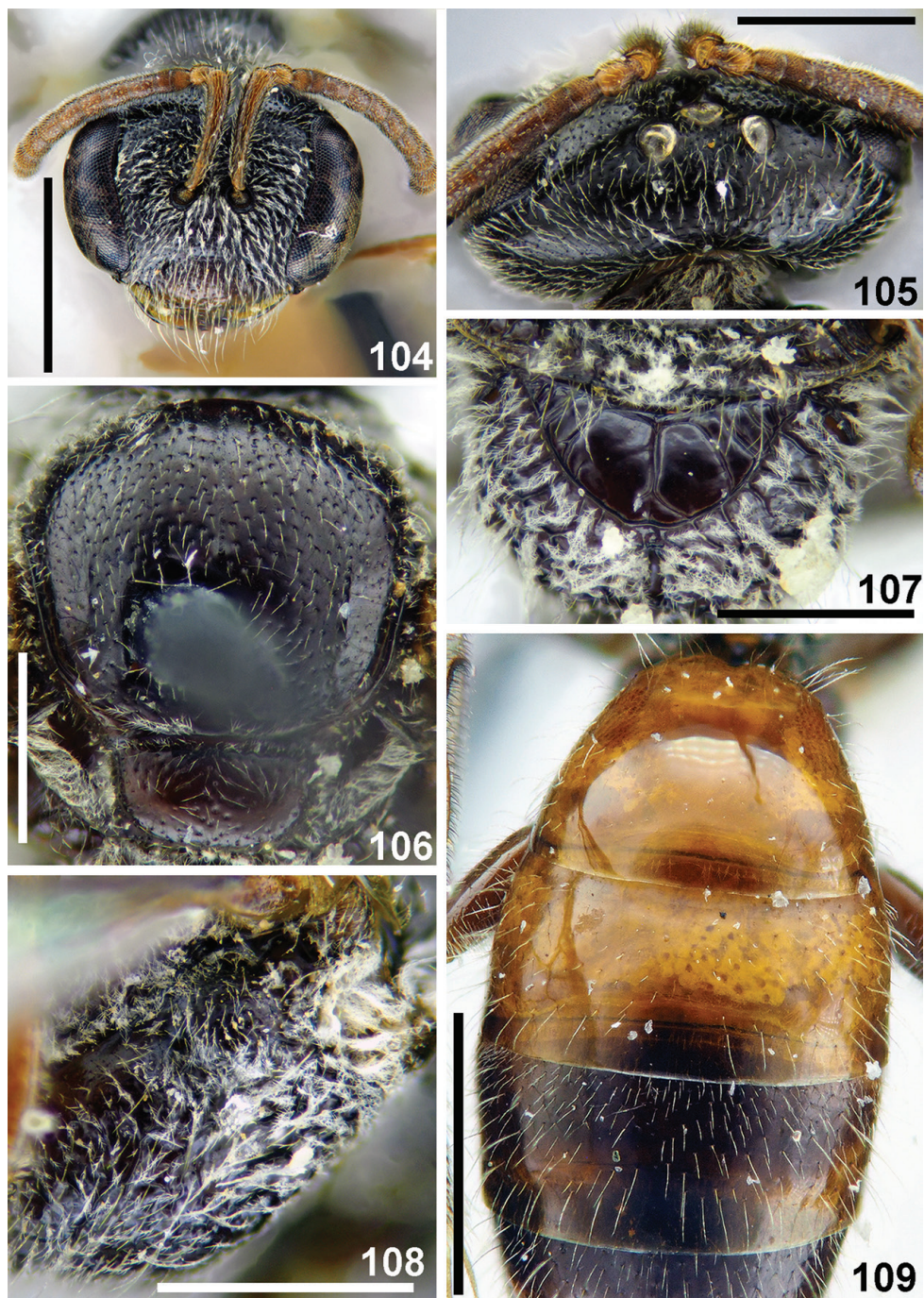
Mesosoma black with legs yellow-brownish to light yellow; wings hyaline, with weak yellowish darkening and light brown stigma and veins; stigma wide, 0.4 times as long as wide; hind wing with angle between basal (M) and cubital (Cu) veins ca.  $90^\circ$ , costal margin with five hamuli; mesoscutum and mesoscutellum (Fig. 106) finely punctate ( $10\text{--}20\text{ }\mu\text{m}$  /  $1\text{--}4$ ); metafemur elongate, weakly enlarged in the proximal half, maximum width 0.3 times its length; hypopimeral area smooth with coarse and dense punctures (Fig. 108), mesepisternum areolate-punctate to rugose, but smooth with minute punctures along posterior margin. Propodeal triangle (metapostnotum) with a few coarse longitudinal wrinkles and shining smooth large interspaces (Fig. 107); lateral and vertical parts of propodeum roughly rugose with dense short plumose setae almost obscuring integument.

Metasomal T1 almost impunctate with a few minute setae pores (Fig. 109); remaining terga with sparse minute setae pores; marginal zones impunctate; T1–T2 red, remaining terga red-brownish; pygidial plate shining and very narrow, 0.4 times as wide as metabasitarsus. Sterna finely tessellate with dense shallow setae pores.

**Male** unknown.

**Etymology.** The species name highlights the morphological similarity with *S. redivivus* Blüthgen.

**Distribution.** Only known from the type locality in Laos.



**Figures 104–109.** *Sphecodes pseudoredivivus* Astafurova & Proshchalykin, sp. nov., female, holotype **104** head, frontal view **105** vertex, dorsal view **106** scutum, dorsal view **107** propodeum, dorsal view **108** hypoepimeral area and mesepisternum, lateral view **109** T1–T3, dorsal view. Scale bars: 1.0 mm (**104**, **109**), 0.5 mm (**105–108**).



***Sphecodes samarensis* Blüthgen, 1927**

Figures 110–114

*Sphecodes samarensis* Blüthgen, 1927: 73, Fig. 19a–e, ♂ (holotype: ♂, Philippines, Insel Samar, Baker leg.; ZMHB, examined, illustrated in Fig. 125).

**Diagnosis.** This species is closest to *Sphecodes bakeri* (refer to diagnosis of *S. bakeri*, above). The male is also similar to *S. biroi* Friese, 1909 and *S. laticeps* Meyer, 1920 owing to a similar structure, sculpture and coloration of the body, including the shape of the male genitalia. The species differs from *S. laticeps* by the areolate and less elevated vertex with distance from top of head to upper margin of lateral ocellus half or one of a lateral ocellar diameter as seen in frontal view (versus shining vertex with interspaces between punctures and distance from top of head to upper margin of lateral ocellus one and a half or two lateral ocellar diameters. The female of *S. samarensis* is unknown, but these features would work in both sexes). From *S. biroi* the species differs in the shape of tyloids with a glabrous medial spot on ventral surface of flagellomeres (versus tyloids usually covering entire ventral flagellar surface or sometimes with a small non-setae spot on basal flagellomeres). The unknown female is probably closest to *S. duplex* and *S. bakeri*.

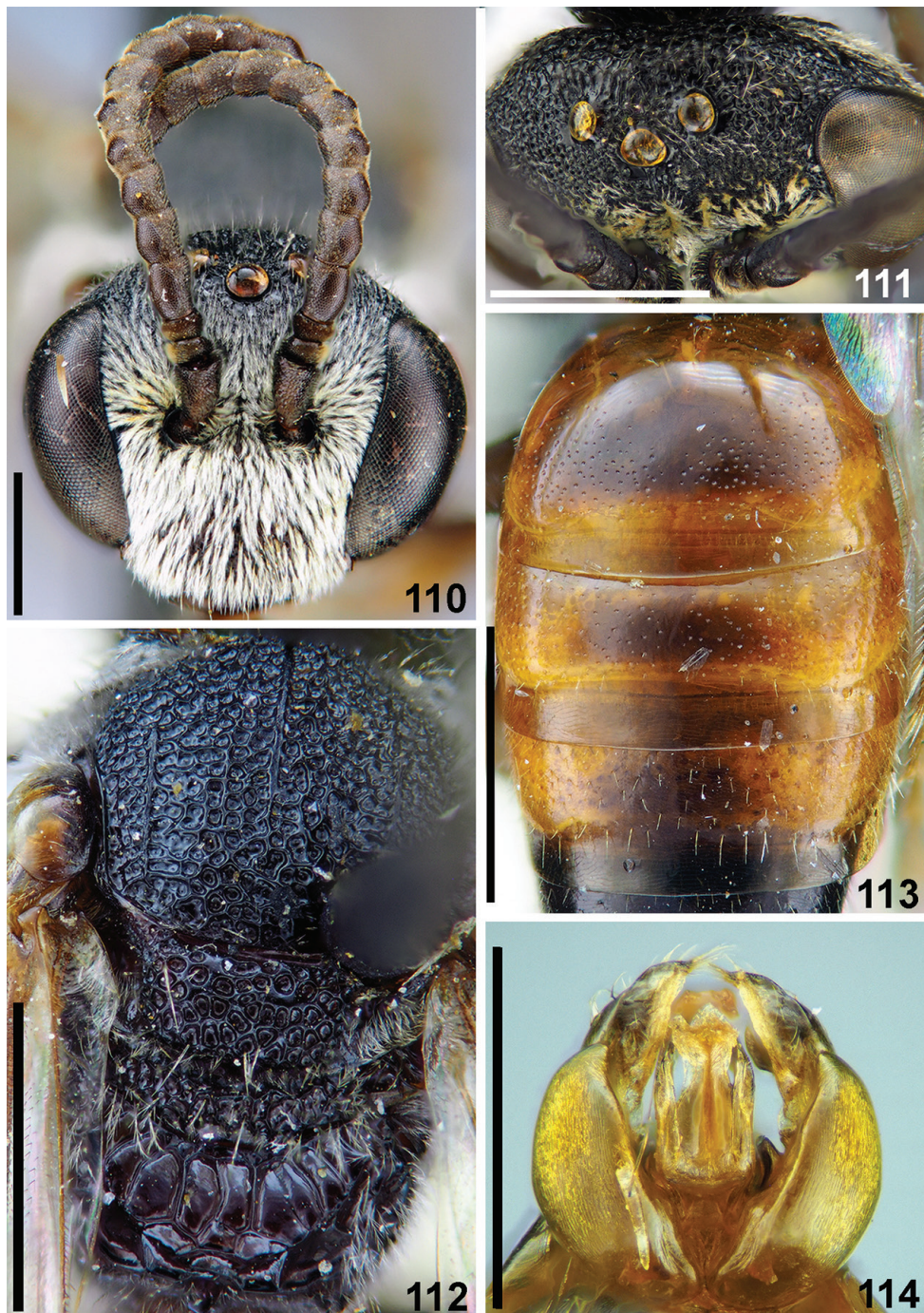
**Descriptive notes.** Wings with weak yellow-brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins almost 80°, costal margin with seven hamuli. Lateral preoccipital carina present. **Male.** Total body length 5–6.5 mm. Head (Fig. 110) transverse, ca. 1.25 times as wide as long; vertex weakly elevated with the distance from top of head to upper margin of a lateral ocellus half or one of a lateral ocellar diameter as seen in frontal view; antennae (Fig. 110) short, reaching posterior margin of mesoscutum, F2 ca. 1.5 times as long as wide, remaining flagellomeres ca. 1.2 times as long as wide; tyloids well developed, covering entire lateral flagellar surfaces and peripheral part of ventral surface (ventral surface medially with glabrous round spot); face and vertex (Fig. 111) finely areolate-punctate; face (below and above the antennal sockets) with adpressed white pubescence obscuring integument, gena with sparser pubescence. Mesoscutum and mesoscutellum areolate (Fig. 112); propodeal triangle sculpture roughly reticulate-rugose, forming a row of large deep longitudinal cells; lateral parts of propodeum rugose with large smooth shiny interspaces. Metasomal terga (Fig. 113) with fine punctures (10–15 µm /1–3); marginal zones impunctate; T1–T3 red; gonocoxite dorsally without impression; gonostylus as on Fig. 114. **Female** unknown.

**Material examined.** INDONESIA: 1 ♂, Sumatra, 500 m, Sirggalang Annai Valley n.r., 14.X.2005, S. Jakl (OLBL/PCMS); MALAYSIA: 1 ♂, Pahang, 30 km NE Raub, 300 m, Lala Lembik, 3°56'N, 101°38'E, IV–V.2002, E. Jendek, O. Sausa (OLBL/PCMS); PHILIPPINES: 4 ♂♂ (holotype and paratypes), Insel Samar, Baker [leg.] (ZMHB).

**Published records.** Blüthgen 1927: 73 (Philippines), Ascher and Pickering 2019 (Philippines).

**Distribution.** \*Indonesia, \*Malaysia, Philippines.





**Figures 110–114.** *Sphecodes samarensis* Blüthgen, male **110** head, frontal view **111** vertex, dorsal view **112** mesosoma, dorsal view **113** T1–T3, dorsal view **114** genitalia, dorsal view. Scale bars: 1.0 mm.

***Sphecodes sauteri* Meyer, 1925**

Figures 115–126

*Sphecodes sauteri* Meyer, 1925: 10, ♂ (holotype: ♂, “Formosa [Taiwan], Mt. Hoozan, 1910, III, Sauter [leg.]”; HNHM, examined, Fig. 125).

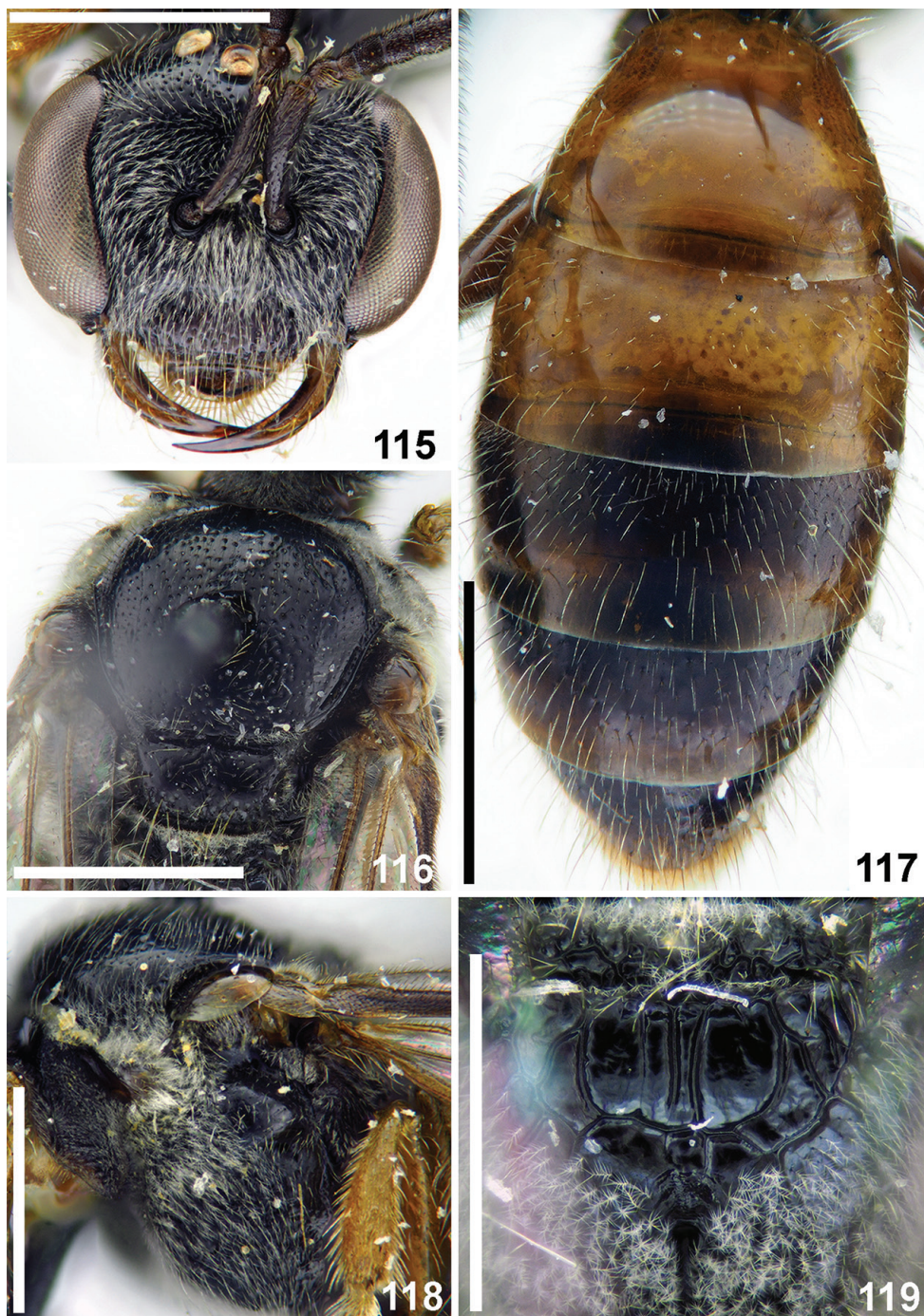
**Diagnosis.** This species is sculpturally closest to *Sphecodes malayensis* Blüthgen, 1927, *S. pseudoredivivus* sp. nov. and *S. redivivus* Blüthgen, 1927 including a scarcely punctate metasomal terga and smoothed hypopimeral area (differences between males of these species are outlined in Table 3). These species belong to the same species-group and females of *S. sauteri* and *S. pseudoredivivus* have simple mandibles, and the unknown females of *S. malayensis* and *S. redivivus* probably have simple mandibles as well. The female of *S. sauteri* differs from *S. pseudoredivivus* in having shorter flagellomeres from F3 onward (ca. 0.9–1.0 versus 1.2) and a scarcely punctate hypopimeral area (versus dense punctures separated by approximately a puncture diameter).

**Descriptive notes.** Wings with weak yellow-brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 90°, costal margin with six or seven hamuli. Preoccipital carina absent. **Female** (new). Total body length 6 mm. Head (Fig. 115) strongly transverse, ca. 1.2 times as wide as long; vertex not elevated as seen in frontal view; mandible simple; labrum short, semi-oval, 0.2 times as long as basal width; F2 and F3 nearly square, ca. 0.9 times as long as wide; ocello-ocular area shining, sparsely punctate (ca. 15 µm / 0.5–3). Gena smooth and shining, with sparse setae pores; paraocular and supraclypeal areas with relatively dense plumose setae, but not obscuring integument. Gena with sparse pubescence. Mesosoma (Figs 116, 118, 119) and metasoma (Fig. 117) sculptured as in the male; lateral and vertical parts of propodeum with dense short plumose setae, obscuring integument. Metasoma red, pygidial plate as wide as metabasitarsus. **Male.** Total body length 5.0–5.5 mm. Head (Fig. 120) transverse, ca. 1.2 times as wide as long; vertex not elevated as seen in frontal view; antennae short (Fig. 121), reaching middle of mesoscutum, flagellomeres (from F2 onward) ca. 1.2 times as long as wide; tyloids semi-oval across basal 1/4–1/3 of flagellar surfaces; face and ocello-ocular area with punctures (20–25 µm) separated by 0.5–2

**Table 3.** Differences between males of *Sphecodes sauteri*, *S. malayensis*, and *S. redivivus*.

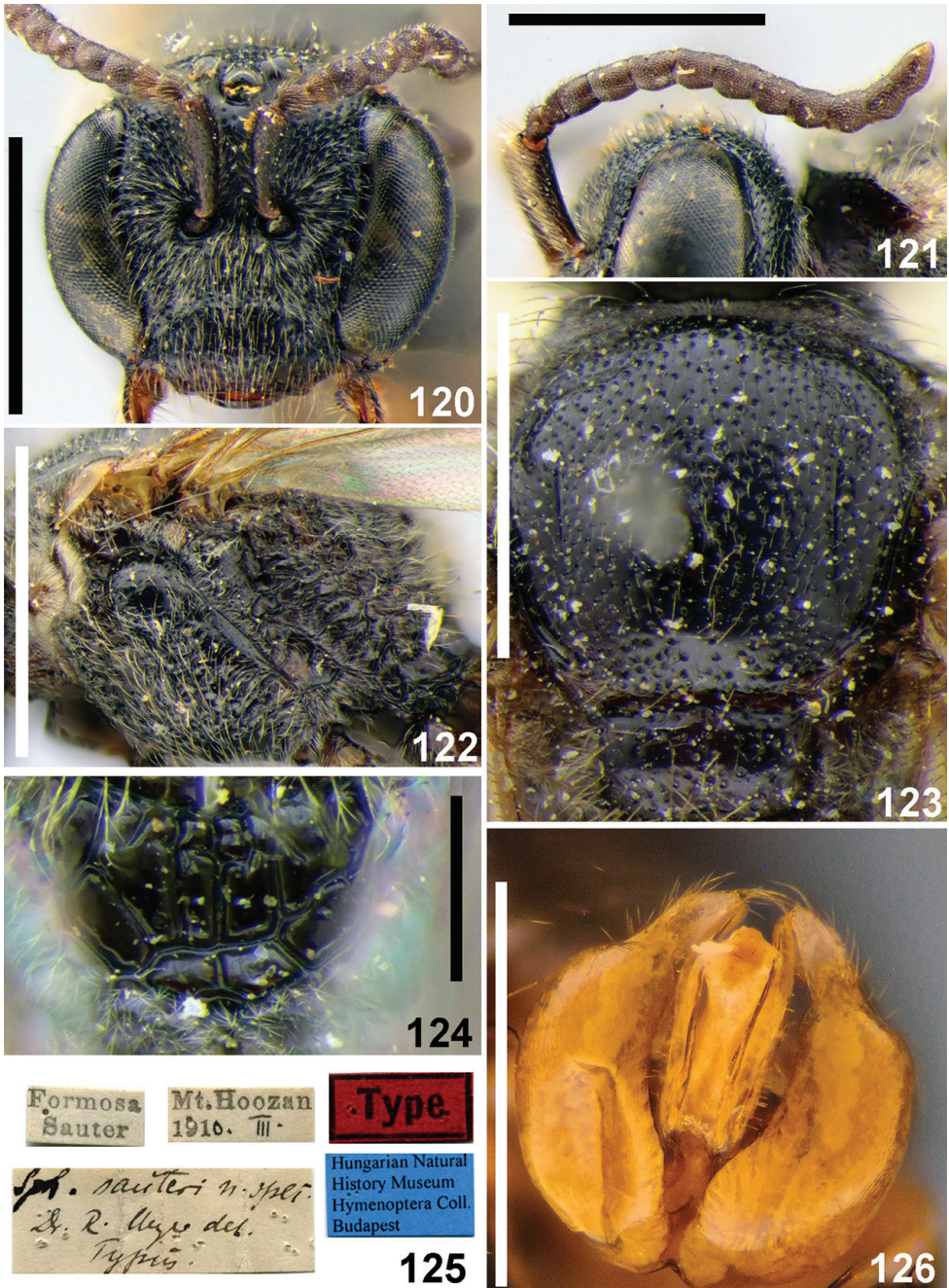
Characters	<i>Sphecodes</i> species		
	<i>sauteri</i>	<i>malayensis</i>	<i>redivivus</i>
Head	1.2 times as wide as long	1.25 times as wide as long	1.2 times as wide as long
Tyloids	Semi-oval across 1/3 basal flagellar surfaces	Semi-oval across 1/2 basal flagellar surfaces	Semi-oval across 1/4 basal flagellar surfaces
F3	1.2 as long as wide	Square	Square
Hypopimeral area	Smooth with tiny and sparse punctures	Smooth with a few microscopical punctures	Smooth to finely rugulose with dense punctures
Number of hamuli	6–7	5	5
Antennae coloration	Red	Brown	Brown





**Figures 115–119.** *Sphecodes sauteri* Meyer, female **115** head, frontal view **116**, **118** mesosoma, dorsal view (**116**), lateral view (**118**) **117** metasoma, dorsal view **119** propodeum, dorsal view. Scale bars: 1.0 mm.





**Figures 120–126.** *Sphecodes sauteri* Meyer, male, holotype (120–125) 120 head, frontal view 121 antennae, lateral view 122 mesepisternum, lateral view 123 scutum, dorsal view 124 propodeum, dorsal view 125 holotype labels 126 genitalia, dorsal view. Scale bars: 1.0 mm (120–123), 0.5 mm (124, 126).

puncture diameters; face and gena with sparse pubescence. Mesoscutum and mesoscutellum (Fig. 123) densely and finely punctate (20–25  $\mu\text{m}$  / 0.5–2); hypoepimeral area smooth with minute and sparse punctures (Fig. 122); propodeal triangle coarsely reticulate-rugose with shining large interspaces between wrinkles (Fig. 124); lateral and vertical parts of propodeum with dense short plumose setae, almost obscuring integument. Metasomal T1 almost impunctate; remaining terga with sparse setae pores; T1–T3 red or brownish; gonocoxite dorsally without impression; gonostylus short, as in Fig. 126.

**Material examined.** LAOS: 1 ♀, Phongsaly prov., Phongsaly env., 21°41'N, 102°06'E, 1500 m, 28.V.-20.VI.2003, V. Kuban (OLBL/PCMS).

**Distribution.** \*Laos, China (Taiwan).

### *Sphecodes sikkimensis* Blüthgen, 1927

*Sphecodes sikkimensis* Blüthgen, 1927: 54, Fig. 12a, ♀ (syntypes: ♀♀, Sikkim [India], 6.97., Rungit Tal, 1000', Coll. Bingham; ZMHB, examined).

**Diagnosis.** This species differs noticeably from other described Oriental species with a lateral preoccipital carina by a combination of large total body length (12–15 mm) and the greatest number (12–15) of hamuli (other large oriental species are usually at most 12 mm in length and have hind wings with at most eleven or twelve hamuli).

**Descriptive notes.** Wings with strong brownish darkening and metallic violet lustre; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 80°, costal margin with 12–15 hamuli. **Female.** Total body length 12–15 mm. Head transverse, 1.25 times as wide as long; vertex elevated with the distance from top of head to upper margin of a lateral ocellus ca. two lateral ocellar diameters as seen in frontal view; labrum short, semi-oval, 0.45 times as long as basal width; face and ocello-ocular area areolate-punctate; paraocular areas and gena with sparse pubescence not obscuring integument. Mesoscutum and mesoscutellum areolate-punctate (50–100  $\mu\text{m}$ ). Propodeal triangle (metapostnotum) coarsely reticulate-rugose; mesepisternum reticulate-rugose. Metasoma red, coarsely and densely punctate (ca. 25  $\mu\text{m}$ ), sparser on T1. Marginal zone impunctate, except T1 with fine punctures (ca. 10  $\mu\text{m}$ ); pygidial plate dull, 1.2 times as wide as metabasitarsus. **Male** unknown.

**Material examined.** LAOS: 1 ♀, Prov. Hua Phan, Phou Pan, Umg. Ort Ban Saleui, 20°13'N, 103°59'E, 1350–1900 m, 28.IV.2012, C. Holzschuh (OLBL/PCMS); MYANMAR: 1 ♀, Nam Tamai, 3000 ft, 9.I.1931, F. Kingdon Ward (NHMUK 013380357).

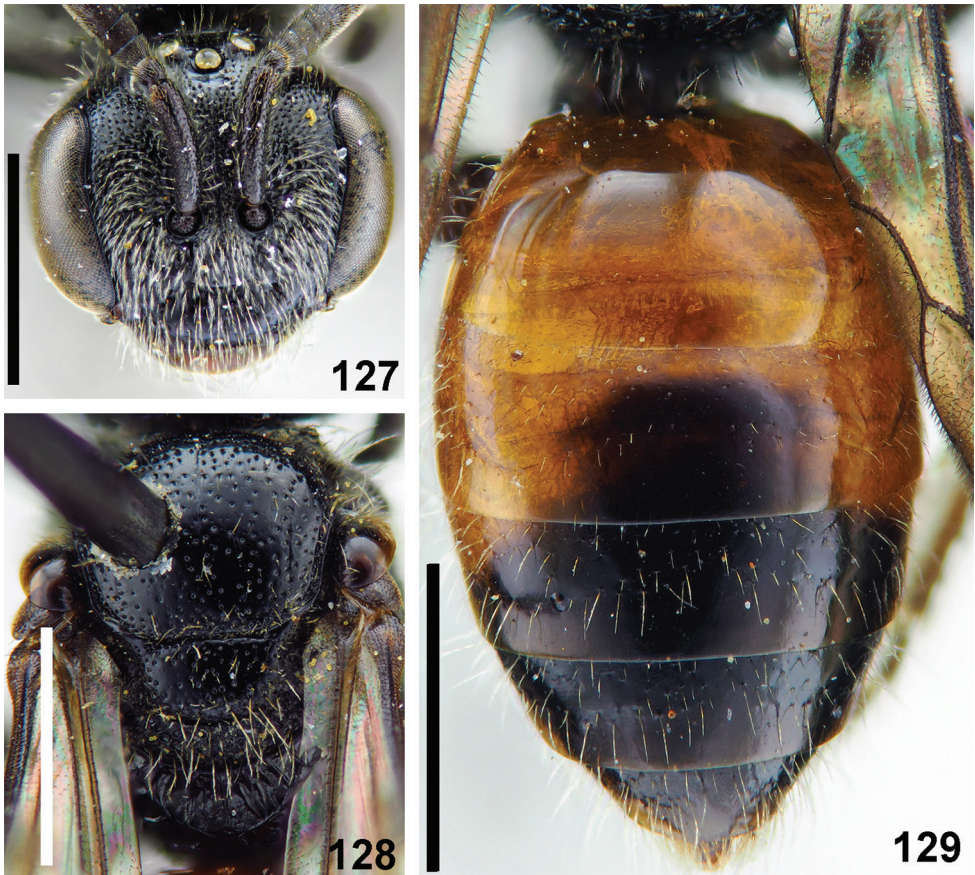
**Distribution.** \*Laos, \*Myanmar, NE India, China (Guangdong).

### *Sphecodes simlaensis* Blüthgen, 1924

Figures 127–134

*Sphecodes simlaensis* Blüthgen, 1924: 514–515, ♀ (syntypes: 2 ♀♀, India, Simla, VIII. and IX.[18]98, Nurse leg.; were not found in NHMUK).



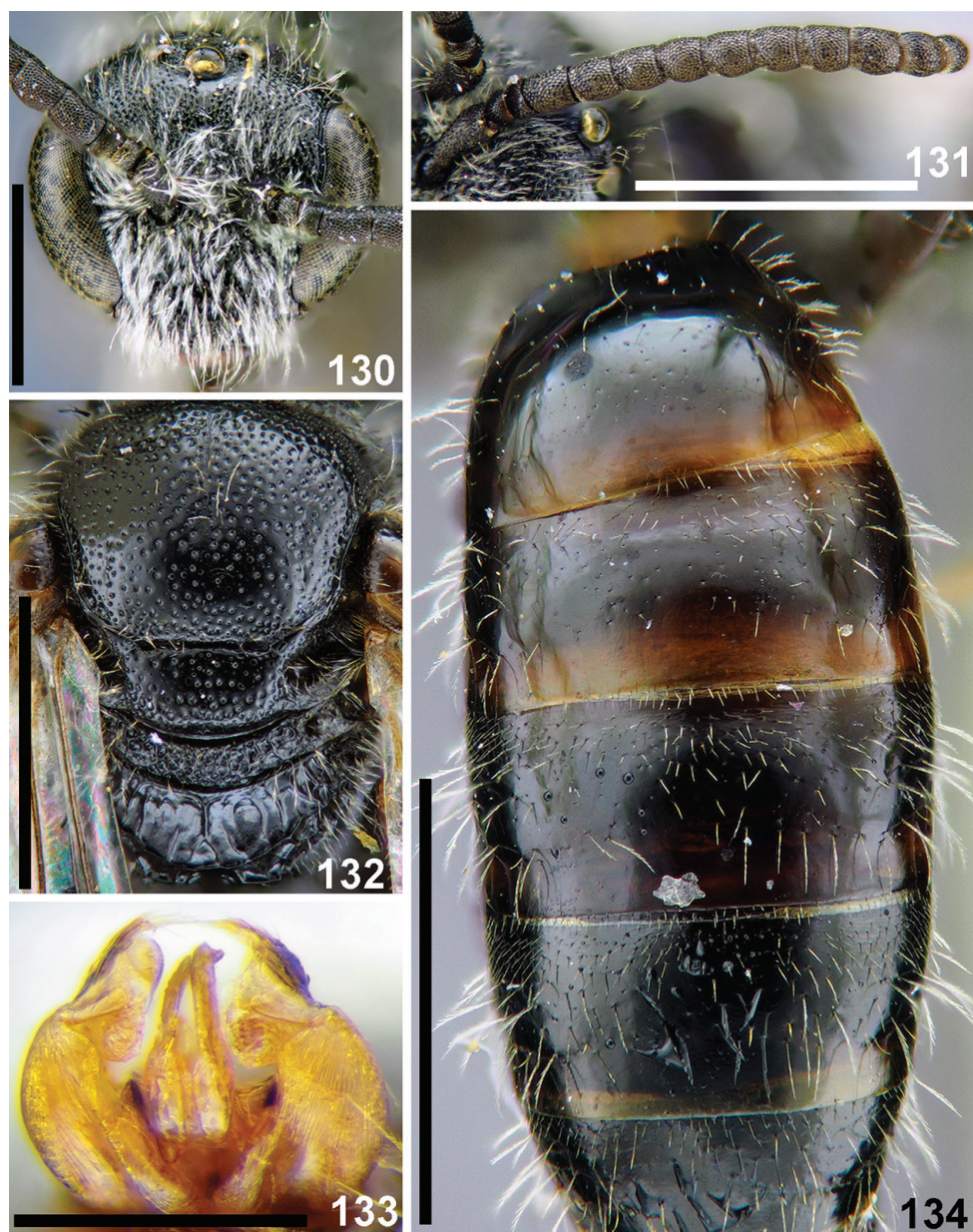


**Figures 127–129.** *Sphecodes simlaensis* Blüthgen, female **127** head, frontal view **128** mesosoma, dorsal view **129** metasoma, dorsal view. Scale bars: 1.0 mm.

*Sphecodes simlaellus* Blüthgen, 1927: 46–48, Fig. 8, ♂ (lectotype (**designated here**): ♂, Simla [India, Himachal Pradesh], 8.98 // Col. C.G. Nurse Collection. 1920-72 // *Sph. simlaensis* n. sp., ♂, P. Blüthgen det. // Type; ZMHB, examined; paralectotype: 1 ♂ [without head]: Type // Simla, Nurse 9. 98 // Col. C.G. Nurse Collection. 1920-72 // *Sph. simlaensis*, Type P. Blüthgen det. // B.M. Type HYM.17a548 // NHMUK 0133803332; examined). Syn. nov.

**Diagnosis.** This species is close to the Palearctic *Sphecodes geoffrellus* (Kirby 1802) owing to a similar structure, sculpture, coloration of the body and shape of the male gonostylus. Females of *S. simlaensis* and *S. geoffrellus* are difficult to distinguish morphologically, but the male of *S. simlaensis* is easily discerned by the weakly developed tyloids, covering at most 1/4 of the basal ventral surfaces of the flagellomeres, Fig. 131 (versus at least 4/5 in *S. geoffrellus*). Structurally, the male of *S. simlaensis* is also close to *S. shillongensis* Blüthgen, 1927, but differs in the shape of the gonostylus which has a membranous part (lacking in *S. shillongensis*).





**Figures 130–134.** *Sphecodes simlaensis* Blüthgen, male **130** head, frontal view **131** antennae, ventral view **132** mesosoma, dorsal view **133** genitalia, dorsal view **134** metasoma, dorsal view. Scale bars: 1.0 mm (**130–132**, **134**), 0.5 mm (**133**).

**Descriptive notes.** Wings with weak yellowish or brownish darkening; hind wing with basal vein strongly curved with angle between basal (M) and cubital (Cu) veins ca. 80°, costal margin with five hamuli. Preoccipital carina absent. **Female.** Total body

length 5–5.5 mm. Head (Fig. 127) weakly transverse, at most 1.2 times as wide as long; vertex not elevated as seen in frontal view; F1 and F2 transverse, 0.6–0.8 times as long as wide, F3 almost square, 0.9 times as long as wide; clypeus with punctures separated by 0.5–2 puncture diameters; ocello-ocular area with fine punctures separated by 1–3 puncture diameters; face and gena with sparse pubescence. Mesoscutum and mesoscutellum (Fig. 128) with punctures (15–20  $\mu\text{m}$ ) separated by 1–4 puncture diameters; hypoepimeral area coarsely reticulate. Propodeal triangle (metapostnotum) with coarse longitudinal wrinkles and shiny interspaces. Metasomal T1 impunctate, remaining terga basally with fine sparse setae pores (Fig. 129); marginal zones impunctate; T1–T3 red, pygidial plate 0.7 times as wide as metabasitarsus. **Male.** Total body length 5–5.5 mm. Head (Fig. 130) slightly transverse, 1.1 times as wide as long; vertex not elevated as seen in frontal view; antenna reaching posterior margin of mesoscutum; F2 1.4 times as long as wide, remaining flagellomeres almost square, ca. 1.1 times as long as wide, tyloids weakly developed, semi-oval across at most basal 1/4 of flagellar ventral surfaces (Fig. 131); ocello-ocular area shining, with fine punctures separated by 1–3 puncture diameters; face with pubescence obscuring integument below antennal stocks and sparser above. Mesoscutum medially with punctures (15–25  $\mu\text{m}$ ) separated by 0.5–3 puncture diameters, becoming denser peripherally (Fig. 132). Propodeal and metasomal sculpture as in the female; terga brownish (Fig. 134); gonocoxite dorsally with impression; gonostylus with small rectangular membranous part (Fig. 133).

**Material examined.** LAOS: 1 ♂, Phongsaly pr., Phongsaly env., 1500 m, 21°41'N, 102°06'E, VII.2003, Pacholatko (OLBL/PCMS); 1 ♂, idem, 6–17.V.2004, V. Kuban (OLBL/PCMS).

**Distribution.** \*Laos, India (Himachal Pradesh), Pakistan.

### *Sphecodes turneri* Cockerell, 1916

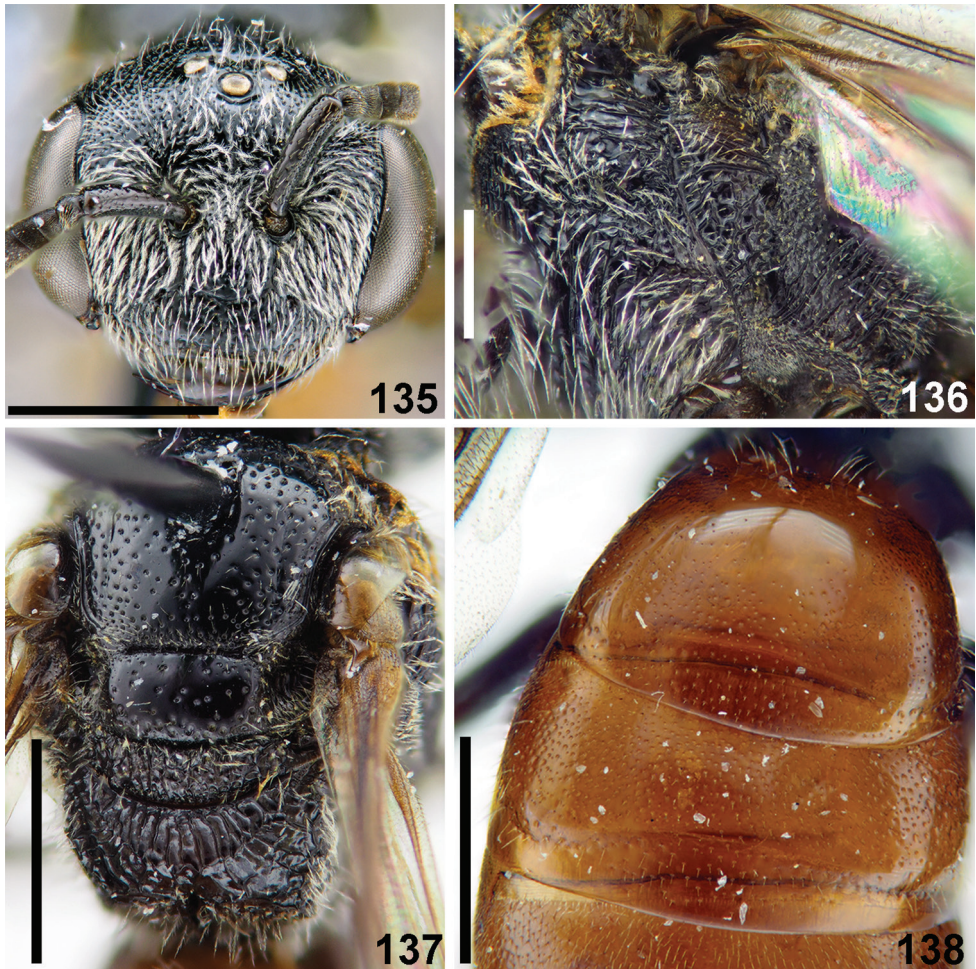
Figures 135–144

*Sphecodes turneri* Cockerell, 1916: 430, ♀ (holotype: ♀, India, Assam, Shilong, 5.03., B. Turner, 1905–125. 17a.561; NHMUK 013380320; examined).

**Diagnosis.** This species differs from other species of the genus by having forewings with two submarginal cells (Fig. 143) (versus three cells in other *Sphecodes* species).

**Descriptive notes.** Wings with brownish darkening; hind wing with the angle between basal (M) and cubital (Cu) veins ca. 70°, costal margin with eight or nine hamuli. **Female.** Total body length 8–9 mm. Head transverse (Fig. 135), ca. 1.3 times as wide as long; vertex elevated with distance from top of head to upper margin of lateral ocellus ca. one and a half lateral ocellar diameter as seen in frontal view; ocello-ocular area shining, with punctures separated by 0.5–2 puncture diameters; paraocular and supraclypeal areas with dense adpressed white plumose pubescence, gena with sparser pubescence. Mesoscutum (Fig. 137) irregularly punctate, denser peripherally and with large interspaces medially (20–35  $\mu\text{m}$  / 0.5–5); mesoscutellum sparsely punctate with

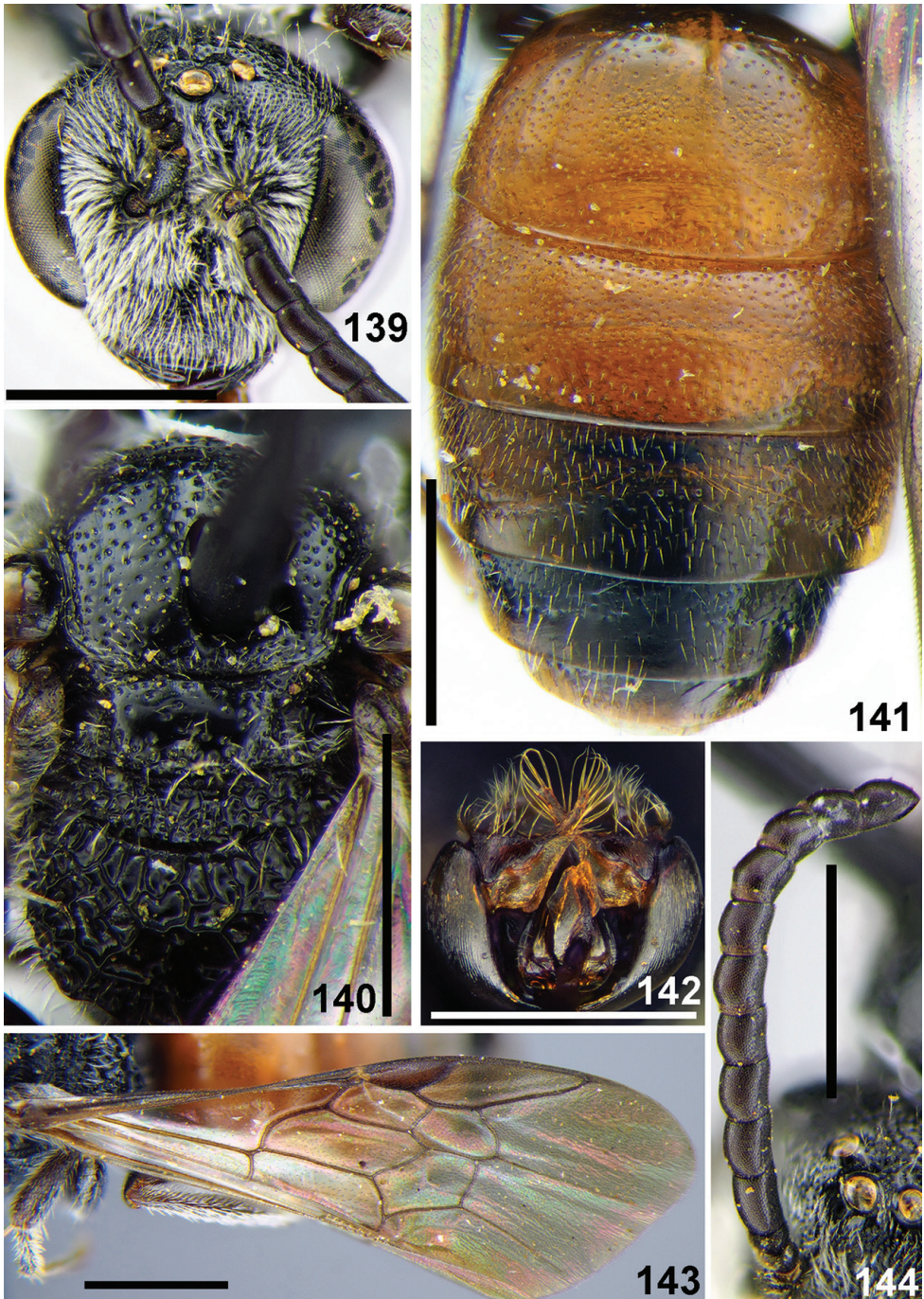




**Figures 135–138.** *Sphecodes turneri* Cockerell, female **135** head, frontal view **136** mesepisternum, lateral view **137** mesosoma, dorsal view **138** T1–T2, dorsal view. Scale bars: 1.0 mm (**135**, **137**, **138**), 0.5 mm (**136**).

large impunctate interspaces; propodeal triangle (metapostnotum) with longitudinal parallel wrinkles (Fig. 137); lateral parts of propodeum striate-rugose; mesepisternum reticulate-rugose (Fig. 136). Metasoma with a mixture of minute and coarse punctures ( $5\text{--}25\text{ }\mu\text{m}$  / 1–3) (Fig. 138); marginal zones T1 entirely and T2 medially punctate. Pygidial plate narrow, 0.4 times as wide as metabasitarsus; T1–T4 red. **Male** (new). Total body length 7.0–8.5 mm. Head (Fig. 139) weakly transverse, 1.15 times as wide as long; vertex elevated, with distance from top of head to upper margin of lateral ocellus ca. one and a half of a lateral ocellar diameter as seen in frontal view; antenna long, reaching mesoscutellum, F2 1.7 times as long as wide, remaining flagellomeres ca. 1.2 times as long as wide; tyloids weakly developed, narrowly semicircular across at





**Figures 139–144.** *Sphecodes turneri* Cockerell, male **139** head, frontal view **140** mesosoma, dorsal view **141** metasoma, dorsal view **142** genitalia, dorsal view **143** forewing, lateral view **144** antennae, ventro-lateral view. Scale bars: 1.0 mm (**139–141**, **143**, **144**), 0.5 mm (**142**).

most 1/4 of the basal flagellar surfaces (Fig. 144). Face and ocello-ocular area densely punctate, the punctures separated by at most 0.5 of a puncture diameter. Mesoscutum coarsely punctate (20–30  $\mu\text{m}$  / 0.5–3); mesoscutellum irregularly punctate with large interspaces (Fig. 140). Propodeal triangle coarsely reticulate-rugose (Fig. 140); mesepisternum reticulate-rugose. Metasoma (Fig. 141) with a mixture of minute and coarse punctures, 5–20  $\mu\text{m}$ ); marginal zones of T1 and T2 punctate; gonocoxite dorsally without impression; gonostylus with a long and narrow apical process as in Fig. 142.

**Material examined.** LAOS: 1 ♀, 1 ♂, Prov. Hua Phan, Phou Pan, Umg. Ort Ban Saleui, 20°13'N, 103°59'E, 1350–1900 m, 15.IV.2012, C. Holzschuh & locals (OLBL/PCMS).

**Distribution.** \*Laos, India (Meghalaya).

**Remarks.** It is noteworthy that the other cleptoparasitic genus *Nomada* Scopoli (Apidae) also has a small group of species with two submarginal cells (Proshchalykin and Lelej 2010).

## Discussion

The most important figures, on which the study is based, are shown in Table 1, which assigns the individual species to the countries of Southeast Asia, with the respective totals and number of collection points. Amongst all bees in the collections we studied, the proportion of specimens from the Oriental Region belonging to the genus *Sphecodes* present turned out to be scanty, which suggests that the genus in this region is extremely rare. Although the number of species recorded here (approximately 50) is less than in the Palearctic Region (approximately 70), this number will probably exceed the number of Palearctic species eventually as further new species are described. In total, 31 species of *Sphecodes* are recorded from Southeast Asia (Table 1) and only eleven of these have a distribution beyond the studied region (India, Pakistan, China). However, the record of 20 other species confined to Southeast Asia does not indicate a large degree of endemism of the fauna, but rather suggests an incomplete knowledge of the distribution of the oriental fauna of *Sphecodes*.

Most species recorded in Southeast Asia have montane distributions and are found up to 1900 m. The range of *S. biroi*, which is distributed from New Guinea to India, is the widest among Southeast Asian species. *Sphecodes simlaensis*, *S. montanus*, *S. sikkimensis*, and *S. fumipennis* are also probably widespread in the mountainous areas of the Oriental Region.

Morphologically, a large proportion of Southeast Asian species have close affinities to some of the Palearctic species or belong to one of the Palearctic species groups. *Sphecodes engeli* belongs to the *hyalinatus* species group (for the composition of Palearctic species groups see Astafurova and Proshchalykin 2017a); *S. discoverlifei* is similar to *S. crassus* Thomson, 1870; *S. montanus* resembles the Eastern Palearctic *S. kozlovi* Astafurova & Proshchalykin, 2015 and *S. simillimus* Smith, 1873; *S. sauteri*, *S. malayensis*, *S. pseudoredivivus* and *S. redivivus* are the closest to several small Palearctic species with simple mandibles which lack an inner tooth (i.e., *S. armeniacus* Warncke,

1992, *S. longuloides* Blüthgen, 1923, *S. hirtellus* Blüthgen, 1923, *S. longulus* Hagens, 1882, *S. puncticeps* Thomson, 1870, *S. turanicus* Astafurova & Proshchalykin, 2017, and *S. trjapitzini* Astafurova & Proshchalykin, 2018); *S. simlaensis* is similar to the Palearctic *S. geoffrellus* (Kirby 1802). Widespread Palearctic *S. scabricollis* Wesmael, 1835 is similar to a significant number of Southeast Asian species (*S. bakeri*, *S. binghami*, *S. biroi*, *S. distinctus*, *S. duplex*, *S. formosanus*, *S. howardi*, *S. insularis*, *S. kershawi*, *S. laticeps*, *S. samarensis*, *S. sibuyanensis*, *S. sikkimensis*, *S. takaensis*, *S. tristellus*, *S. rotundiceps*, and *S. ilyadadaria*) by the presence of a lateral preoccipital carina and densely punctate mesosoma. At the same time two species have a unique combination of characters that has no analogue to any of the known Palearctic and Oriental species: *S. turneri* with two submarginal cells in the forewing and *S. brunneipes* with a combination of simple mandibles in the female and a lateral preoccipital carina.

It is quite certain that new species will be found in further studies, and through synonymy and the association of sexes described as separate species, numerous changes in the species spectrum can be expected in the future.

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# Five new species of *Dolichomitus* Smith from the tropical Andes, with a key for the South American species (Hymenoptera, Ichneumonidae, Pimplinae)

Rodrigo O. Araujo<sup>1,2</sup>, Diego G. Pádua<sup>3</sup>, Jorge Jaramillo<sup>4</sup>, Luis A. Mazariegos<sup>4</sup>

**1** Centro de Investigación de Estudios Avanzados del Maule, Vicerrectoría de Investigación y Postgrado, Universidad Católica del Maule, Avenida San Miguel, 3605, Talca, Chile **2** Laboratorio de Ecología de Abejas, Departamento de Ciencias Biológicas y Químicas, Facultad de Ciencias Básicas, Universidad Católica del Maule, Avenida San Miguel, 3605, Talca, Chile **3** Programa de Pós-Graduação em Entomologia, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil **4** The Hummingbird Conservancy, Mesenia-Paramillo nature reserve, Jardín, Antioquia, Colombia

Corresponding author: Rodrigo O. Araujo ([araujorodrigodeoliveira@gmail.com](mailto:araujorodrigodeoliveira@gmail.com))

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## Abstract

*Dolichomitus* Smith is a widely distributed pimpline genus with more than seventy known species. There are eight species previously reported from South America: *D. annulicornis* (Cameron), *D. bivittatus* Townes, *D. hypermeces* Townes, *D. jatai* Loffredo & Pentead-Dias, *D. longicauda* Smith, *D. megalourus* (Morley), *D. moacyri* Loffredo & Pentead-Dias and *D. zonatus* (Cresson). In this paper, we describe five new species: *D. mariajosae* Araujo & Pádua, **sp. nov.**, *D. menai* Araujo & Pádua, **sp. nov.**, *D. orejuelai* Araujo & Pádua, **sp. nov.**, *D. pimmi* Araujo & Pádua, **sp. nov.**, and *D. rendoni* Araujo & Pádua, **sp. nov.** All have been collected in cloud forests in the Colombian tropical Andes. An illustrated key to the South American species of the genus is also provided.

## Keywords

Colombia, Darwin wasps, Ephialtini, Mesenia-Paramillo, Neotropical, ovipositor, parasitoid wasps, taxonomy

## Introduction

The Darwin wasps are among the most species-rich branches of the tree of life, with approximately 25,000 species belonging to 41 subfamilies (Yu et al. 2016; Bennett et al. 2019; Klopstein et al. 2019). At the same time, it is one of the groups for which our taxonomic knowledge most severely lags behind their actual diversity (Klopstein et al. 2019). The Pimplinae are one of the best studied subfamilies in the Neotropical Region, mainly due to the taxonomic revisions performed by Ian Gauld (e.g. Gauld 1991; Gauld et al. 1998, 2002). However, recent studies continue to reveal new species of this subfamily in this region (e.g. Gómez et al. 2014; Sääksjärvi et al. 2015; Bordera et al. 2016; Palacio et al. 2018; Bordera and Palacio 2019; Palacio et al. 2019; Bordera et al. 2019; Pádua et al. 2020), as well as expanding the distribution records for some of its genera (Pádua et al. 2019a, 2019b). These studies indicate that unsampled areas have great potential for revealing new species to science, especially considering that few areas of South America were sampled adequately (Gómez et al. 2009).

Because of their long ovipositors and large bodies, *Dolichomitus* wasps are one of the most conspicuous and well-known genera in the Ichneumonidae, with more than seventy known species in the world (Matsumoto 2018). There are 15 species in the Neotropical region, with eight species occurring in South America: *D. annulicornis* (Cameron, 1886); *D. bivittatus* Townes, 1975; *D. hypermeces* Townes, 1975; *D. jatai* Loffredo & Penteado-Dias, 2012; *D. longicauda* Smith, 1877; *D. megalourus* (Morley, 1914); *D. moacyri* Loffredo & Penteado-Dias, 2012 and *D. zonatus* (Cresson, 1874), besides two subspecies (Yu et al. 2016). From a biological point of view, they are pupal ectoparasitoids known to attack mainly coleopteran larvae that bore in dead wood, especially Cerambycidae and, less commonly, Curculionidae, Melandryidae, and Scolytidae (Townes and Townes 1960; Fitton et al. 1988).

Herein we describe five new species of *Dolichomitus* and provide the first identification key for the species present in South America.

## Materials and methods

Morphological terminology follows Broad et al. (2018). The information contained in “Type Material” sections corresponds to the specimen labels *verbatim*. The specimens will be deposited in the Universidad de los Andes (UNIANDES) entomological collection in Bogotá, Colombia, under “ANLA collection permit of specimens of the biological diversity” (curator Emilio Rialpe).

The specimens examined in this study were all collected with sweeping net and manual collection during an inventory carried out in the Mesenia-Paramillo Natural Reserve (5°29'46.1"N, 75°53'20.5"W) between February and December 2019, in the department of Antioquia, Colombia. This is a private conservation area of 3,500 ha located in the western Andes, more specifically in the Northwestern Andean montane forest ecoregion, which is among the most diverse regions on the planet (see Pádua et al. 2019a).

Drawings were adapted from Gauld (1991) and vectorized by Adobe Illustrator. Photographs were prepared using a Canon EOS 5D Mark IV and 5DSR, and Canon EF 100mm f/2.8 IS USM and MP-E 65mm f/2.8 1-5X macro lenses and edited with Adobe Photoshop (v. CS5), or a Leica DMC4500 digital camera attached to a Leica M205A stereomicroscope and combined using the software Leica Application Suite V4.10.0. All measurements were rounded to the nearest 0.05.

## Taxonomy

### *Dolichomitius* Smith, 1877

*Closterocerus* Hartig, 1847: 18. Type-species: *Closterocerus sericeus* Hartig, by monotypy. [Homonym of *Closterocerus* Westwood, 1833].

*Dolichomitius* Smith, 1877: 411. Type-species: *Dolichomitius longicauda* Smith, by monotypy.

*Mesoepialtes* Schmiedeknecht, 1906: 1014. Type-species: *Mesoepialtes coracinus* Schmiedeknecht (= *Pimpla zonata* Cresson), by monotypy.

*Diclostercerus* Viereck, 1914: 45. [Replacement name for *Closterocerus* Hartig].

**Diagnosis.** The genus can be identified by the following combination of character states: (1) clypeus not divided in anterior and posterior parts; (2) clypeal margin narrow, apically bilobate; (3) occipital carina more or less complete, mediodorsally dipped, sometimes weak; (4) propodeum with a trace of the lateromedian longitudinal carinae discernible anteriorly; (5) fore wing with *3rs-m* present; (6) hind wing with distal abscissa of *CU* present, joining *cu-a* either closer to *1AA* than to *M*, or closer to *M* than to *AA*; (7) male (in most species) with middle coxa modified in one or two concavities on outer surface and basal, apical and/or centrally tubercles; (8) female with basal lobe on tarsal claws; (9) tergite II with oblique groves cutting off depressed triangular areas anterolaterally; (10) male with sternite IX transverse, posteriorly slightly convex; (11) ovipositor 3.00–13.00× as long as hind tibia; (12) upper valve smooth and lower valve of ovipositor laterally expanded to partially enclose upper valve.

### Key to the South American species of *Dolichomitius*

[The males of *D. bivittatus* Townes, *D. hypermeces* Townes, *D. longicauda* Smith, *D. mariajosae* sp. nov., *D. menai* sp. nov., *D. orejuelai* sp. nov., *D. pimmi* sp. nov. and *D. rendoni* sp. nov. are unknown].

1	Female .....	2
–	Male .....	14
2	Ovipositor sheath long, < 1.50× as long as body .....	3
–	Ovipositor sheath very long, > 3.00× as long as body .....	11



- 3 Mesosoma reddish brown or reddish black with white, yellow or black marks (Figs 1C, D, 4A, B, 6A, B)..... **4**
- Mesosoma black or yellow or orange yellow or yellowish brown with black marks (Figs 1A, B, 2A, B, 3A, B, 5A, B) ..... **6**
- 4 Head almost yellow with vertex brown; occipital region, central frons and mandible black; fore wing yellowish with anterior margin more fuscous, pterostigma yellow (Fig. 1L)..... ***D. moacyri* Loffredo & Penteado-Dias**
- Head almost reddish black, without yellow marks; fore wing entirely yellowish, pterostigma light or dark brown (Figs 4G, 6G)..... **5**
- 5 Tegula reddish black (Fig. 4D, E); areolet not petiolate; pterostigma light brown (Fig. 4G); hind wing with vein *cu-a* ca. 2.25× as long as proximal abscissa of *CU*; fore and mid legs with color pattern mostly red and reddish black; metasoma mostly yellowish brown (Fig. 4A, B)... ***D. orejuelai* sp. nov.**
- Tegula white (Fig. 6D, E); areolet slightly petiolate; pterostigma dark brown (Fig. 6G); hind wing with vein *cu-a* ca. 1.20× as long as proximal abscissa of *CU*; fore and mid legs with color pattern mostly white; metasoma mostly dark brown (Fig. 6A, B)..... ***D. rendoni* sp. nov.**
- 6 Fore wing iridescent or hyaline or yellowish, but always with apex black (Figs 2G, 3G, 5G)..... **7**
- Fore wing entirely yellowish or yellowish with anterior margin more strongly yellowish (Fig. 1I, J, L) ..... **9**
- 7 Malar space 0.55× as long as basal mandibular width; head mostly black (Fig. 3C); full-spectrum iridescent wings with strongly contrasting apical darkened area that at least covers completely the fourth submarginal cell and third discal cell, pterostigma black (Fig. 3G); metasoma mostly black shining (Fig. 3A, B, F)..... ***D. menai* sp. nov.**
- Malar space 0.30× as long as basal mandibular width; head mostly yellowish (Figs 2C, 5C); wings hyaline or yellowish with strongly contrasting apical darkened area that covers only the distal half of fourth submarginal cell, pterostigma dark or light brown (Figs 2G, 5G); metasoma mostly yellowish with lateral spots and an anterior dorsal longitudinal stripe on tergite I (Figs 2F, 5F) ..... **8**
- 8 Fore wing hyaline with pterostigma dark brown (Fig. 2G); hind wing with proximal abscissa of *CU* inclivous; tergites II–IV yellow with a dorsolateral mark on anterior margin and a band in the posterior margin black; ovipositor ca. 4.40× as long as hind tibia; ovipositor sheath ca. 4.20× as long as hind tibia (Fig. 2A) ..... ***D. mariajosae* sp. nov.**
- Fore wing yellowish with pterostigma light brown (Fig. 5G); hind wing with proximal abscissa of *CU* vertical; tergites II–IV yellow with posterior margins

- black; ovipositor ca. 3.40× as long as hind tibia; ovipositor sheath ca. 3.00× as long as hind tibia (Fig. 5A) ..... ***D. pimmi* sp. nov.**
- 9 Metasoma yellowish brown with tergites III+ or IV+ blackish (Fig. 1F) .....  
..... ***D. jatai* Loffredo & Penteado-Dias**
- Metasoma mostly light brown; tergite I–III subapically yellow with lateral posterior of margin brown to black; rest of tergites with posterior margins brown. (Fig. 1E) ..... **10**
- 10 Propodeum with a central and anterior smooth area, strongly and evenly broadened posteriorly so that near to the hind margin is more than twice as broad as anteriorly (Fig. 1N), generally with this area partly to completely black and the slightly raised part lateral to it yellow; hind wing with distal abscissa of *CU* joining *cu-a* almost equidistant between *AA* and *M*, or sometimes closer to *AA* ..... ***D. annulicornis* (Cameron)**
- Propodeum with a central and anterior smooth area, only slightly expanded posteriorly so that near the hind margin is less than twice as broad as anteriorly (Fig. 1O), generally with this area black, but with parallel black stripes on the slightly raised, yellow, lateral part; hind wing with distal abscissa of *CU* joining *cu-a* obviously closer to *M* than to *AA* ..... ***D. zonatus* (Cresson)**
- 11 Fore wing black with pterostigma yellow (Fig. 1K) ... ***D. megalourus* (Morley)**
- Fore wing yellow with two black bands or entirely infumate or brown with a broad pale yellowish-brown band on apex ..... **12**
- 12 Fore wing with two black bands (Fig. 1M) ..... ***D. bivittatus* Townes**
- Fore wing entirely infumate or brown with a broad pale yellowish brown band on apex ..... **13**
- 13 Body black; ovipositor sheath 7.00–8.10× as long as body; fore wing brown with a broad pale yellowish brown band on apex ..... ***D. hypermeces* Townes**
- Body black with metasomal tergites I–II yellow; ovipositor sheath 4.50–7.00× as long as body; fore wing infumate ..... ***D. longicauda* Smith**
- 14 Middle coxa modified in two concavities on outer surface or a distinct basal prominence (Fig. 1P, Q) ..... **15**
- Middle coxa evenly convex (Fig. 1R) ..... **16**
- 15 Middle coxa modified in two concavities on outer surface (Fig. 1P) .....  
..... ***D. annulicornis* (Cameron)**
- Middle coxa with a distinct basal prominence on outer surface (Fig. 1Q) .....  
..... ***D. zonatus* (Cresson)**
- 16 Fore wing black with pterostigma yellow (Fig. 1K) ... ***D. megalourus* (Morley)**
- Fore wing yellowish or yellowish with anterior margin slightly fuscous (Fig. 1J, L) ..... **17**

- 17 Mesosoma yellow with mesoscutum with three black stripes, the anterior margin and posterior lateral margin of the propodeum with a narrow black stripe, pronotum, mesopleuron and metapleuron with posterior margin black (Fig. 1B); metasoma yellow with tergites III+ or IV+ black (Fig. 1F).....  
.....*D. jatai* Loffredo & Penteado-Dias
- Mesosoma reddish brown, with three black stripes on mesoscutum, dorselum yellow, and propleuron black (Fig. 1D); metasoma with tergite I brownish and tergites II+ reddish brown (Fig. 1H).....  
.....*D. moacyri* Loffredo & Penteado-Dias

***Dolichomitus mariajosae* Araujo & Pádua, sp. nov.**

<http://zoobank.org/9EFFAC5D-B6B0-447D-94FF-F6835D03EDAA>

Fig. 2A–G

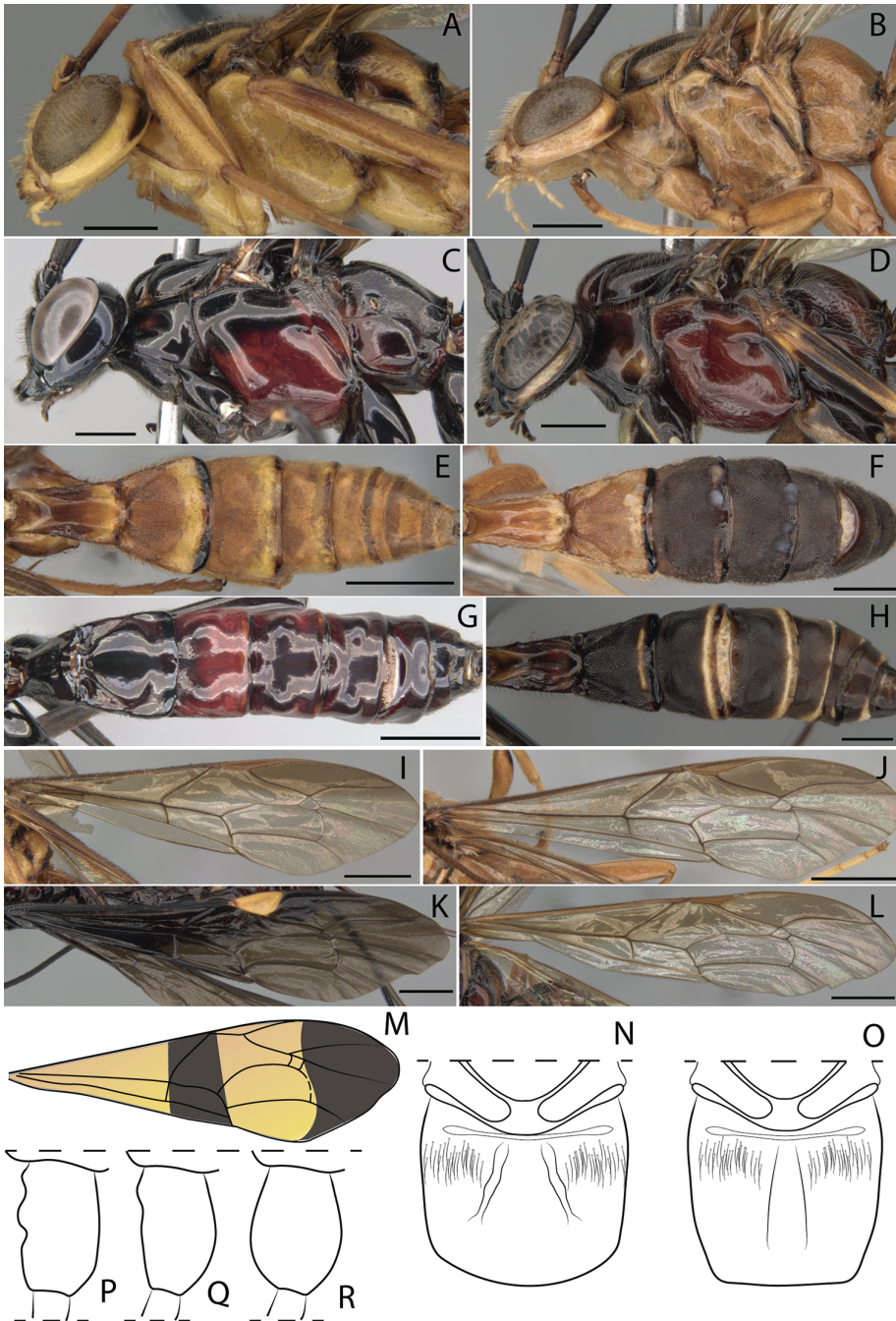
**Diagnosis.** *Dolichomitus mariajosae* sp. nov. may be distinguished from other Neotropical species by the combination of the following characteristics: general color pattern (yellow with various specific black marks); malar space  $0.30\times$  as long as basal mandibular width; areolet not petiolate; wings hyaline with strongly contrasting apical darkened area, pterostigma dark brown; hind wing with proximal abscissa of *CU* inclivous; ovipositor sheath ca.  $1.30\times$  as long as body, and ca.  $4.20\times$  as long as hind tibia.

**Description. Holotype female** (Fig. 2A–G). Approximate body length (without ovipositor): 15.90 mm; fore wing length: 14.00 mm.

**Head.** Antenna with 34 flagellomeres, first flagellomere  $3.80\times$  as long as width. Gena smooth with setiferous punctures,  $0.50\times$  as long as eye (Fig. 2D), in frontal view almost straight and moderately constricted below eyes (Fig. 2C). Vertex smooth and shiny, with isolated setiferous punctures. Posterior ocellus separated from eye  $1.35\times$  its maximum diameter. Distance between hind ocelli  $1.25\times$  maximum diameter of posterior ocellus. Face with fine, setiferous punctures. Clypeal sulcus slightly curved. Clypeus  $3.25\times$  as broad as medially long, almost flat. Clypeus with long erect setae on its surface and small setae across all its margins. Anterior tentorial pits conspicuous. Malar space  $0.30\times$  as long as basal mandibular width. Mandible bidentate,  $2.05\times$  as long as basal width (front view).

**Mesosoma.** Pronotum polished, with fine and scattered setiferous punctures. Epomia present. Mesoscutum shiny, with moderately dense setiferous punctures. Notauli deep, reaching ca.  $0.30$ – $0.40$  of length of mesoscutum. Mesopleuron shiny, with relatively dense setiferous punctures. Epicnemial carina strong. Metapleuron shiny, with scattered setiferous punctures, ca.  $1.45\times$  as long as height. Submetapleural carina strong, enlarged anteriorly, reaching ca.  $0.40$  metapleuron length, its anterior end slightly curved up. Propodeum shiny, with fine and scattered setiferous punctures, denser laterally, in dorsal view  $1.15\times$  as long as medially wide. Propodeal spiracle elliptic. Pleural carina complete and strong, culminating posteriorly in a small propodeal crest (Fig. 2D). Hind leg with femur ca.  $6.50\times$  as long as height and ca.  $0.70\times$  as long as tibia. Fore wing with vein *Icu-a* more or less interstitial to *M&R*<sub>2</sub>; areolet  $1.50\times$  as



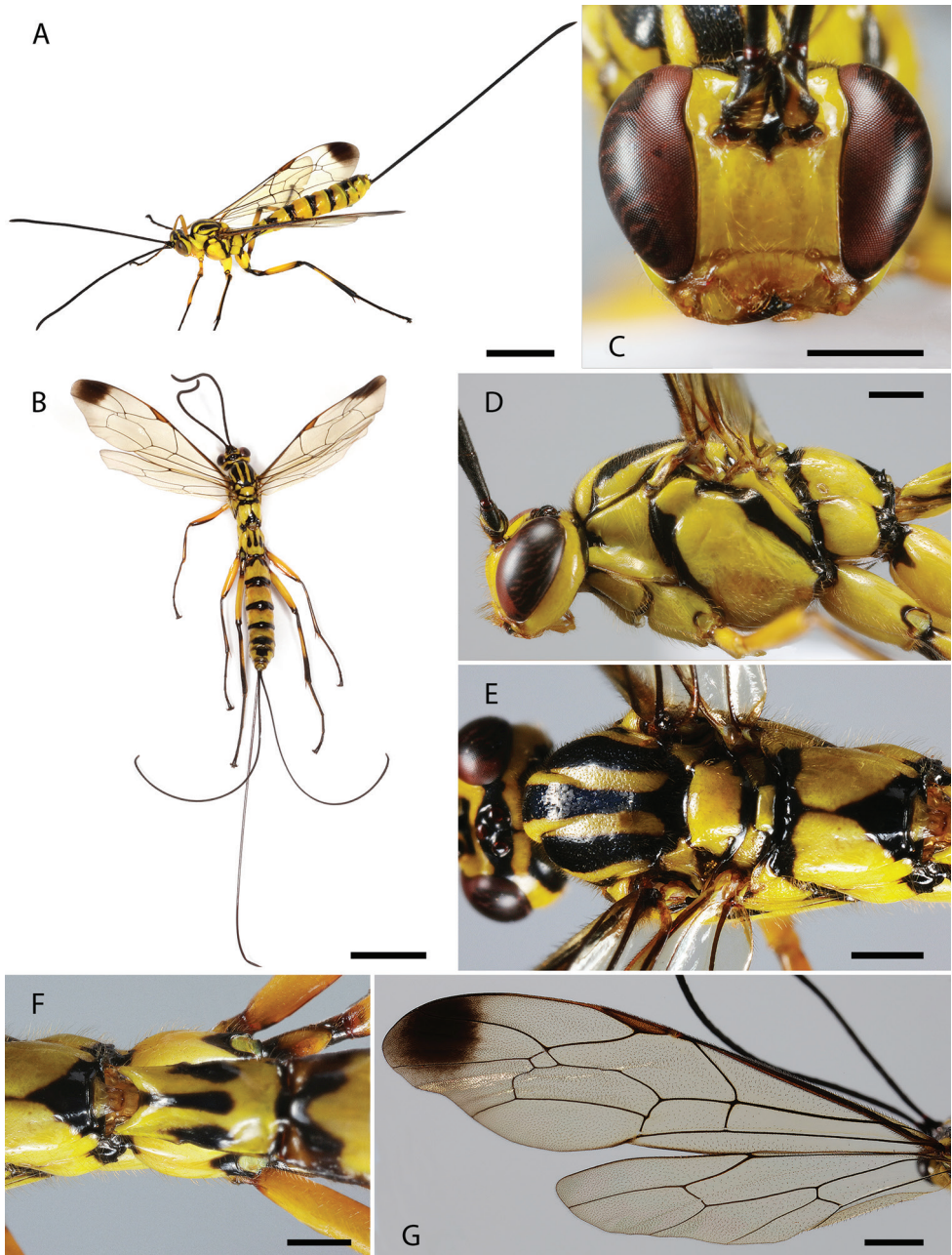


**Figure 1.** **A–R** *Dolichomitus* species **A–D** head and mesosoma, lateral view: **A** *D. annulicornis* **B** *D. jatai* **C** *D. megalourus* **D** *D. moacyri* **E–H** metasoma, dorsal view: **E** *D. annulicornis* **F** *D. jatai* **G** *D. megalourus* **H** *D. moacyri* **I–M** fore wing **I** *D. annulicornis* **J** *D. jatai* **K** *D. megalourus* **L** *D. moacyri* **M** *D. bivittatus* **N, O** propodeum, dorsal view: **N** *D. annulicornis* **O** *D. zonatus* **P–R** mid coxa, lateral view, ♂ (Modified of Gauld 1991): **P** *D. annulicornis* **Q** *D. zonatus* **R** *D. megalourus*. Scale bars: 1.00 mm (**A, B, C, D, F, H**); 2.00 mm (**E, G, I, J, K, L**).

wide as height; vein *1cu-a* and vein *2m-cu* slightly curved. Hind wing with vein *cu-a* ca.  $2.10\times$  as long as proximal abscissa of *CU*; vein *cu-a* reclivous and straight; proximal abscissa of *CU* inclivous; distal abscissa of *CU* present, reaching wing margin (Fig. 2G).

**Metasoma.** Tergite I ca.  $1.75\times$  as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally (Fig. 2F); spiracle near its anterior 0.40; dorsolateral carinae of first metasomal tergite weak, present on petiole and postpetiole. Posterior membranous section of first metasomal sternite ca. 0.50 of length of tergite. Tergite II ca.  $1.20\times$  as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally and posteriorly. Ovipositor slender, evenly down curved at distal 0.15, ca.  $4.40\times$  as long as hind tibia (Fig. 2A); upper valve of ovipositor smooth; apex of ovipositor with expanded area of lower valve bearing ca. 11 teeth, with most proximal 5 vertical; ovipositor sheath ca.  $1.30\times$  as long as body, and ca.  $4.20\times$  as long as hind tibia, bearing fine dense hairs which are ca.  $0.75\times$  as long as width of sheath.

**Color.** Head mostly yellow with mandibles apically, frons, stemmaticum (extending to outer orbit dorsally), a narrow longitudinal stripe on vertex, dorsal half of occipital carinae, scape, pedicel, and flagellum black; scape ventrally and malar space infuscate. Mesosoma mostly yellow with anterior, posterior, and inner margin of propleuron, a narrow longitudinal stripe on pronotal collar dorsally (dorsally extending to pronotum), anterior margin of pronotum (connecting with mesoscutum), posterior margin of pronotum, subtegular ridge, lateral and central longitudinal stripes on mesoscutum, two marks on the lateral margins of mesoscutum (just above tegula), scuto-scutellar groove, posterior margin of scutellum, anterior margin and axilla posteriorly, anterior and posterior margins of metanotum, epicnemium (with a small rounded projection toward speculum), anterior and dorsal margin of mesopleuron, mesopleural furrow, anterior margin of mesepisternum, anterior and posterior margin of metapleuron, submetapleuron carina anteriorly, anterior and posterior margin of propodeum, a triangle mark dorsally based on the posterior margin that projects itself towards the anterior margin through a narrow longitudinal stripe, black. Fore leg mostly yellow with a dorsal spot on coxa, posterior margin on coxa, anterior spot on trochanter, femur ventrally, tibia dorsally, tarsus black. Mid leg mostly yellow with anterior and posterior margin of coxa, anterior margin of trochanter, ventral stripe on femur, dorsal stripe on tibia, tarsus, black; trochantellus infuscate. Hind leg mostly yellow with anterior (projecting ventrally), posterior (projecting dorsally) margins of coxa, anterior and posterior margins trochanter, trochanter ventrally, trochantellus, anterior and posterior margins of femur, ventral stripe on femur, anterior and posterior margins of tibia, dorsal stripe on tibia, tarsus black (Fig. 2A, B, F). Wings hyaline with strongly contrasting apical darkened area that covers only the distal half of fourth submarginal cell, pterostigma dark brown (Fig. 2G). Metasoma mostly yellow, tergite I with lateral and posterior margins, lateral spots (near spiracle) and a median longitudinal stripe reaching ca. 0.70 of tergite I; a dorsolateral mark on anterior margin and a band on the posterior margin of tergites II–IV, a dorsal mark on tergites VI–VIII, ventral corner of the posterior margin of tergites V–VI, black. Ovipositor dark brown and ovipositor sheath black.



**Figure 2.** A–G *Dolichomit mariajosae* sp. nov. (holotype female): **A** habitus in lateral view (*in vivo*) **B** habitus in dorsal view **C** head in frontal view **D** head and mesosoma in lateral view **E** mesosoma in dorsal view **F** first tergite in dorsal view **G** wings. Scale bars: 5.00 mm (**A**, **B**); 1.00 mm (**C**, **D**, **E**, **F**); 2.00 mm (**G**).



**Male.** Unknown.

**Type material. *Holotype*.** 1 ♀, Colombia, Jardín, Antioquia, La Lucrecia, Mesenia-Paramillo nature reserve (2400m elevation), 5°30'50.61"N, 75°50'32.02"W, entomological net, 06–I–2020, coll. Jaramillo, J. (UNIANDES).

**Distribution.** Colombia.

**Etymology.** The specific epithet is in honor of Maria Jose Valencia, daughter of Carlos Eduardo Valencia, Colombian entrepreneur, who supports conservation initiatives in the Andes and Chocó ecoregions, and enjoys the natural world and the challenges of exploring the outdoors.

**Biological note.** Host unknown.

**Comments.** *Dolichomitus mariajosae* sp. nov. is most similar to the *D. zonatus* (Cresson, 1874), *D. cantillanoi* Gauld, 1991, and *D. annulicornis* (Cameron, 1886) mainly for the color pattern of the body yellowish with black marks, but this new species differs mainly for the fore wing with black spot in the apex (yellowish with anterior margin strongly yellow in *D. annulicornis* and *D. zonatus*, and entirely yellowish in *D. cantillanoi*).

***Dolichomitus menai* Araujo & Pádua, sp. nov.**

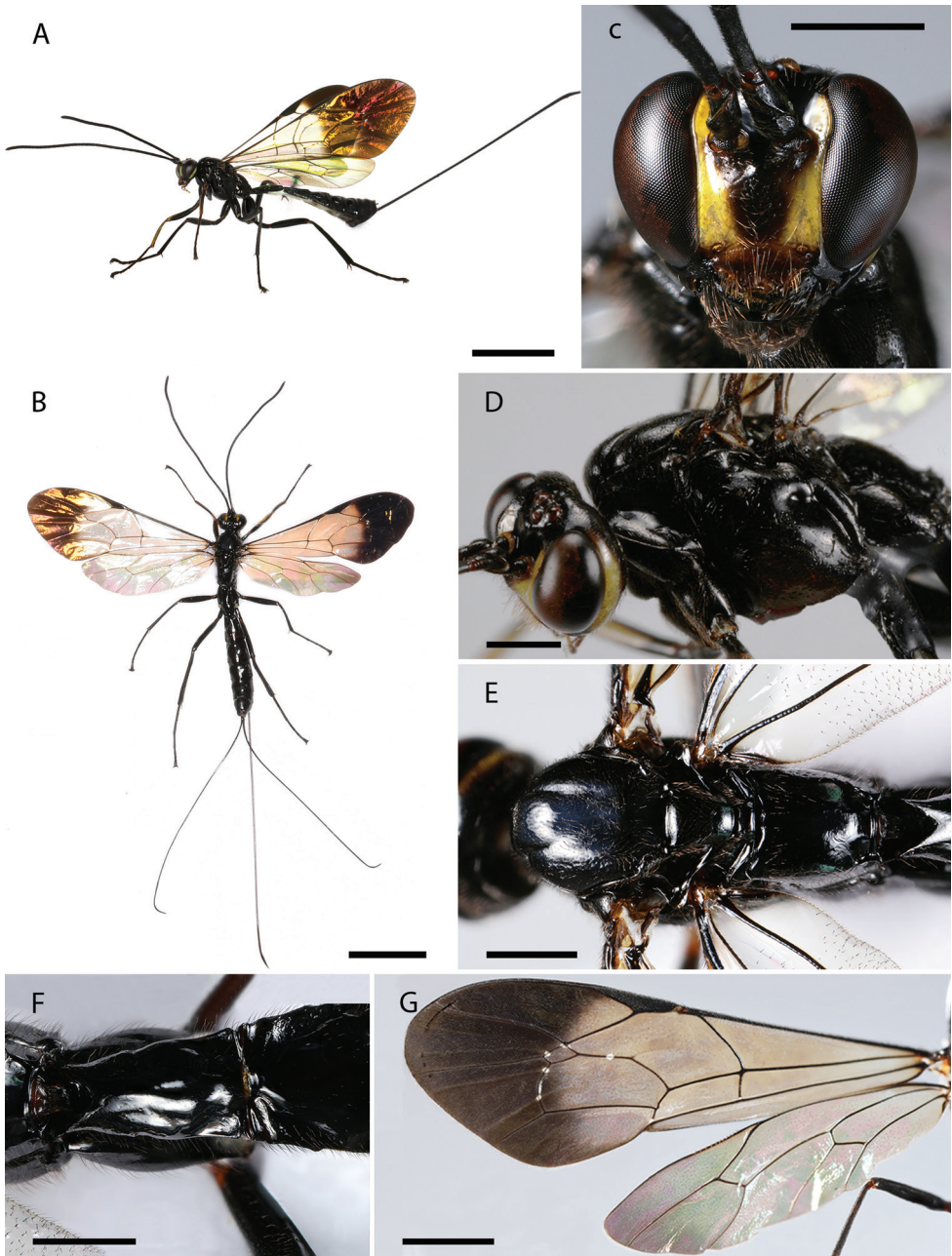
<http://zoobank.org/AF3875BF-C9F5-411E-BA97-52D608350FEB>

Fig. 3A–G

**Diagnosis.** *Dolichomitus menai* sp. nov. may be distinguished from other Neotropical species by the combination of the following characteristics: head mostly black with clypeus predominantly dark brown, anterior margin of clypeus, inner orbit, frontal orbit, outer orbit yellow; fore leg mostly black with ventral surfaces of femur and tibiae yellow; wings iridescent rainbow colors with strongly contrasting subapical darkened area, pterostigma black; areolet not petiolated; malar space 0.55× as long as basal mandibular width; areolet ca. 1.80× as wide as height; fore wing with vein *Icu-a* vertical; hind wing with proximal abscissa of *CU* slightly inclivous and straight; metasoma mostly black, with posterior membranous section of first metasomal sternite, sternites II–VI and part of sternite VII white; ovipositor sheath ca. 1.25× as long as body, and ca. 3.60× as long as hind tibia.

**Description. *Holotype female*** (Fig. 3A–G). Approximate body length (without ovipositor): 12.50 mm; fore wing length: 12.30 mm.

**Head.** Antenna with 31 flagellomeres, first flagellomere 4.50× as long as width. Gena smooth with setiferous punctures, in dorsal view somewhat rounded, 0.60× as long as eye, in frontal view almost straight and moderately constricted below eyes (Fig. 3C). Vertex smooth and shiny, with very isolated setiferous punctures. Posterior ocellus separated from eye 1.05× its maximum diameter. Distance between hind ocelli 0.65× maximum diameter of posterior ocellus. Face with fine, setiferous punctures. Clypeal sulcus slightly curved. Clypeus 2.70× as broad as medially long, almost flat. Clypeus with long parallels setae on its surface and small setae across all its margins. Anterior tentorial pits conspicuous. Malar space 0.55× as long as basal mandibular width. Mandible bidentate, 2.25× as long as basal width (Fig. 3C).



**Figure 3.** **A–G** *Dolichomitrus menai* sp. nov. (holotype female): **A** habitus in lateral view (*in vivo*) **B** habitus in dorsal view **C** head in frontal view **D** head and mesosoma in lateral view **E** mesosoma in dorsal view **F** first tergite in dorsal view **G** wings. Scale bars: 5.00 mm (**A**, **B**); 1.00 mm (**C**, **D**, **E**, **F**); 2.00 mm (**G**).

**Mesosoma.** Pronotum polished, with fine and scattered setiferous punctures (Fig. 3D). Epomia present. Mesoscutum shiny, with moderately dense setiferous punctures. Notauli deep, reaching ca. 0.20 of length of mesoscutum. Mesopleuron shiny, with relatively dense setiferous punctures. Epicnemial carina strong. Metapleuron shiny, with scattered setiferous punctures, ca. 1.40× as long as height. Submetapleural carina strong, enlarged anteriorly, reaching ca. 0.55 of metapleuron length, its anterior end slightly curved up. Propodeum shiny, with fine and scattered setiferous punctures, denser anteriorly, in dorsal view 1.25× as long as medially wide. Propodeal spiracle elliptic, just above the pleural carina. Pleural carina strong, culminating posteriorly in a small propodeal crest. Hind leg with femur ca. 7.90× as long as height and ca. 0.70× as long as tibia. Fore wing with vein *Icu-a* interstitial to *M&R*; areolet ca. 1.80× as wide as height; vein *Icu-a* vertical, vein *2m-cu* slight curved. Hind wing with vein *M+CU* almost straight; vein *cu-a* ca. 2.50× as long as proximal abscissa of *CU*; vein *cu-a* reclivous and straight; proximal abscissa of *CU* slightly inclivous and straight; distal abscissa of *CU* present, reaching wing margin (Fig. 3G).

**Metasoma.** Tergite I ca. 1.80× as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally (Fig. 3F); spiracle near its anterior 0.40; dorsolateral carinae of first metasomal tergite weak, present on petiole and postpetiole. Posterior membranous section of first metasomal sternite ca. 0.25 of length of tergite. Tergite II ca. 1.20× as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally and posteriorly; ovipositor slender, evenly down curved at distal 0.20, ca. 4.65× as long as hind tibia (Fig. 3A); apex of ovipositor with expanded area of lower valve bearing ca. 11 teeth, the most proximal 2 vertical; ovipositor sheath ca. 1.25× as long as body, and ca. 3.60× as long as hind tibia, bearing fine dense hairs which are ca. 1.35× as long as width of sheath.

**Color.** Head mostly black with most of clypeus dark brown, anterior margin of clypeus, inner, frontal and outer orbit (but frons, stemmaticum and vertex, black) and temple yellow. Mesosoma entirely black shining (Fig. 3B). Fore leg mostly black with ventral surfaces of femur and tibiae yellow. Mid and hind legs entirely black. Wings with iridescent rainbow colors with strongly contrasting apical darkened area that at least covers completely the fourth submarginal cell and third discal cell, pterostigma black (Fig. 3G). Metasoma mostly black shining, with posterior membranous section of first metasomal sternite, sternites II–VI and part of sternite VII white (there are some randomly black spots on the sternites II–VII varying between the specimens) (Fig. 3A, B, F); ovipositor dark brown, darker on tip. Ovipositor sheath black.

**Male.** Unknown.

**Variation.** There are some specimens with body length (12.50–19.00 mm) and wing length (12.30–18.50 mm).

**Type material. Holotype.** 1 ♀, Colombia, Jardín, Antioquia, El Alto, Mesenia-Paramillo nature reserve (1800m–3000m elevation), 5°29'45.8"N, 75°53'21.3"W, entomological net, 09–III–2019, coll. Mazariegos, L. (UNIANDES). **Paratypes.** 3 ♀♀, same locality, same collection method, 14–IV–2019, coll. Araujo, R. (UNIANDES); 2 ♀♀, same locality, same collection method, 15–IX–2019, coll. Rendon, U. (UNIANDES).



**Distribution.** Colombia.

**Etymology.** The specific epithet is in honor of Luis Fernando Mena for his continued support of the Mesenia-Paramillo nature reserve in the acquisition of forested areas for conservation. Mr. Mena is known for his support of important causes and has supported many NGO's in Colombia that have an important social impact.

**Biological note.** Host unknown.

**Comments.** *Dolichomitus menai* sp. nov. is most similar to the *D. hypermeces* Townes, 1975, *D. irritator* (Fabricius, 1775) and *D. longicauda* Smith, 1877 mainly by black color of body. However, this new species differs mainly by having ovipositor sheath  $< 1.50\times$  as long as body (except *D. irritator*) and the fore wing hyaline with strongly contrasting subapical darkened area, pterostigma black (entirely infumate and ovipositor sheath  $> 3.00\times$  as long as body in *D. longicauda*; yellowish with pterostigma black in *D. irritator*; and brown with a broad pale yellowish brown band on apex and ovipositor sheath  $> 3.00\times$  as long as body in *D. hypermeces*).

***Dolichomitus orejuelai* Araujo & Pádua, sp. nov.**

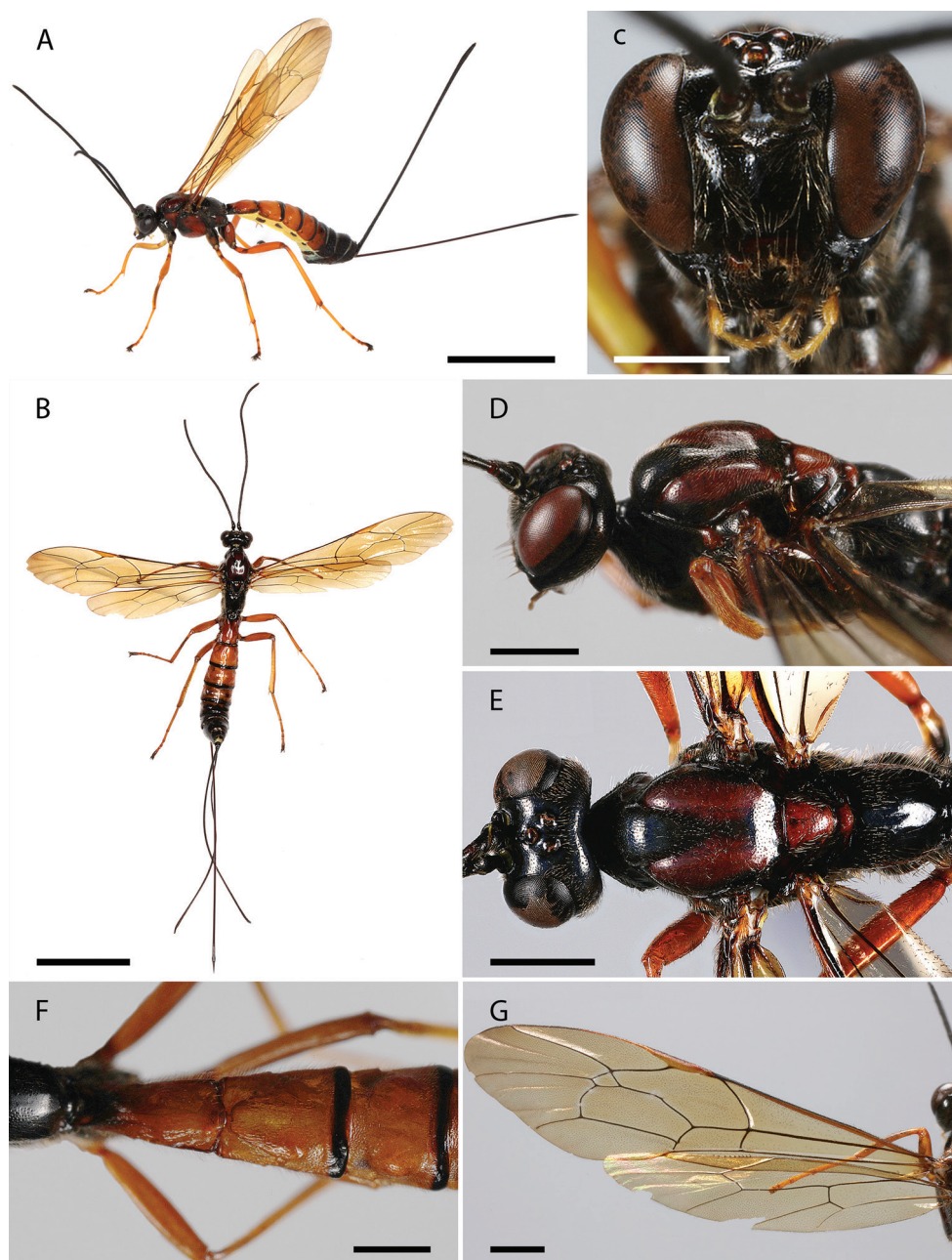
<http://zoobank.org/7DCDBD61-6051-490B-B66E-F3DC1CFC13B3>

Fig. 4A–G

**Diagnosis.** *Dolichomitus orejuelai* sp. nov. may be distinguished from other Neotropical species by the combination of the following characteristics: head and mesosoma mostly reddish black; metasoma mostly yellowish brown with anterior half of tergite I dorsally, posterior margin of tergites II–V, a semicircular dorsal spot based on the anterior margin of tergite V, tergites VI–VIII reddish black; face with abundant setiferous punctures; malar space  $0.30\times$  as long as basal mandibular width; mandible bidentate,  $1.40\times$  as long as basal width; hind leg with femur ca.  $5.50\times$  as long as height; wings yellowish, pterostigma light brown; areolet not petiolated; dorsolateral carinae of first metasomal tergite present on petiole and stronger on postpetiole; posterior half of tergite II and tergites III–V densely and strongly punctuate; ovipositor sheath ca.  $1.10\times$  as long as body, and ca.  $3.00\times$  as long as hind tibia.

**Description. Holotype female** (Fig. 4A–G). Approximate body length (without ovipositor): 12.30 mm; fore wing length: 11.15 mm.

**Head.** Antenna with 32 flagellomeres, first flagellomere  $4.50\times$  as long as width. Gena smooth with setiferous punctures, in dorsal view somewhat rounded,  $0.55\times$  as long as eye (Fig. 4E), in frontal view almost straight and moderately constricted below eyes (Fig. 4C). Vertex smooth and shiny, with setiferous punctures. Posterior ocellus separated from eye  $1.30\times$  its maximum diameter. Distance between hind ocelli  $0.85\times$  maximum diameter of posterior ocellus. Occipital carina complete. Face with abundant setiferous punctures. Clypeal sulcus curved. Clypeus  $3.20\times$  as broad as medially long, almost flat. Clypeus with long parallels setae on its surface and small setae across all its margins. Anterior tentorial pits conspicuous. Malar space  $0.30\times$  as long as basal mandibular width. Mandible bidentate,  $1.40\times$  as long as basal width (front view).



**Figure 4. A–G** *Dolichomitus orejuelai* sp. nov. (holotype female): **A** habitus in lateral view (*in vivo*) **B** habitus in dorsal view **C** head in frontal view **D** head and mesosoma in dorsolateral view **E** mesosoma in dorsal view **F** tergites I–III in dorsal view **G** wings. Scale bars: 5.00 mm (**A**, **B**); 1.00 mm (**C**, **D**, **E**, **F**); 2.00 mm (**G**).

**Mesosoma.** Pronotum polished, with fine and scattered setiferous punctures. Epomia present. Mesoscutum shiny, with moderately dense setiferous punctures. Notauli deep, reaching ca. 0.40 of length of mesoscutum. Mesopleuron shiny, with relatively dense setiferous punctures. Epinomial carina strong. Metapleuron shiny, with scattered setiferous punctures, ca.  $1.65\times$  as long as height. Submetapleural carina strong, enlarged anteriorly, reaching ca. 0.70 metapleuron length, its anterior end slightly curved up. Propodeum shiny, with fine and scattered setiferous punctures, denser laterally, in dorsal view  $1.10\times$  as long as medially wide. Propodeal spiracle elliptic, just above the pleural carina (Fig. 4D–E). Pleural carina complete and strong, culminating posteriorly in a small propodeal crest. Hind leg with femur ca.  $5.50\times$  as long as height and ca.  $0.75\times$  as long as tibia. Fore wing with vein *Icu-a* interstitial to *M&R*<sub>2</sub>; areolet  $1.45\times$  as wide as height; vein *Icu-a* and vein *2m-cu* slight curved. Hind wing with vein *cu-a* ca.  $2.25\times$  as long as proximal abscissa of *CU*; vein *cu-a* reclivous and straight; proximal abscissa of *CU* vertical; distal abscissa of *CU* present, reaching wing margin (Fig. 4G).

**Metasoma.** Tergite I ca.  $1.90\times$  as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally (Fig. 4F); spiracle near its anterior 0.40; dorsolateral carinae of first metasomal tergite present on petiole and stronger on postpetiole. Posterior membranous section of first metasomal sternite ca. 0.40 of length of tergite. Tergite II ca.  $1.10\times$  as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally; posterior half of tergite II and tergites III–V densely and strongly punctuate; ovipositor slender, evenly down curved at distal 0.20, ca.  $4.35\times$  as long as hind tibia (Fig. 4A); apex of ovipositor with expanded area of lower valve bearing ca. 7 teeth, the most proximal 2 vertical; ovipositor sheath ca.  $1.10\times$  as long as body, and ca.  $3.00\times$  as long as hind tibia, bearing fine dense hairs which are ca.  $1.10\times$  as long as width of sheath.

**Color.** Head and antenna entirely reddish black. Mesosoma mostly reddish black with pronotal spiracle, two wide longitudinal stripes interrupted by notauli on mesoscutum, scutellum dorsally, metanotum dorsally, red. Fore, mid and hind legs mostly red, with coxa and trochanter (except posterior margin), reddish black. Wings yellowish, pterostigma light brown (Fig. 4G). Metasoma mostly yellowish brown with anterior half of tergite I dorsally, posterior margin of tergites II–V, a semicircular dorsal spot based on the anterior margin of tergite V, tergites VI–VIII, reddish black (Fig. 4A, B, F). Ovipositor dark brown and ovipositor sheath reddish black.

**Male.** Unknown.

**Variation.** There are some specimens with body length (12.30–13.85 mm) and wing length (11.15–13.40 mm).

**Type material.** *Holotype*. 1 ♀, Colombia, Jardín, Antioquia, El Alto, Mesenia-Paramillo nature reserve (1800m–3000m elevation), 5°29'45.8"N, 75°53'21.3"W, entomological net, 24–IV–2019, coll. Mazariegos, L. (UNIANDES). *Paratypes*. 1 ♀, same locality, same collection method, 15–VIII–2019, coll. Jaramillo, J. (UNIANDES); 2 ♀♀, same locality, same collection method, 15–IX–2019, coll. Rendon, U. (UNIANDES).

**Distribution.** Colombia.



**Etymology.** The specific epithet is a tribute to Jorge Enrique Orejuela Gardner, National Geographic 2007 Buffet prize winner for his work over three decades in Colombia on conservation education, protected area management and sustainable development. His accomplishments include the establishment of the cloud forest nature reserve La Planada, also helped establish Utría and Gorgona Island national parks, and the Quindío Basin and Calima River nature reserves. His mentoring for the creation of the Mesenia-Paramillo nature reserve was key to the success of this conservation project.

**Biological note.** Host unknown.

**Comments.** *Dolichomitus orejuelai* sp. nov. is most similar to the Neotropical species *D. rufescens* (Cresson, 1865), *D. grilloi* Gauld, 1991, *D. flacissimus* Gauld, Ugalde & Hanson, 1998 and *D. bivitattus* Townes, 1975 mainly by color pattern reddish black or brown on the body. But this new species differs from *D. bivitattus* by having ovipositor sheath  $< 1.50\times$  as long as body ( $> 3.50$  in *D. bivitattus*) and differs from *D. flacissimus* by having fore wing yellowish with pterostigma light brown (infumate with pterostigma brown in *D. flacissimus*). Differs mainly from *D. grilloi* by having posterior ocellus separated from eye  $1.30\times$  its maximum diameter ( $0.80\text{--}0.90\times$  in *D. grilloi*) and differs from *D. rufescens* by having metasoma mostly yellowish brown with anterior half of tergite I dorsally, posterior margin of tergites II–V, a semicircular dorsal spot based on the anterior margin of tergite V, tergites VI–VIII reddish black (entirely reddish in *D. rufescens*).

***Dolichomitus pimmi* Araujo & Pádua, sp. nov.**

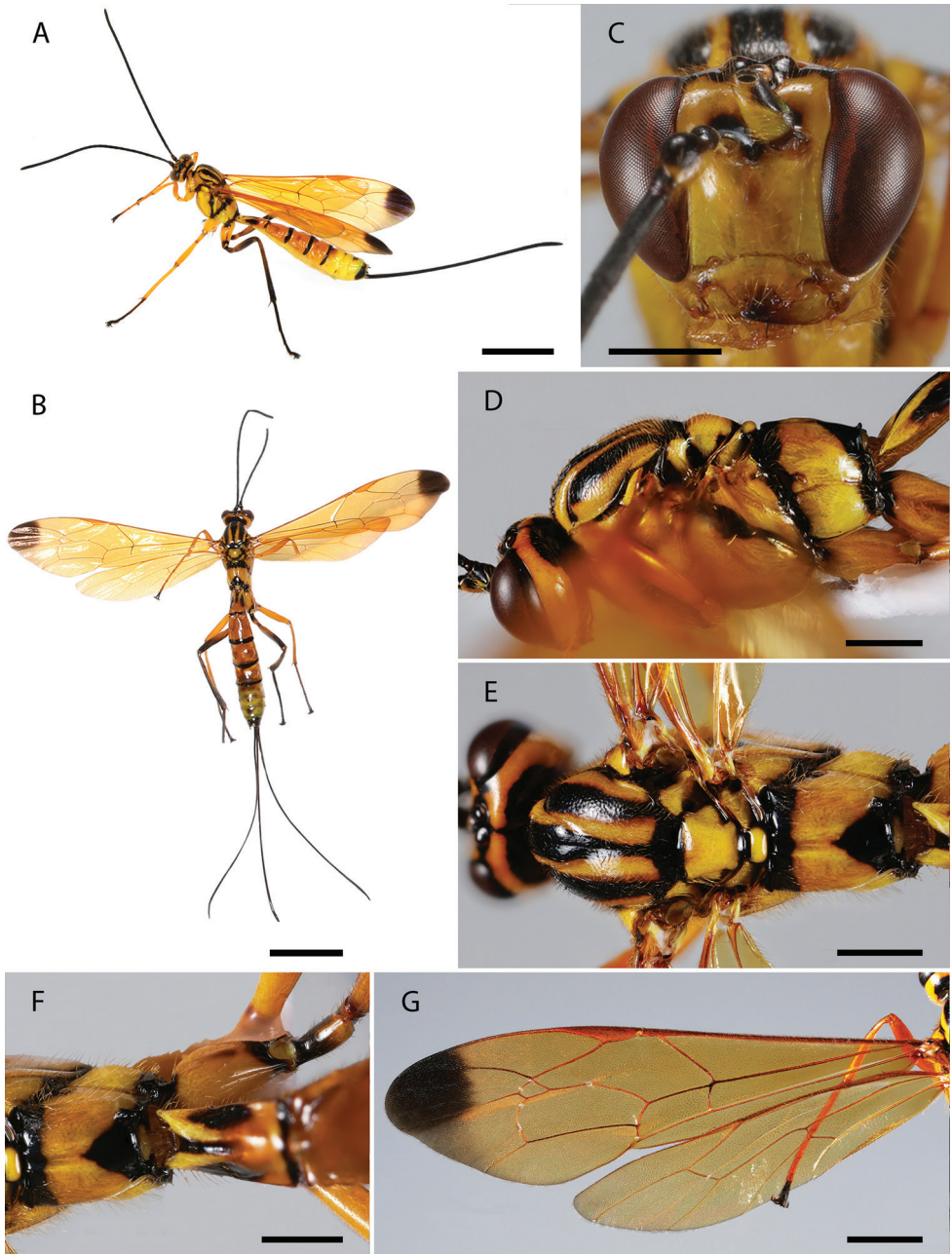
<http://zoobank.org/374BC2BD-21FF-42D1-8766-6EFA8601FEC2>

Fig. 5A–G

**Diagnosis.** *Dolichomitus pimmi* sp. nov. may be distinguished from other Neotropical species by the combination of the following characteristics: general pattern of general color (orange yellow with various specifics black marks; wings yellowish with strongly contrasting apical darkened area, pterostigma light brown; areolet not petiolate; malar space  $0.30\times$  as long as basal mandibular width; mandible bidentate,  $2.55\times$  as long as basal width (front view); tergite I ca.  $2.20\times$  as long as posteriorly wide; ovipositor sheath ca.  $0.90\times$  as long as body, and ca.  $3.00\times$  as long as hind tibia.

**Description.** **Holotype female** (Fig. 5A–G). Approximate body length (without ovipositor): 15.55 mm; fore wing length: 14.70 mm.

**Head.** Antenna with 32 flagellomeres, first flagellomere  $4.50\times$  as long as width. Gena smooth with setiferous punctures, in dorsal view somewhat rounded,  $0.50\times$  as long as eye, in frontal view almost straight and moderately constricted below eyes (Fig. 5C). Vertex smooth and shiny, with isolated setiferous punctures. Posterior ocellus separated from eye  $1.40\times$  its maximum diameter. Distance between hind ocelli  $0.85\times$  maximum diameter of posterior ocellus. Face with fine, setiferous punctures. Clypeal sulcus curved (Fig. 5C). Clypeus  $3.45\times$  as broad as medially long, almost flat. Clypeus with long parallels setae on its surface and small setae across all its margins. Anterior



**Figure 5.** **A–G** *Dolichomit pimmi* sp. nov. (holotype female): **A** habitus in lateral view (*in vivo*) **B** habitus in dorsal view **C** head in frontal view **D** mesosoma in lateral view **E** mesosoma in dorsal view **F** first tergite in dorsal view **G** wings. Scale bars: 5.00 mm (**A**, **B**); 1.00 mm (**C**, **D**, **E**, **F**); 2.00 mm (**G**).

tentorial pits conspicuous. Malar space  $0.30\times$  as long as basal mandibular width. Mandible bidentate,  $2.55\times$  as long as basal width (front view).

**Mesosoma.** Pronotum polished, with fine and scattered setiferous punctures. Epomia present. Mesoscutum shiny, with moderately dense setiferous punctures (Fig. 5D–E). Notauli deep, reaching ca.  $0.30$ – $0.40$  of length of mesoscutum. Mesopleuron shiny, with relatively dense setiferous punctures. Epicnemial carina strong. Metapleuron shiny, with scattered setiferous punctures, ca.  $1.70\times$  as long as height. Submetapleural carina strong, enlarged anteriorly, reaching ca.  $0.65$  of metapleuron length, its anterior end slightly curved up. Propodeum shiny, with fine and scattered setiferous punctures, denser laterally, in dorsal view  $1.20\times$  as long as medially wide. Propodeal spiracle elliptic, just above the pleural carina. Pleural carina complete and strong, culminating posteriorly in a small propodeal crest. Hind leg with femur ca.  $6.60\times$  as long as height and ca.  $0.70\times$  as long as tibia. Fore wing with vein *Icu-a* more or less interstitial to *M&Rs*; areolet  $1.50\times$  as wide as height; vein *Icu-a* and vein *2m-cu* slightly curved. Hind wing with vein *cu-a* ca.  $2.60\times$  as long as proximal abscissa of *CU*; vein *cu-a* reclivous and straight; proximal abscissa of *CU* vertical; distal abscissa of *CU* present, reaching wing margin (Fig. 5G).

**Metasoma.** Tergite I ca.  $2.20\times$  as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally (Fig. 5F); spiracle near its anterior  $0.35$ ; dorsolateral carinae of first metasomal tergite weak, present on petiole and postpetiole. Posterior membranous section of first metasomal sternite ca.  $0.30$  of length of tergite. Tergite II ca.  $1.20\times$  as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally and posteriorly; ovipositor slender, evenly down curved at distal  $0.30$ , ca.  $3.40\times$  as long as hind tibia (Fig. 5A); upper valve of ovipositor smooth; apex of ovipositor with expanded area of lower valve bearing ca. 10 teeth, the most proximal 3 subvertical; ovipositor sheath ca.  $0.90\times$  as long as body, and ca.  $3.00\times$  as long as hind tibia, bearing fine dense hairs which are ca.  $1.10\times$  as long as width of sheath.

**Color.** Head mostly orange yellow with mandibles apically, frons, stemmaticum (extending to outer orbit dorsally), a longitudinal stripe on vertex, dorsal half of occipital carinae, scape dorsally, pedicel and flagellum black. Mesosoma mostly orange yellow with pronotal collar dorsally (dorsally extending to pronotum), posterior margin of pronotum, tegula dorsally, subtegular ridge, lateral and central longitudinal stripes on mesoscutum, scuto-scutellar groove, ventral and posterior margin of scutellum, posterior margin of axilla, metanotum posteriorly, epicnemium ventrally, anterior and dorsal margin of mesopleuron, anterior margin of mesepisternum, anterior and posterior margin of metapleuron, a narrow strip over the submetapleural carina, anterior and posterior margin of propodeum, a triangle mark dorsally based on the posterior margin that projects to the center of propodeum, black. Fore and mid legs mostly orange yellow with a dorsal mark on the anterior margin of coxa, tarsi V on fore and mid leg and tarsal claws, black. Mid leg with tarsi II–IV dark brown. Hind leg mostly dark brown (infusate) with the coxa orange yellow; posterior half of trochanter and anterior half of femur dark yellow; anterior and posterior margin of coxa, posterior margin of



tibia and tarsus, black (Fig. 5A, B, F). Wings yellowish with strongly contrasting apical darkened area that covers only the distal half of fourth submarginal cell, pterostigma light brown (Fig. 5G). Metasoma mostly orange yellow with anterior half of tergite I, posterior half of tergite V, tergites VI–VII and posterior margin of tergite VIII yellow. Lateral spots and an anterior dorsal longitudinal stripe on tergite I, posterior margin of tergites I–IV, tergite VIII black. Anterior margin of tergites VI and VII with a dark brown spot dorsally. Ovipositor dark brown and ovipositor sheath black.

**Male.** Unknown.

**Variation.** There are some specimens with body length (11.80–15.55 mm) and wing length (11.15–14.70 mm).

**Type material. Holotype.** 1 ♀, Colombia, Jardín, Antioquia, El Alto, Mesenia-Paramillo nature reserve (1800m–3000m elevation), 5°29'45.8"N, 75°53'21.3"W, entomological net, 09–III–2019, coll. Mazariegos, L. (UNIANDES). **Paratypes.** 1 ♀, same locality, same collection method, 14–IV–2019, same collector (UNIANDES); 1 ♀, same locality, same collection method, 15–IX–2019, coll. Rendon, U. (UNIANDES).

**Distribution.** Colombia.

**Etymology.** The specific epithet is in honor of Stuart Pimm, Doris Duke Chair of Conservation Ecology in the Nicholas School of the Environment at Duke University. Winner of the 2006 Heineken Prize for Environmental Sciences, awardee of the Tyler Prize for Environmental Achievement in 2010, and recipient of the 2019 International Cosmos Prize – among the most prestigious honors in the environmental field – for his research on endangered species and his work to help reverse species' declines by protecting their shrinking habitats. His support of the Mesenia-Paramillo nature reserve conservation project to restore areas and reconnect forest fragments has been invaluable.

**Biological note.** Host unknown.

**Comments.** *Dolichomitus pimmi* sp. nov. is most similar to *D. mariajosae* sp. nov. mainly by the pattern color of the body yellowish with black marks and the fore wing with a strongly contrasting apical darkened area, but this new species differs mainly by the fore wing yellowish with pterostigma light brown, hind wing with proximal abscissa of *CU* vertical, ovipositor ca. 3.40× as long as hind tibia and ovipositor sheath ca. 3.00× as long as hind tibia (fore wing hyaline with pterostigma dark brown, hind wing with proximal abscissa of *CU* inclivous, ovipositor ca. 4.40× as long as hind tibia and ovipositor sheath ca. 4.20× as long as hind tibia in *D. mariajosae* sp. nov.).

***Dolichomitus rendoni* Araujo & Pádua, sp. nov.**

<http://zoobank.org/A42CEA69-EC56-4F69-954E-56B92EAB9839>

Fig. 6A–G

**Diagnosis.** *Dolichomitus rendoni* sp. nov. may be distinguished from other Neotropical species by the combination of the following characteristics: malar space 0.35× as long as basal mandibular width; mesosoma mostly red with the tegula white; wings yellowish, pterostigma dark brown; areolet slightly petiolate; fore leg with a white concavity

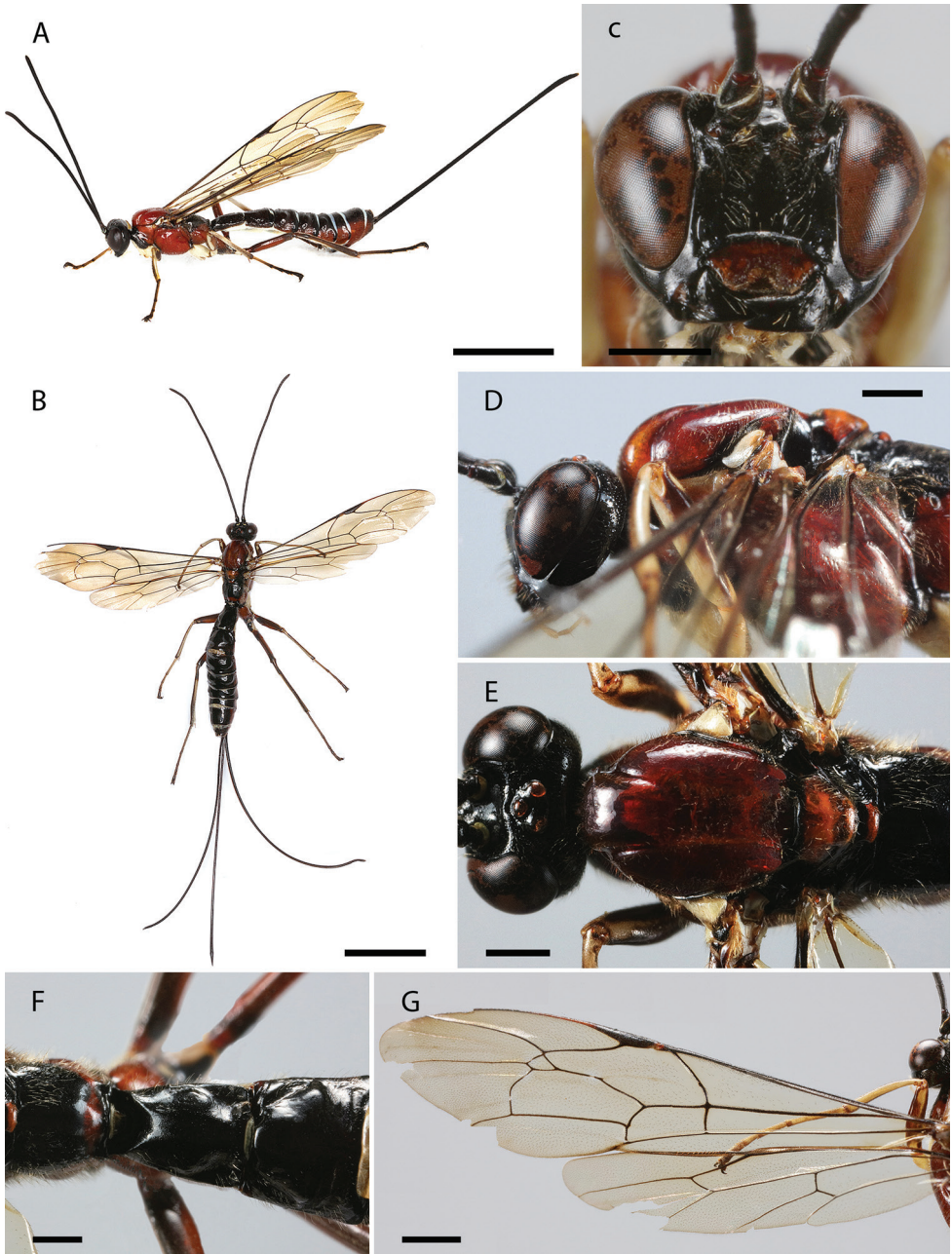
on it postero-dorsal margin; fore and mid legs mainly white; hind wing with vein *cu-a* ca. 1.20× as long as proximal abscissa of *CU*; metasoma mostly reddish black with ventro-lateral spots on tergites III–IV, lateral of tergites V–VIII red (except for the posterior margin of tergites V and VI laterally reddish black); posterior margin of tergite I–VII with a white band dorsally (small and narrow on tergite I); posterior membranous section of first metasomal sternite ca. 0.60 of length of tergite; ovipositor sheath ca. 0.90× as long as body, and ca. 2.90× as long as hind tibia.

**Description. Holotype female** (Fig. 6A–G). Approximate body length (without ovipositor): 13.50 mm; fore wing length: 12.00 mm.

**Head.** Antenna with 31–34 flagellomeres, first flagellomere 4.20× as long as width. Gena smooth with setiferous punctures, in dorsal view somewhat rounded, 0.55× as long as eye (Fig. 6E), in frontal view almost straight below eyes (Fig. 6C). Vertex smooth and shiny, with setiferous punctures. Posterior ocellus separated from eye 1.10× its maximum diameter. Distance between hind ocelli 0.95× maximum diameter of posterior ocellus. Occipital carina complete. Face with abundant setiferous punctures. Clypeal sulcus curved. Clypeus 3.15× as broad as medially long, almost flat. Clypeus with sparse parallel setae on its surface. Anterior tentorial pits conspicuous. Malar space 0.35× as long as basal mandibular width. Mandible bidentate, 1.40× as long as basal width (front view).

**Mesosoma.** Pronotum polished, with fine and scattered setiferous punctures. Epomia present. Mesoscutum shiny, with sparse setiferous punctures. Notauli deep, reaching ca. 0.40 of length of mesoscutum. Mesopleuron shiny, with relatively dense setiferous punctures. Epicnemial carina strong. Metapleuron shiny, with relatively dense setiferous punctures, ca. 1.30× as long as height. Submetapleural carina strong, enlarged anteriorly, reaching ca. 0.65 metapleuron length, its anterior end slightly curved up. Propodeum shiny, with fine and scattered setiferous punctures, denser laterally, in dorsal view 1.05× as long as medially wide. Propodeal spiracle elliptic (Fig. 6D–E). Pleural carina complete and strong. Hind leg with femur ca. 5.60× as long as height and ca. 0.80× as long as tibia. Fore wing with vein *1cu-a* interstitial to *M&R*<sub>2</sub>; areolet slightly petiolate, 1.60× as long as height; vein *1cu-a* and vein *2m-cu* slightly curved. Hind wing with vein *cu-a* ca. 1.20× as long as proximal abscissa of *CU*; vein *cu-a* reclivous and straight; proximal abscissa of *CU* vertical; distal abscissa of *CU* present, reaching wing margin.

**Metasoma.** Tergite I ca. 1.40× as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally (Fig. 6F); spiracle near its anterior 0.45; dorsolateral carinae of first metasomal tergite present on petiole and stronger on postpetiole. Posterior membranous section of first metasomal sternite ca. 0.60 of length of tergite. Tergite II ca. 1.20× as long as posteriorly wide, shiny, with fine and relatively dense setiferous punctures, more extended laterally. Ovipositor slender, evenly down curved at distal 0.12, ca. 3.60× as long as hind tibia (Fig. 6A); apex of ovipositor with expanded area of lower valve bearing ca. 10 teeth, the most proximal are 2 vertical, followed by 2 subvertical; ovipositor sheath ca. 0.90× as long as body, and ca. 2.90× as long as hind tibia, bearing fine dense hairs which are ca. 0.90× as long as width of sheath.



**Figure 6.** A–G *Dolichomitrus rendoni* sp. nov. (holotype female): **A** habitus in lateral view (*in vivo*) **B** habitus in dorsal view **C** head in frontal view **D** head and mesosoma in lateral view **E** head and mesosoma in dorsal view **F** first tergite in dorsal view **G** wings. Scale bars: 5.00 mm (**A**, **B**); 1.00 mm (**C**, **D**, **E**, **F**); 2.00 mm (**G**).



**Color.** Head and antenna entirely reddish black. Mesosoma mostly red with propleuron, pronotal collar, anterior margin of pronotum, two marks on the lateral margins of mesoscutum (just above tegula), subtegular ridge, scuto-scutellar groove, axilla, metanotum anteriorly, a narrow mark on the ventro-anterior margin of epicnemium, a narrow mark on the ventral half of mesopleural furrow, a narrow mark on the ventral margin of mesepisternum, propodeum reddish black. Tegula white, with posterior margin infusate. Fore leg mostly white with the dorsal surface of femur (except for a white concavity on its postero-dorsal margin), ventral surface of tibia and tarsus reddish brown. Mid leg mostly white with the dorsal surface of femur (except for a white spot on its postero-dorsal margin), ventral surface of tibia, tarsi II–V reddish brown (tarsus I infusate). Hind leg mostly reddish brown with the ventral surface of trochanter and trochantellus, posterior 0.70 of the dorsal surface of tibia white; coxa and ventral surface of femur red (Fig. 6A, B, F). Wings yellowish, pterostigma dark brown (Fig. 6G). Metasoma mostly reddish black with ventro-lateral spots on tergites III–IV, lateral of tergites V–VIII red (except for the posterior margin of tergites V and VI laterally reddish black). Posterior margin of tergite I–VII with a white band dorsally (small and narrow on tergite I). Ovipositor dark brown and ovipositor sheath reddish black.

**Male.** Unknown.

**Variation.** There are some paratypes with body length (17.50 mm), fore wing length (15.95 mm) and the coloration (posterior margin of propodeum red; width of the dorsal white bands narrower on the posterior margin of tergites II–IV).

**Type material. Holotype.** 1 ♀, Colombia, Jardín, Antioquia, La Lucrecia, Mesenia-Paramillo nature reserve (2400m elevation), 5°30'50.61"N, 75°50'32.02"W, entomological net, 06–I–2020, coll. Jaramillo, J. (UNIANDES). **Paratype.** 1 ♀, same locality, same collection method, 15–IX–2019, coll. Rendon, U. (UNIANDES).

**Distribution.** Colombia.

**Etymology.** The specific epithet is in honor of Ubiel Rendon, park ranger at the Mesenia-Paramillo nature reserve. A La Mesenia village native and once an avid hunter, his knowledge of the surrounding forests has been key for monitoring wildlife and helping with long-term studies using camera traps. He has made several important contributions to the scientific world, finding multiple new species of amphibians, reptiles and orchids at the reserve, including this Darwin wasp named in his honor.

**Biological note.** Host unknown.

**Comments.** *Dolichomitus rendoni* sp. nov. is most similar to *D. orejuelai* sp. nov. mainly by the pattern color reddish black on head, antenna, propleuron, pronotal collar, anterior margin of pronotum and propodeum dorsally, besides the yellowish wings. But this new species differs by having the areolet slightly petiolate, hind wing with vein *cu-a* ca. 1.20× as long as proximal abscissa of *CU*, pterostigma dark brown and the pattern color mostly white on fore and mid legs (areolet not petiolate, hind wing with vein *cu-a* ca. 2.25× as long as proximal abscissa of *CU*, pterostigma light brown and the pattern color mostly red on fore and mid legs in *D. orejuelai* sp. nov.).

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We would like to thank Ubiel Rendon, park ranger at the Mesenia-Paramillo nature reserve, for his assistance in collecting and conservation of the ichneumonids. To the Invertebrate Collection of INPA for the possibility to use the layer-photo equipment. Also, to the staff at the reserve for their assistance during the expeditions. We are also grateful to Bernardo Santos, Mabel Alvarado and Santiago Bordera by their invaluable suggestions. Thanks to Vicerrectoría de Investigación y Postgrado, Universidad Católica del Maule, for providing the necessary resources for the realization of this research and CAPES support for a PNPD grant to DGP (process No. 88887.372005/2019-00).

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# Three new species of the genus *Chilocorellus* Miyatake (Coleoptera, Coccinellidae, Sticholotidini) from the Philippines

Xiaoning Zhang<sup>1</sup>, Xinyue Liang<sup>1,2</sup>, Xiaosheng Chen<sup>1,2</sup>, Xingmin Wang<sup>1</sup>

**1** Key Laboratory of Bio-Pesticide Innovation and Application, Engineering Technology Research Center of Agricultural Pest Biocontrol, Ministry of Education & Guangdong Province; Department of Entomology, South China Agricultural University, Guangzhou 510640, China **2** Department of Forest Protection, College of Forestry and Landscape Architecture, South China Agricultural University, Guangzhou, 510640, China

Corresponding author: Xingmin Wang ([wangxmcn@scau.edu.cn](mailto:wangxmcn@scau.edu.cn))

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## Abstract

The genus *Chilocorellus* Miyatake, 1994 has been revised. Three new species (*C. uncinacanthus* Zhang & Wang, **sp. nov.**, *C. denspinulifer* Zhang & Wang, **sp. nov.**, and *C. fistulachaetodontus* Zhang & Wang, **sp. nov.**) from the Philippines are described and illustrated in the present paper. An updated key to the species of the genus *Chilocorellus* is provided. In addition, a list of all known species and their distributions is also provided.

## Keywords

*Chilocorellus*, Coccinellidae, Coccinelloidea, Coleoptera, new species, Philippines

## Introduction

The subfamily Sticholotidinae was recognized by Weise (1887) in the modern sense as a peculiar group of the family Coccinellidae. It has been used to accommodate small or very small ladybird beetles in which the form of the terminal maxillary palpomere is



not securiform and is elongate conical or apically acuminate (Gordon 1977, Ślipiński 2004). Gordon (1977) and Hoàng (1982) used Sticholotidini after “Sticholotini” was first-used by Weise (Weise 1887, 1901). Miyatake (1994) revised the subfamily Sticholotidinae from Asia and established six new genera (*Synonymchimorpha*, *Chilocorellus*, *Sulcolotis*, *Filipinolotis*, *Mimoserangium*, and *Coelolotis*) in the tribe Sticholotidini.

*Chilocorellus* Miyatake, 1994 was described from Luzon, Philippines with *C. luzonicus* as the type species. Subsequently three new species (*C. quadrimaculatus*, *C. protuberans*, and *C. tenuus*) from China were described by Wang and Ren (2010). In 2011, another species (*C. seleuyensis*) from Laos was added to this genus by Wang and Ren. The molecular phylogenetic analyses revealed no significant support for the tribe Sticholotidini (Giorgi et al. 2009; Magro et al. 2010; Seago et al. 2011; Robertson et al. 2015) and Sticholotidini was placed into an expanded concept of Coccinellinae (Escalona and Ślipiński, 2012; Ślipiński, 2007). The taxonomic status of the genus *Chilocorellus* has changed. Seago et al. (2011) investigated the phylogeny and evolution of the Coccinellidae based on the combination of molecular and morphological data. Their results showed that *Chilocorellus* was embedded in the tribe Chilacorini and recovered as the sister group of *Chilocorus*. They transferred *Chilocorellus* from Sticholotidini to Chilacorini. Recently, Li et al. (2020) reconstructed the phylogeny of the tribe Chilacorini. The results indicated that the two unidentified specimens of *Chilocorellus* were forming a single branch. However, they excluded *Chilocorellus* from Chilacorini as it was recovered far from this tribe based on combined molecular and morphological data analyses.

In this study, examination of ladybird specimens from the Australian National Insect Collection revealed that three species belong to this genus and they are described herein as new to science.

## Materials and methods

The specimens of the new species were collected from Luzon, Philippines. All examined materials are preserved in the Australian National Insect Collection, CSIRO, Canberra, Australia (ANIC) and the Insect Collection of South China Agricultural University, Guangzhou, China (SCAU). External morphology was observed with a dissecting stereoscope (Zeiss Discovery. V20). The following measurements were made with an ocular micrometer following Wang et al. (2017): total length (TL), length from apical margin of clypeus to apex of elytra; total width (TW = EW), width across both elytra at widest part; height (TH), from the highest part of the beetle to elytral outer margins; head width (HW) in a frontal view, widest part including eyes; pronotal length (PL), from the middle of anterior margin to the base of pronotum; pronotal width (PW) at widest part; elytral length (EL), along the suture, from the apex to the base including the scutellar shield; eyes width (Eye W) in a frontal view.

Images were taken with digital cameras (ZEISS Imager M2 and Axiocam 506 Color) connected to a dissecting microscope. The software ZEN 2.3 was used to capture images from the cameras. And Adobe Photoshop CC was used to clean up images. The distribution map was downloaded from a free map website (<http://alabamamaps.ua.edu>).

Terminology follows Ślipiński (2007) and Ślipiński and Tomaszewska (2010). Type specimens designated in the present paper are deposited in ANIC.

## Taxonomy

### Genus *Chilocorellus* Miyatake, 1994

**Type species.** *Chilocorellus luzonicus* Miyatake, 1994.

**Diagnosis.** *Chilocorellus* is similar to *Synonychomorpha* Miyatake, 1994 in general appearance, with body rounded and glabrous; dorsal surface predominantly yellowish, elytral epipleuron broad (Fig. 1a–c); antenna with 11-antennomeres, long, antennal club distinctly 3-antennomeres, terminal antennomere elongate, and apically distinctly pointed (Fig. 1d, f). It can be distinguished from *Synonychomorpha* by its prosternal process in the form of an approximately ovoid prominence without carinae (Fig. 1l). In *Synonychomorpha*, prosternal process is square.

**Description.** Body rounded, moderately to strongly convex, sub-hemispherical; dorsal surface apparently glabrous (Fig. 1a–c).

Head strongly hypognathous and small (Fig. 1c, d). Frons wide and flat with punctate (Fig. 1d). Clypeus short and transverse with anterior margin emarginate medially (Fig. 1e). Eyes large, coarsely faceted, inner eye canthus absent (Fig. 1c, d). Antennae with eleven antennomeres, scape and pedicel robust, scape elongate and curved near base, pedicel approximately as broad as scape; flagellum with nine antennomeres, antennomeres 3–5 slender, antennomeres 6–8 subequal in length and width; three terminal antennomeres comparatively wider than other antennomeres, forming a fusiform club with setae (Fig. 1d, f). Labrum transverse, rounded anteriorly and covered with long dense setae (Fig. 1g). Mandible subtriangular with two apical teeth, sharp and smooth; the two parts of mandibles asymmetrical, mola normal with two molar teeth on the left and one molar tooth on the right (Fig. 1h, i). Maxillary palp with four palpomeres, palpomere 1 small, palpomere 2 geniculate and at least two times as long as wide, palpomere 3 obviously short, terminal one slender and sharp, with strong obliquely truncated apex (Fig. 1j). Labial palp with three palpomeres, palpomere 1 tiny, palpomere 2 robust, terminal palpomere slender with setae, strongly conical, pointed apically; ligula membranous; insertion of labial palps visible ventrally on prementum; mentum trapezoidal, distinctly narrowed basally (Fig. 1k). Pronotum moderately transverse, broadly arcuate in both of frontal and lateral view, anterior margin emarginate; hind margin rounded; lateral margin rounded; not conspicuously angulate (Fig. 1a–c). Scutellar shield triangular (Fig. 1a, c). Elytra with prominent humeral angles, convex, anterior margin almost equal in width to hind margin of pronotum, lateral margins rounded, broadly explanate; dorsal surface glabrous, with dense and similar-sized punctation (Fig. 1a–c). Elytral epipleuron broad and gently complete apically, approximately 1/4 width of elytra. Hind wings well developed (Fig. 1a, b). Prosternum T-shaped, with golden pubescence and inconspicuous punctures; prosternal process significantly narrower than the transverse procoxa, prosternal carina absent; hypomeron broad without foveate (Fig. 1l). Meso-

and metaventral processes broad, as wide as midcoxal diameter, with golden pubescence and inconspicuous punctures; metaventral postcoxal lines angled at the middle joint and complete (Fig. 1m). Metendosternite stalk distinctly shorter (0.5 or less) than broad, tendons widely separated and placed near apices of arms (Figs 1n, 2n, 3n). Legs robust with dense pubescence; pro and hind coxae transverse but mid coxae oval; trochanter subtriangular, robust; femora thick, as long as tibia, but tibia slender, half as wide as femora; tarsi with four tarsomeres, tarsomere 3 minute, tarsomere 4 slender, longer than other tarsomeres; claws bidentate with two teeth (Fig. 1o–q). Abdomen with five ventrites; ventrite 1 slightly longer than ventrite 2, abdominal postcoxal lines incomplete, not recurved reaching the hind margin of ventrite 1; ventrites 2–4 sub-equal in length; ventrite 5 longer than ventrite 4, with hind margin rounded (Fig. 1r–1, s). Segment VIII, hind margin of male sternite emarginate and hind margin of female sternite rounded; tergite with hind margin rounded (Fig. 1r–1, s). Male terminalia, sternite IX and X sclerotized, with hind margin rounded (Fig. 1r–2). Male genitalia: tegmen slender and symmetrical, basal piece membranous; tegminal strut T-shaped and widened apically; penis guide slender in ventral and lateral views, parameres slender, setose at apex. Penis slender and long, curved; penis capsule asymmetrical, inner arm developed, outer arm reduced; the front part and apex of penis tubular with teeth (Fig. 1t, u). Female genitalia: coxites triangular, setose apically; styli conspicuous (Fig. 1x).

**Distribution.** China, Indonesia, Laos, Philippines (Fig. 4).

***Chilocorellus uncinacanthus* Zhang & Wang, sp. nov.**

<http://zoobank.org/7D8DFD2B-33EC-4F08-85FF-B42D484E628C>

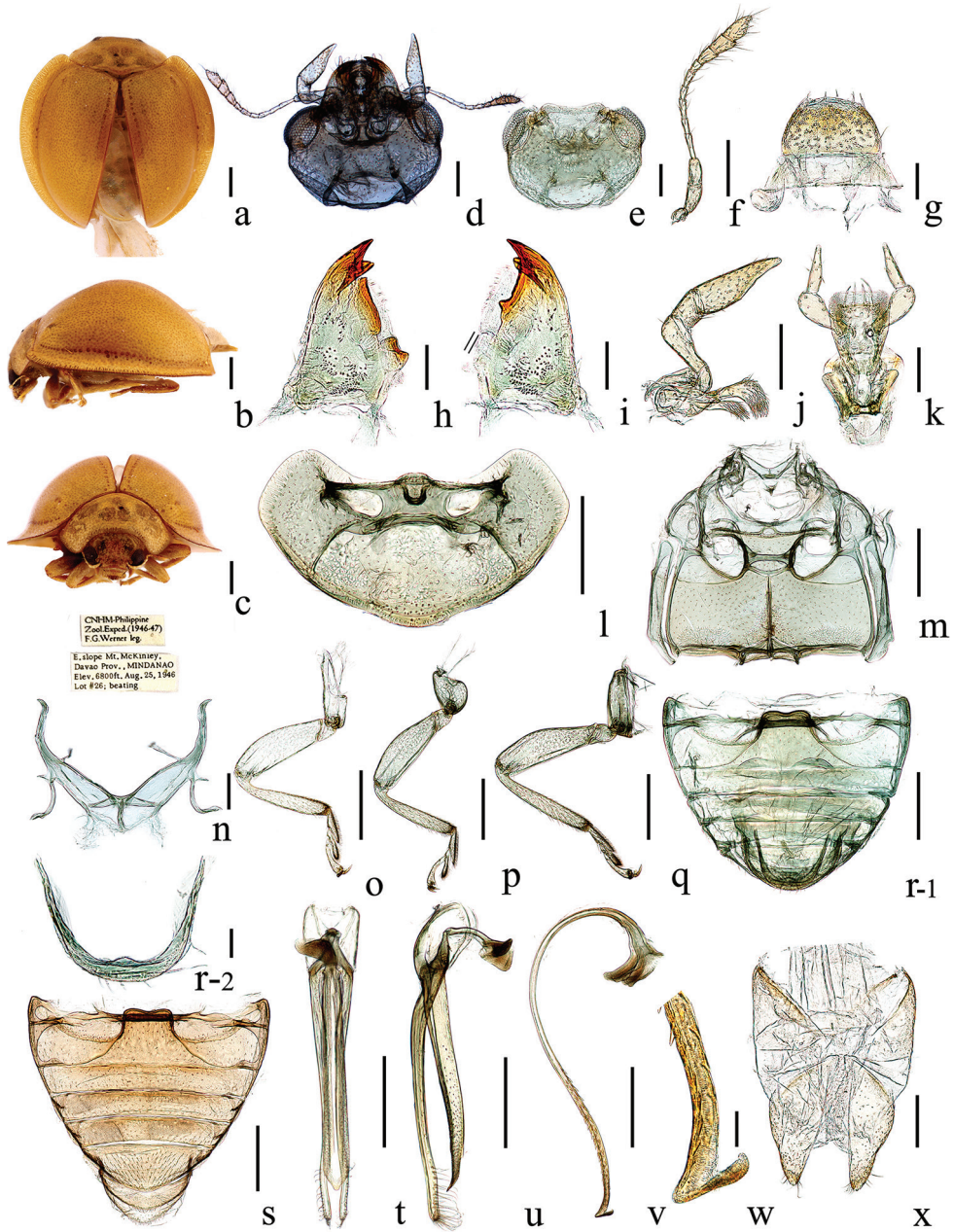
Figures 1, 4

**Holotype.** Philippines: 1 male, CNHM Philippines Zool. Exped. (1946–47) F. G. Werner leg., E. slope Mt. McKinley, Davao Province, MINDANAO Elev. 6800 ft., 25 Aug. 1946 Lot #26, beating.

**Paratypes.** 1 female, CNHM Philippines Zool. Exped. (1946–47) H. Hoogstraal leg.; Lake Linau, E. slope Mt. Apo, Davao Province, MINDANAO Elev. 7900 ft., mossy forest. 2 Nov. 1946. 1 female, CNHM Philippines Zool. Exped. (1946–47) H. Hoogstraal leg.; Baclayan, E. slope of Mt. Apo, Davao Province, MINDANAO Elev. 6500 ft., original forest. Nov. 1946. 1 female, CNHM Philippines Zool. Exped. (1946–47) H. Hoogstraal leg.; Lake Linau, E. slope Mt. McKinley, Davao Province, MINDANAO Elev. 7900 ft. stunted mossy forest, 11 Jun. 1946.

**Diagnosis.** This species is similar to *C. protuberans*, *C. tenuous*, and *C. seleuyensis* in general appearance (e.g., the elytra yellow without any spots and broad), but can be distinguished from them by the anterior part and apex of penis hatchet-shaped with irregularly serrated coupled teeth. In *C. protuberans*, the penis is long and slender, with a large penis capsule and apex of penis is curved, with many small teeth. In *C. tenuous*, penis is very long and slender and apex of penis has many large teeth. In *C. seleuyensis*, penis is longer than in other species and apex of penis is partly membranous, with many small teeth.





**Figure 1.** *Chilocorellus uncinacanthus* sp. nov. **a** dorsal habitus **b** lateral habitus **c** frontal habitus **d** head, ventral **e** head, ventral **f** antenna **g** labrum **h** left mandible **i** right mandible **j** maxilla **k** labium **l** prothorax, ventral **m** mesoventrite and metaventrite **n** metendosternite **o** front leg **p** mid leg **q** hind leg **r-1** male abdomen **r-2** male terminalia **s** female abdomen **t** tegmen, ventral view **u** tegmen, lateral view **v** penis, lateral **w** apex of penis **x** female genitalia (ovipositor). Scale bars: 0.5 mm (**a-c, l-m, o-v**); 0.2 mm (**d-f, j, n, x**); 0.1 mm (**g-i, k**); 0.05 mm (**w**).

**Description.** TL: 3.26–3.30 mm, TW: 2.87–3.02 mm, TH: 1.29–1.40 mm, TL/TW: 1.09–1.14; PL/PW: 0.23–0.24; EL/EW: 0.86–0.98 HW/PW: 0.55–0.58; PW/TW: 0.54–0.55; HW/TW: 0.30–0.32; Eye W/HW: 0.5–0.57.

Head yellow, with eyes silvery gray. Pronotum, scutellar shield, and elytra yellow, with small dense punctures. Underside yellow, except mesoventrite and metaventrite yellowish brown.

Body oval, moderately convex (Fig. 1b, c). Head small, 0.3 times elytral width ( $HW/TW = 1:3.2$ ) with sparse pubescence. Eyes oval, widest interocular distance 0.54 times head width ( $eye\ W/HW = 1:1.87$ ). Frons broad with irregular transparent spots, punctures uniform and dense (Fig. 1c, d).

Pronotum 0.55 times elytral width ( $PW/TW = 1:1.83$ ), moderately transverse, with irregular transparent spots, punctures uniform and dense (Fig. 1c). Elytra with transparent humeral angles, punctures uniform and dense (Fig. 1a–c). Male genitalia (Fig. 1t–w): penis guide in lateral view wide at base and uniformly narrowing to pointed apex; parameres distinctly longer than penis guide, uniformly slender with densely distributed long setae apically (Fig. 1t, u); penis tubular, extremely long, curved; flabellate part of penis capsule very broad, anterior part and apex of penis hatchet-shaped with irregularly serrated coupled teeth (Fig. 1v, w).

**Distribution.** Philippines (Davao).

**Etymology.** The name *uncinacanthus* is composed of the Latin word *uncin*, which refers to the anterior part of uncinat penis and *acantha*, referring to the anterior part and apex of the penis.

***Chilcorellus denspinulifer* Zhang & Wang, sp. nov.**

<http://zoobank.org/8505FE62-5070-44FE-BA1A-1CD6EFE1E8B8>

Figures 2, 4

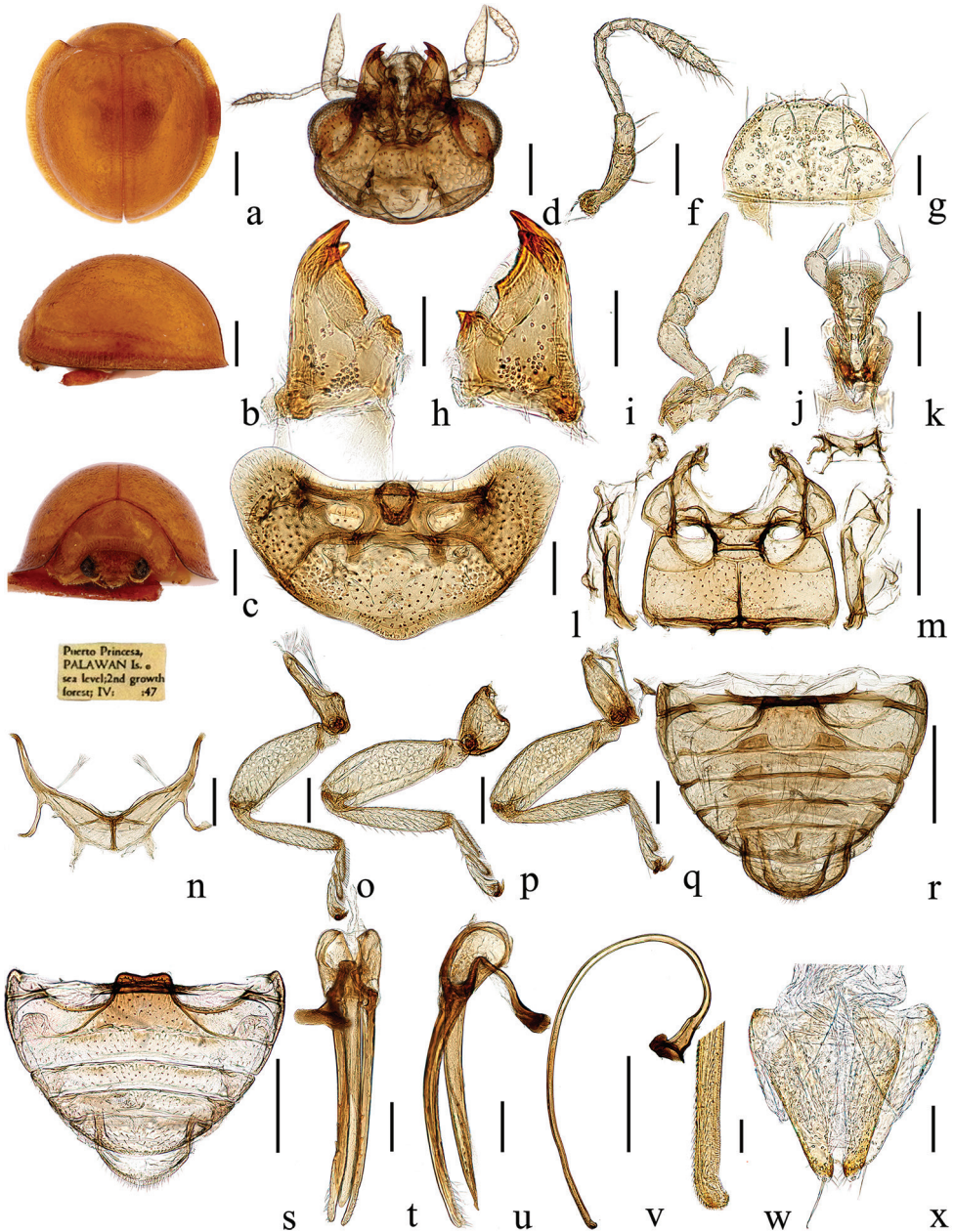
**Holotype.** Philippines: 1 male, Puerto Princesa, Palawan Is, sea level, secondary growth forest, IV 47.

**Paratype.** 1 female, Philippines, Puerto Princesa, Palawan Baker.

**Diagnosis.** This species is similar to *C. uncinacanthus*, *C. protuberans*, *C. tenuous*, and *C. seleuyensis* by the strongly convex, yellow elytra having no spots. But unlike these species, its body is small, the anterior and apex of the penis is tubular with irregular dense tiny teeth. In *C. uncinacanthus*, the apex of the penis is hatchet-shaped and bears large teeth; in *C. protuberans*, the apex of the penis is curved and membranous, with many small teeth; in *C. tenuous*, the apex of the penis is straight and membranous, with many asymmetrical large teeth.

**Description.** TL: 2.33–2.40 mm, TW: 2.26–2.28 mm, TH: 1.11–1.21 mm, TL/TW: 1.03–1.05; PL/PW: 0.37–0.47; EL/EW: 0.94–0.97 HW/PW: 0.53–0.55; PW/TW: 0.58–0.59; HW/TW: 0.31–0.32; Eye W/HW: 0.33–0.41.

Head yellow, with eyes silver-gray. Pronotum, scutellar shield, and elytra uniformly yellow, with tiny dense punctures. Underside yellow; prosternum, mesoventrite, metaventrite, and legs yellowish brown.



**Figure 2.** *Chilcorellus denspinulifer* sp. nov. **a** dorsal habitus **b** lateral habitus **c** frontal habitus **d** head, ventral **f** antenna **g** labrum **h** left mandible **i** right mandible **j** maxilla **k** labium **l** prothorax, ventral **m** mesoventrite and metaventrite **n** metendosternite **o** front leg **p** mid leg **q** hind leg **r** male abdomen **s** female abdomen **t** tegmen, ventral view **u** tegmen, lateral view **v** penis, lateral **w** apex of penis **x** female genitalia (ovipositor). Scale bars: 0.5 mm (**a–c**, **m**, **r–s**, **v**); 0.2 mm (**d**, **l**, **n–q**, **t–u**; **f**), 0.1 mm (**h–k**, **x**); 0.05 mm (**g**, **w**).



Body rounded, strongly convex (Fig. 2b, c). Head small, 0.32 times elytral width ( $HW/TW = 1:3.2$ ), with sparse pubescence. Eyes oval, widest interocular distance 0.37 times head width (eye  $W/HW = 1:2.7$ ). Frons broad, punctures uniform and dense (Fig. 2c, d).

Pronotum 0.59 times elytral width ( $PW/TW = 1:1.7$ ), moderately transverse, punctures uniform (Fig. 2a, c). Elytra with humeral angles, punctures uniform and dense (Fig. 2a–c). Male genitalia (Fig. 2t–w): penis guide wide at base in lateral view and uniformly narrowing to pointed apex; parameres obviously longer than penis guide, uniformly slender with densely distributed long setae apically (Fig. 2t, u); penis tubular, extremely long, curved; flabellate part of penis capsule broad, anterior and apex of penis with irregular tiny dense teeth, and apex of penis nest-shaped (Fig. 2v, w).

**Distribution.** Philippines (Puerto Princesa).

**Etymology.** The name *denspinulifer* is composed of the Latin word *dens*, meaning dense, and *spinulifer*, which refers to the part of the penis with spinulose appendage.

***Chilocorellus fistulachaetodontus* Zhang & Wang, sp. nov.**

<http://zoobank.org/F57C9A4F-0185-4140-8717-2C13CCAF6163>

Figures 3, 4

**Holotype.** Philippines: 1 male, Mt Makiling, Luzon, Baker.

**Paratypes.** 1 female, Mt Makiling, Luzon, Baker; 1 female, Mt Banahaw, Philippines, Luzon, Baker; 1 female, Philippines, Luzon: Lagunas Mt Banahaw nr acool ca. 1 km from Kinabuhayan, 500 m, degraded rain forest, 28 Nov. 1998.

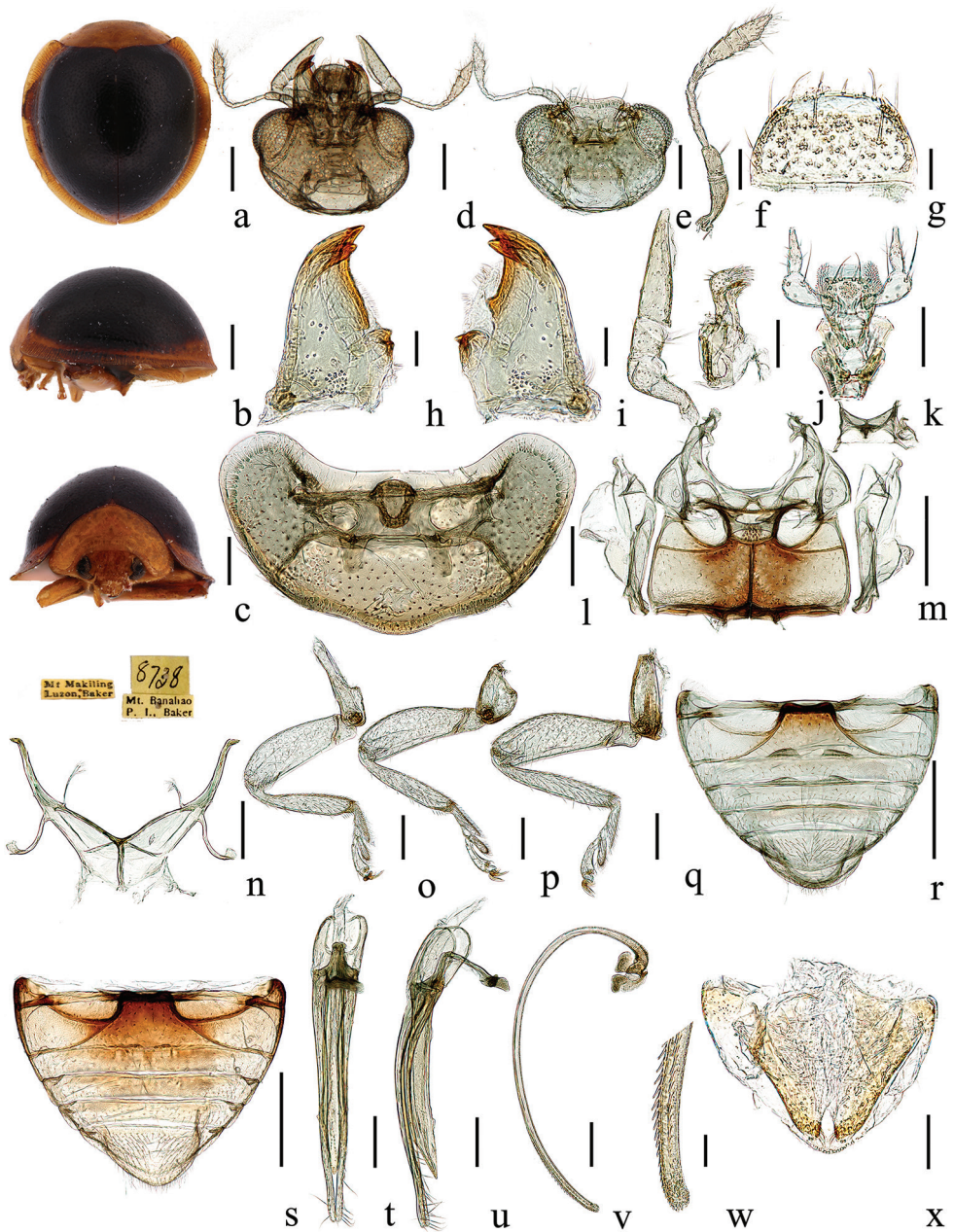
**Diagnosis.** This species can be distinguished from the other species of the *Chilocorellus* by following characters: body is small; elytra are black with just yellow margin; apex of penis guide with a membranous triangular prominence; penis long, anterior part and apex of penis with teeth, and apex of penis simple.

**Description.** TL: 2.20–2.37 mm, TW: 1.98–2.14 mm, TH: 1.19–1.21 mm, TL/TW: 1.10–1.11; PL/PW: 0.37–0.44; EL/EW: 1.01–1.02; HW/PW: 0.50–0.56; PW/TW: 0.61–0.65; HW/TW: 0.32–0.34; Eye  $W/HW$ : 0.55–0.56.

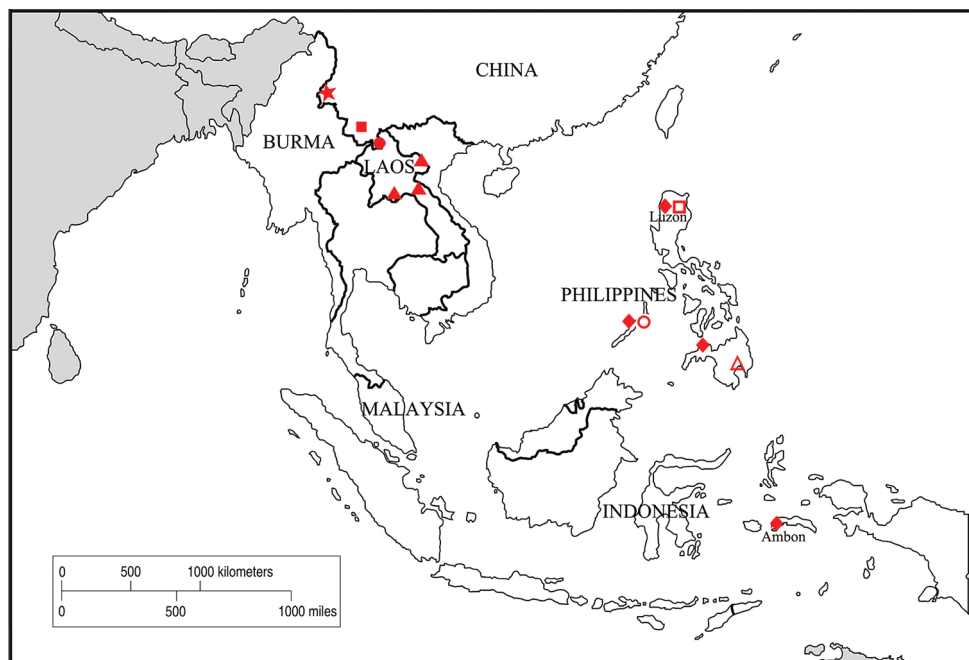
Head yellow, eyes black. Pronotum, scutellar shield, and elytral epipleuron yellow. Elytra black with yellow margin. Underside yellow; prosternum, mesoventrite, metaventrite, and legs dark brown.

Body approximately rounded, strongly convex (Fig. 3a–c). Head small, 0.33 times elytral width ( $HW/TW = 1:3.0$ ), with sparse pubescence. Eyes oval, widest interocular distance 0.56 times head width (eye  $W/HW = 1:1.8$ ). Frons broad, punctures uniform and dense (Fig. 3c, d).

Pronotum 0.63 times of elytral width ( $PW/TW = 1:1.6$ ), moderately transverse, punctures uniform (Fig. 3a, c). Elytra with black humeral angles, punctures uniform and dense (Fig. 3a–c). Male genitalia (Fig. 3t–w): penis guide wide, uniformly narrowing to pointed apex, apex of penis guide with a membranous triangular prominence. Parameres extremely slender, longer than penis guide, uniformly slender with densely distributed long setae apically (Fig. 3t, u). Penis tubular, long, curved; flabellate part of penis capsule broad, anterior part and apex of penis with dense small teeth, and apex of penis simple (Fig. 3v, w).



**Figure 3.** *Chilocorellus fistulachaetodontus* sp. nov. **a** dorsal habitus **b** lateral habitus **c** frontal habitus **d** head, ventral **e** head, ventral **f** antenna **g** labrum **h** left mandible **i** right mandible **j** maxilla **k** labium **l** prothorax, ventral **m** mesoventrite and metaventrite **n** metendosternite **o** front leg **p** mid leg **q** hind leg **r** male abdomen **s** female abdomen **t** tegmen, ventral view **u** tegmen, lateral view **v** penis, lateral **w** apex of penis **x** female genitalia (ovipositor). Scale bars: 0.5 mm (**a–c**, **m**, **r–s**); 0.2 mm (**d–e**, **l**, **n–q**, **t–v**); 0.1 mm (**f**, **j–k**, **x**); 0.05 mm (**g**, **h–i**, **w**).



**Figure 4.** Distribution map. *C. luzonicus* Miyatake, 1994 (◆); *C. quadrimaculatus* Wang & Ren, 2010 (★); *C. protuberans* Wang & Ren, 2010 (●); *C. tenuus* Wang & Ren, 2010 (■); *C. seleuyensis* Wang & Ren, 2011 (▲); *C. uncinacanthus* Zhang et Wang, sp. nov. (Δ); *C. denspinulifer* Zhang et Wang, sp. nov. (○); *C. fistulachaetodontus* Zhang et Wang, sp. nov. (◻).

**Distribution.** Philippines (Luzon).

**Etymology.** The name *fistulachaetodontus* is composed of the word *fistula*, which refers to the penis shape, and *chaetodontus*, which refers to the anterior part and apex of penis with irregular short, dense teeth.

### An updated key to the species of *Chilocorellus* Miyatake

- 1 Dorsal surface bicolored, pronotum and scutellar shield all yellow, but elytra yellow with dark spots or elytra black with yellow margin.....2
- Dorsal surface uniformly yellow, without spots .....4
- 2 Elytra yellow with dark spots .....3
- Elytra black with yellow margin; anterior part and apex of penis with irregular short, dense teeth, and apex of penis siphon-shaped. Distributed in Philippines.....*fistulachaetodontus* Zhang et Wang, sp. nov.
- 3 A longitudinal oval spot on elytral suture. Distributed in the Philippines.....*luzonicus* Miyatake
- Four large round spots on elytra, apex of penis with many oppositely arranged large teeth; parameres slightly longer than penis guide; apex of penis



- pointed and curved. Distributed in China .....  
 ..... ***quadrимaculatus* Wang & Ren**
- 4 Parameres prominently longer than penis guide ..... **5**
- Parameres slender, slightly longer than or as long as penis guide, apex of penis with many large teeth. Distributed in China..... ***tenuous* Wang & Ren**
- 5 Penis tubular, long and simple curved ..... **6**
- Penis extremely long, strongly curved; apex of penis partly membranous, with dense small teeth. Distributed Laos..... ***seleuyensis* Wang & Ren**
- 6 Apex of penis with membranous uncinus or hatchet-shaped ..... **7**
- Apex of penis nest-shaped, with serrated appendage. Distributed in Philippines ..... ***denspinulifer* Zhang et Wang, sp. nov.**
- 7 Apex of penis with membranous uncinus, with many small teeth. Distributed in China ..... ***protuberans* Wang & Ren**
- Apex of penis hatchet-shaped, with many small teeth. Distributed in the Philippines ..... ***uncinacanthus* Zhang et Wang, sp. nov.**

### List of species of *Chilocorellus* Miyatake, 1994

***Chilocorellus luzonicus* Miyatake, 1994: 249**

**Distribution.** Philippines (Luzon, Mindanao, Palawan); Indonesia (Ambon).

***Chilocorellus quadrимaculatus* Wang & Ren, 2010: 205.**

**Distribution.** China (Yunnan).

***Chilocorellus protuberans* Wang & Ren, 2010: 205.**

**Distribution.** China (Yunnan).

***Chilocorellus tenuous* Wang & Ren, 2010: 208.**

**Distribution.** China (Yunnan).

***Chilocorellus seleuyensis* Wang & Ren, 2011: 123.**

**Distribution.** Laos (Xam Nua, Vientiane, Bolikhamxai).

***Chilocorellus uncinacanthus* sp. nov.**

**Distribution.** Philippines (Davao).

***Chilocorellus denspinulifer* sp. nov.**

**Distribution.** Philippines (Puerto Princesa).

***Chilocorellus fistulachaetodontus* sp. nov.**

**Distribution.** Philippines (Luzon).

## Acknowledgements

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# A new species of *Sarcophaga* (*Pandelleisca*) (Diptera, Sarcophagidae) from Turkey

Gamze Pekbey<sup>1</sup>

<sup>1</sup> Department of Plant Protection, Faculty of Agriculture, Yozgat Bozok University, Yozgat-Turkey

Corresponding author: Gamze Pekbey ([gamze.pekbey@bozok.edu.tr](mailto:gamze.pekbey@bozok.edu.tr))

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## Abstract

A new species, *Sarcophaga* (*Pandelleisca*) *mersinensis* **sp. nov.** is described from the Mediterranean region of Turkey. The male terminalia are documented with line drawings, photographs and scanning electron microscope images. The species is compared with the two most similar species, *Sarcophaga* (*Pandelleisca*) *baudeti* (Lehrer) and *Sarcophaga* (*Pandelleisca*) *theodori* (Lehrer), both known from Israel. A key is provided to the western Palaearctic species of *Pandelleisca* Rohdendorf.

## Keywords

Anatolia, flesh fly, identification, Mediterranean region, Mersin, Middle East

## Introduction

The subgenus *Pandelleisca* Rohdendorf, 1937 (of *Sarcophaga* Meigen, 1826) contains 24 species of flesh flies, mainly distributed in the Oriental region (Verves 1986; Sugiyama et al. 1990; Pape 1996; Lehrer 1998, 2008; Kurahashi and Leh 2007; Piwczynski et al. 2014). Most species are Oriental or eastern Palaearctic, and only three species have so far been recorded from the western Palaearctic: *S. (P.) baudeti* (Lehrer, 1998) and *S. (P.) theodori* (Lehrer, 1998), both known only from Israel, and *S. (P.) similis* Meade, 1876, which is widely distributed in both the Palaearctic and the Oriental regions (Pape 1996; Lehrer 1998). *Sarcophaga* (*P.*) *similis* is the only representative of the subgenus recorded in Turkey so far (Kara and Pape 2002; Verves et al. 2018).

The assignment of *Pandelleisca* at either the generic or subgeneric level differs among authors. The nominal taxon was erected by Rohdendorf (1937) as a subgenus in his broad concept of the genus *Parasarcophaga* Johnston & Tiegs, 1921, with the designation of *S. similis* as type species. Subsequently, Pape (1996) employed a broad generic concept and placed *Pandelleisca* within the genus *Sarcophaga*.

The general morphological outline of the phallus within species of *Pandelleisca* appears remarkably similar to what is found in the subgenus *Liosarcophaga*; however, *Pandelleisca* has been separated from *Liosarcophaga* essentially due to having a massive, long and well-sclerotized paraphallus with a broader and larger median process of juxta, one or two pairs of curved lateral juxtal arms, two-paired and spiky vesical lobes, thin and long styli, and absence of the marginal bristles on the genital tergite (Rohdendorf 1937; Tumrasvin and Kano 1979; Povolný 1987; Povolný and Verves 1997; Peris et al. 1999).

This paper describes a new species of *Sarcophaga* (*Pandelleisca*) from the Mediterranean region of Turkey, providing photographs, scanning electron microscope (SEM) images, and line drawings of the male terminalia, and a key to the western Palaearctic species.

## Materials and methods

The material was collected during the years 2013–2017 in Mezitli and Erdemli districts of Mersin Province of Turkey using insect sweep nets. The specimens were killed in ethyl acetate vapour, pinned shortly afterwards when they were still fresh and air-dried.

Males were relaxed in a humidifier, and the terminalia of each specimen were detached from the abdomen using forceps and fine insect pins. The dissected terminalia of the holotype were subjected to 10% KOH for 12 hours, rinsed with distilled water and placed into glycerine for further examinations under a Leica S8APO stereomicroscope.

The air-dried genitalia of the paratype were prepared for SEM by fixing on an aluminium stub with carbon double-stick tape. The gold-coated specimens were examined and imaged in a FEI Quanta 450 FEG scanning electron microscope at BILTEM (Science and Technology Application and Research Centre of Yozgat Bozok University) using high vacuum.

Light microscope photographs were taken with a Leica DFC 450 camera integrated on a Leica M125 stereomicroscope and stacked in Helicon Focus Pro (version 7.6.1). Line drawings of terminal structures were produced with CorelDraw Graphics Suite 2019.

The terminalia of the holotype of the new species are stored in a micro-vial with glycerine and the dissected parts of the terminalia of the paratype were glued to a piece of card and both are pinned together beneath the source specimens. All the samples are deposited in the Entomology Collection of the Department of Plant Protection, Faculty of Agriculture, Bozok University, Yozgat, Turkey.

For identification, the following works were consulted: Böttcher (1912), Senior-White (1924), Rohdendorf (1937), Tumrasvin and Kano (1979), Nandi (1982), Sugi-



yama et al. (1988, 1990), Kurahashi and Leh (2007), Lehrer (1998, 2008), Kurahashi and Chaiwong (2013). The nomenclature and classification follow Pape (1996). The terminology of external morphology and terminalia follow Richet et al. (2011) except for vesical lobes where the terms “superior vesical lobes” and “inferior vesical lobes” are used as adopted by Lehrer (1998) to provide a detailed description of these structures. The comparisons of *S. (P.) baudeti* (Lehrer, 1998) and *S. (P.) theodori* (Lehrer, 1998) with the other western Palearctic species were based on the original descriptions of Lehrer (1998).

Data from labels of the type specimens are quoted verbatim: commas are used to separate the lines on the same label, labels are separated by a double forward slash, and any remarks are given in square brackets.

## Results

### *Sarcophaga (Pandelleisca) mersinensis* sp. nov.

<http://zoobank.org/31EF981D-0E7D-459D-98F7-F4D6815DABC3>

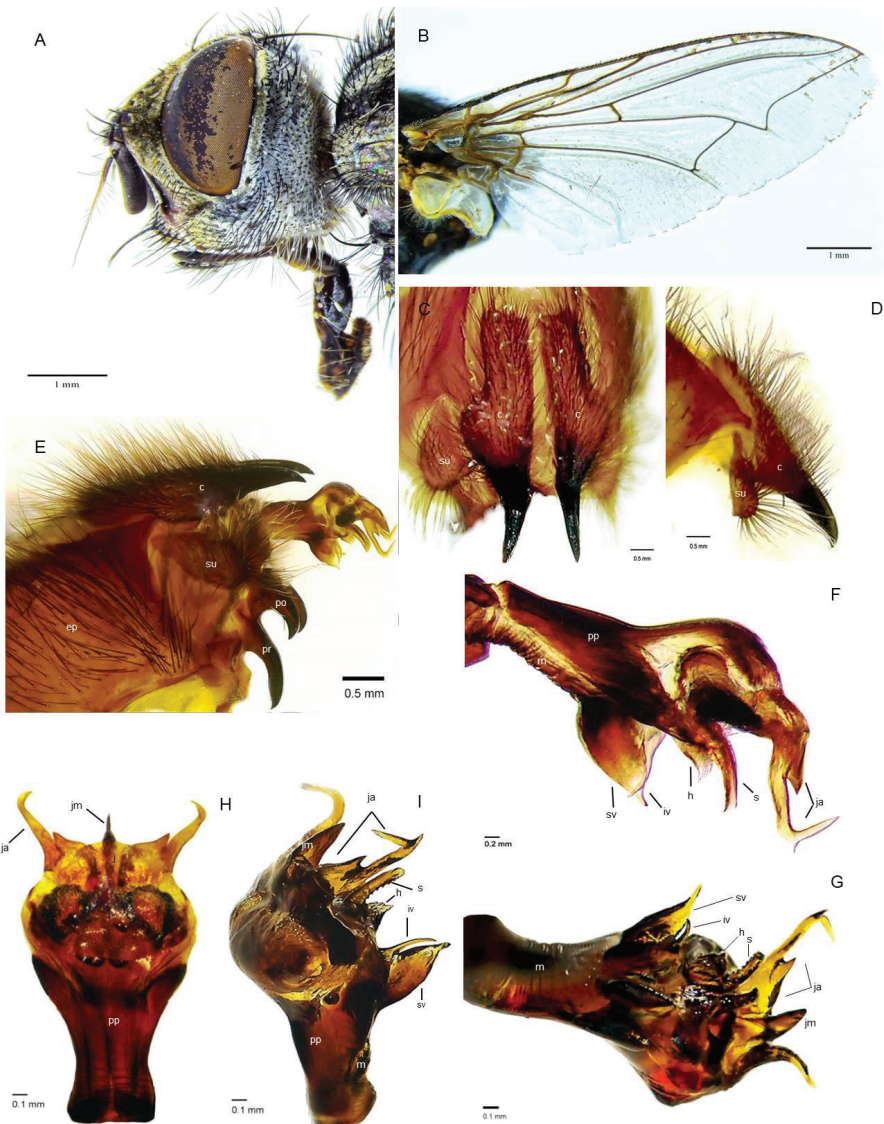
Figures 1–3

**Type material. Holotype:** ♂, TR// Mersin province [southern Turkey], Mezitli district, 1.2 km NE Kuzucu village, 608 m, 36°50'32"N, 34°25'24"E, 07.VII.2017, Leg. G. Bakır [printed on white paper] // Holotype ♂ *Sarcophaga (Pandelleisca) mersinensis*, Det. Pekbey, 2020 [printed on red paper]. **Paratype:** ♂, TR// Mersin province [southern Turkey], Erdemli district, Kösbucağı village, 542 m, 36°40'58"N, 34°14'37"E, 11.VII.2013, Leg. C. Metin [printed on white paper]. *Sarcophaga (Pandelleisca) mersinensis*, Det. Pekbey, 2020 [printed on red paper].

**Differential diagnosis.** *Sarcophaga (Pandelleisca) mersinensis* sp. nov. is similar to the East Mediterranean species *S. (P.) theodori* (Lehrer, 1998) and *S. (P.) baudeti* (Lehrer, 1998). It is distinguished from *S. (P.) baudeti* by having a brown epandrium (Fig. 1E), and it differs from *S. (P.) theodori* by the following features of the male terminalia: in *S. (P.) mersinensis* the harpes are subtriangular in lateral view, poorly sclerotized and very small (Figs 1F, G, I; 3A, B) that they can be easily overlooked due to shrinkage and overlapping by the long and broad ventral projections of the phallus in dry genitalia (Fig. 2A, B). In macerated specimens, the harpes lie anteroventrally from the base of the lateral styli but never reach beyond these (Fig. 1F, G, I). The superior vesical lobe extends to a long and pointed end. The lateral styli are flattened and serrated along the entire ventral margin. Surstyli are narrow and rounded distally (Figs 1F–I; 2A–D; 3A, B). Cercal prongs are blackish (Fig. 1C, D). Postgonites show a pair of bristles just distal to the middle on ventral surface (Figs 1E, 2A).

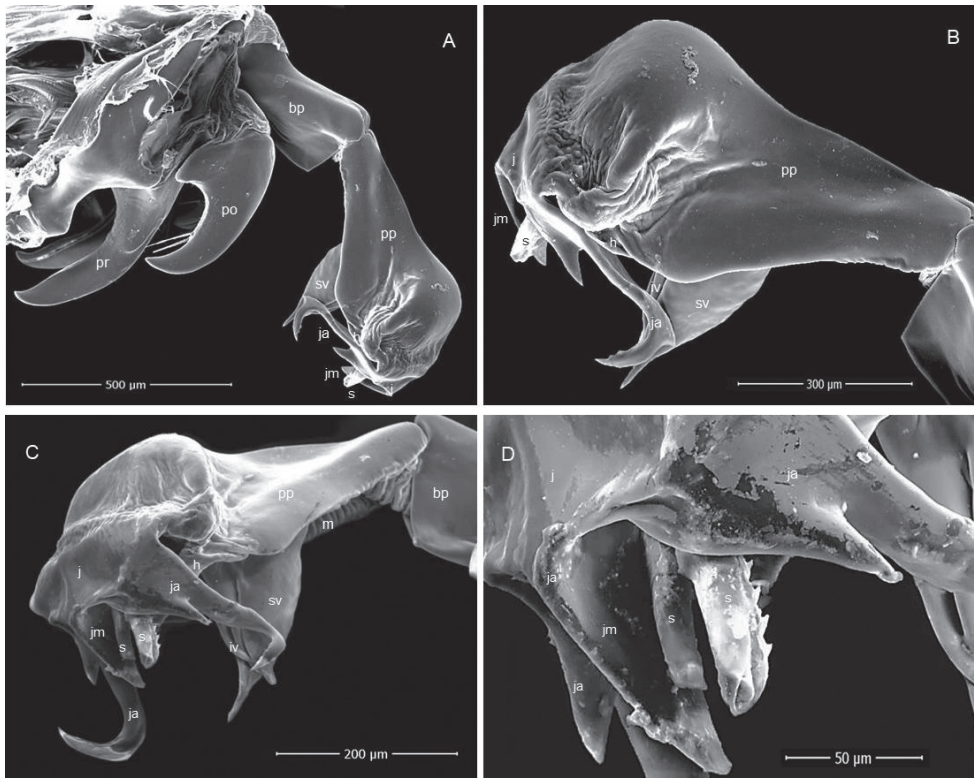
**Description. Male.** Body length 10.7–11.2 mm (without terminal extension).

**Head.** Black with golden microtomentum and the eye 0.38 times as wide as head in dorsal view. Inner vertical seta long and strong, outer vertical and proclinate orbital seta indistinct. Reclinate orbital seta well developed. Eye bare. Postocular seta black,



**Figure 1.** *Sarcophaga (Pandelleisca) mersinensis* sp. nov., male holotype **A** head, left lateral view **B** wing, ventral view **C** cerci and surstyli, dorsal view **D** cerci and surstyli, right lateral view **E** terminalia, right lateral view in glycerine **F** distiphallus, right lateral view in glycerine **G** distiphallus, right lateroventral view **H** distiphallus, dorsal view flipped vertically **I** distiphallus, right laterodorsal view flipped vertically. Abbreviations: c, cerci; ep, epiandrium; h, harpes; iv, inferior vesical lobe; ja, lateral juxta arms; jm, medial part of juxta; m, membrane; po, postgonite; pp, paraphallus; pr, pregonite; s, styli; su, surstyli; sv, superior vesical lobe.

arranged in two rows on each side of occiput. Frons apically protruding and at its narrowest point 0.68 times as wide as an eye in dorsal view. Frontal vitta black, slightly widening to antennal insertion, 0.48 times as wide as frons. Frontal bristles 11 or 12

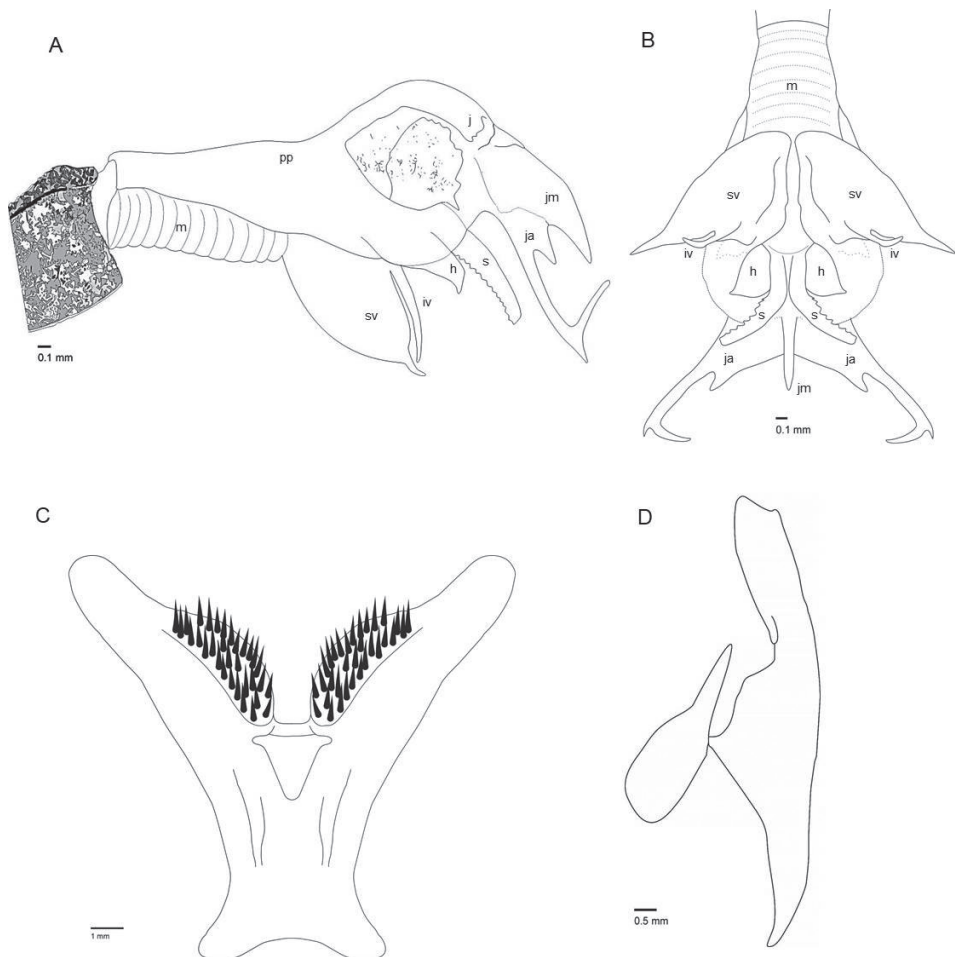


**Figure 2.** SEM microphotography of *Sarcophaga (Pandelleisca) mersinensis* sp. nov. terminalia, male paratype **A** habitus of phallus and gonites, right lateral view **B** distiphallus, right lateral view flipped horizontally **C** distiphallus frontolateral view **D** apical part of distiphallus. Abbreviations: h, harpes; iv, inferior vesical lobe; ja, lateral juxta arms; jm, medial part of juxta; m, membrane; po, postgonite; pp, paraphallus; pr, pregonite; s, styli; sv, superior vesical lobe.

pairs, not descending below of the midline of pedicel. Parafacial plate black with golden microtomentum, with a row of fine and black setulae in lower half near eye margin. Parafacial at its narrowest point 0.42 times as wide as an eye at maximum eye width in lateral view. Gena black with golden-silvery microtomentum, anterior half covered with black seta, post genal seta pale. Gena in profile 0.36 times as high as the height of an eye. Genal dilation distinct, brownish black. Vibrissa well developed. Facial ridge with a few decumbent setulae above vibrissa. Antenna brownish black, pedicel with a reddish-brown tinge on the distal part. Postpedicel 2.76 times longer than pedicel. Arista light brown, 2/3 plumose, slightly thickened on basal part. Prementum and palpus dark brown, 2.2 times longer than wide (Fig. 1A).

**Thorax.** Black with silver microtomentum with three black longitudinal stripes. Anterior stigma brown, posterior one bright yellow. Propleuron bare. Prosternum and postalar wall setulose. Acrostichals 0+1, dorsocentrals 4+4, presutural and first two postsuturals short and reduced, intra-alars 1+2, presutural 1, supra-alars 3–4, humer-





**Figure 3.** *Sarcophaga (Pandelleisca) mersinensis* sp. nov., male, holotype **A** distiphallus, right lateral view in macerated terminalia **B** distiphallus, ventral view in macerated terminalia **C** ST5, frontal view **D** cerci and surstyli, right lateral view. Abbreviations: h, harpes; iv, inferior vesical lobe; ja, lateral juxtal arms; jm, medial part of juxta; m; membrane; pp, paraphallus; s, styli; ST5, sternite 5; sv, superior vesical lobe.

als 3, posthumeral 2, notopleurals 4 (2 primary + 2 subprimary), katepisternals 2 + 1; scutellum with two pairs of subapical setae, one pair of basal and one pair of discal setae.

**Legs** black. Fore tibia with three anterodorsal and one posteroventral seta. Mid femur with scarce and short ctenidium. Mid tibia with two or three anterodorsal, one anteroventral, and three or four posteroventral setae. Hind tibia with a row of hair-like setae on posteroventral and ventral surface, with two strong anterodorsal setae, 1 anteroventral and one posterodorsal.

**Wing.** Hyaline. Epaulet black. Basicosta bright yellow. Costal spine absent. Vein  $R_1$  bare. Vein  $R_{4+5}$  dorsally with short and black setulae at base. Distal part of M curved at a right angle. Second costal section 1.44 times as long as fourth costal section. Cell  $r_{4+5}$  open at wing margin. Haltere brown. Lower calypter yellowish white (Fig. 1B).

**Abdomen.** Black with silvery microtomentum with small checkerboard patterns changing with the incidence of light. Syntergite I+II and tergite III without median marginals. Tergite IV with a pair of median marginals. Tergite V with a complete row of marginal setae.

**Terminalia.** Sternite 5 V-shaped, elongated and slightly indented medially at base; arms of sternite 5 flattened with a median expansion with a bunch of short and stout setulae proximally along the inner margin of each arm (Fig. 3C). Syntergosternite 7+8 brownish and subrectangular, without marginal setae. Epandrium brown with irregular fine and long setulae (Fig. 1E). Base and body of cerci brown and setose, dilated in the midline posteriorly (Fig. 1C). Cercal prongs dark, bare on ca 2/3 of dorsal surface, nearly straight with the exception of a median protuberance ventrally, descending to the middle, slightly curved and terminated with a more or less pointed apex in lateral view (Fig. 1C, D). Surstyli brown, elongated, rounded distally, and covered with long black setae (Figs 1C, D; 3D). Gonites dark brown; pregonite long and compressed with a slight convex curve of the ventral surface and a pointed tip; postgonite short and robust, hook shaped with two median bristles ventrally (Figs 1E; 2A). Phallus brown; basiphallus nearly 1/2 length of phallus and with an articulated connection to paraphallus. Paraphallus and juxtal plate well sclerotized; median part of juxta long and blade-like, bent in a right angle apico-ventrally. Lateral arms of juxta narrow, bipartite and nearly 0.50 times as long as distiphallus; basal projection of juxtal arm short and spur-shaped, distal projection long and sharply upturned at the end with a right angle and asymmetrically forked at the tip (i.e., at the bend). Lateral styli long and slender, extended beyond 2/3 the length of the lateral juxtal arms and serrated throughout the ventral surface (Figs 1F–I; 2A–D; 3A, B). Harpes membranous, small, and subtriangular in lateral view, not reaching beyond half-way along the lateral styli and only visible in macerated terminalia (Figs 1F–I; 3A, B). Vesica bilobed. The superior lobe leaf-like, compressed, greatly enlarged, inferior lobe short and narrow. Each lobe sharply pointed at the tip (Figs 1F–I; 2A–D; 3A, B).

**Female.** Unknown

**Biology.** Unknown

**Distribution.** Palaearctic – Turkey (Mediterranean region of Anatolia, Mersin).

**Etymology.** The species epithet is derived from Mersin Province situated in the Mediterranean region of Turkey, where the type series was collected.

### Key to the western Palaearctic species of the male *Sarcophaga (Pandelleisca)* (Rohdendorf, 1937)

- 1 Median part of juxta with a strong tooth on the ventral surface; lateral juxtal arms not expanding basally and narrow at the tip; each vesical lobes poorly sclerotized, slender and nearly filamentous in lateral view; sternite 5 roughly Y-shaped ..... *S. (P.) similis*
- Median part of juxta without a strong tooth on the ventral surface; lateral juxtal arms expanding basally and bi-paired at half-way; vesical lobes more or less sclerotized; superior vesical lobes leaf-like in lateral view; sternite 5 V-shaped ..... **2**

- 2 Lateral juxtal arms narrow at the tip with an axe-shaped basal expansion; cerci medium sized, relatively widening at midline, cercal prongs flat and slightly bending outwards at apex; surstyli narrow and long; epandrium black..... *S. (P) baudeti*
- Lateral juxtal arms slightly forked at the tip with a spiky and pointed tip basal expansion; cerci relatively short, dilated in midline, cercal prongs slightly curved and terminating with a more or less pointed apex; surstyli more or less quadrangular, with round corners; epandrium brown ..... **3**
- 3 Harpes triangular, narrow, and reaching beyond lateral styli. Lateral styli with recurving teeth ventrally on the distal 1/3 at most..... *S. (P) theodori*
- Harpes subtriangular, small and never reaching beyond lateral styli. Recurving teeth extending along the entire ventral surface of lateral styli (Figs 1F, G, I; 2A–D; 3A, B) ..... *S. (P) mersinensis* sp. nov.

## Discussion

Thirteen species of *Pandelleisca* are recorded only from the Oriental region, and the six Palearctic species are restricted to the far eastern territories including Palearctic China, Russia, North Korea, South Korea, and Japan (Rohdendorf 1937; Verves 1986; Sugiyama et al. 1990; Pape 1996; Kurahashi and Leh 2007; Kurahashi and Tan 2009). *Sarcophaga (P) similis* is widely distributed throughout the Palearctic and Oriental regions and is found mostly in mesophytic forest habitats (Povolný and Verves 1997). The species has also been recorded in Turkey from the coastal provinces such as Aydın and Muğla in the Aegean part, and Trabzon of the Black Sea area (Kara and Pape 2002; Verves et al. 2018). The newly described species *S. (P) mersinensis* was collected from the Mediterranean coastal region as are the two Israeli species, *S. (P) theodori* (Lehrer 1998) and *S. (P) baudeti* (Lehrer, 1998).

*Sarcophaga (P) theodori* is the species most similar to *S. (P) mersinensis* sp. nov. with regard to morphological structures of the phallus. In both species, the distiphallus expands abruptly apicolaterally in dorsal view and has elongated ventral appendages. The median process of juxta is broad, flattened, and spur-like in lateral view in both species, and bends anteroventrally with a wide angle towards the lateral juxtal arms. These arms are paired, widened basally, and slightly bifurcated at the tip. The superior vesical lobes are leaf-like, and the inferior ones are relatively thin and spiky. The lateral styli are broad and tubular in both species.

As stated by some authors, the vast majority of *Pandelleisca* species have a shiny black epandrium (Rohdendorf 1937; Verves 1986; Sugiyama et al. 1990; Lehrer 1998; Peris et al. 1999; Kurahashi and Leh 2007; Lehrer 2008), but in a few species such as *S. (P) ballardi* (Senior-White, 1924), *S. (P) brachiata* (Sugiyama, 1990), *S. (P) quinqueramosa* (Sugiyama, 1990), and *S. (P) theodori* (Lehrer, 1998) the colouration of the epandrium is brown as in *S. (P) mersinensis* sp. nov.

The taxonomic limits between *Pandelleisca* and *Liosarcophaga* are still unsettled. Some molecular studies have shown that *Liosarcophaga* and *Pandelleisca* are not mono-



phyletic in their current circumscriptions, and that the subgenus *Pandelleisca* as proposed by Pape (1996) is paraphyletic or even polyphyletic (Song et al. 2008; Ming et al. 2014; Piwczynski et al. 2014). On the other hand, Piwczynski et al. (2014) provided evidence, that five species formerly assigned to different genera from the Oriental and eastern Palearctic regions are better grouped within the subgenus *Pandelleisca*. The phylogenetic placement of *S. (P.) similis* in the study of Piwczynski et al. (2014) was particularly striking, because it was recovered as the sister taxon of *Sarcophaga (Rosellea) aratrix* Pandellé rather than grouping with all other species here considered under *Pandelleisca* (Piwczynski et al. 2014). This must, however, be under strong suspicion of being an example of one of the many misidentifications that are well-known within the genus *Sarcophaga*.

In conclusion, although all *Pandelleisca* species appear to be recorded from the coastal geographic regions in Turkey, it is thought that future more comprehensive faunistic surveys will reveal the true distribution of this subgenus.

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# The genus *Scaptodrosophila* Duda (Diptera, Drosophilidae), part III: the riverata species group from China, with morphological and molecular evidence for five new species

Yong Lin<sup>1</sup>, Hong-Wei Chen<sup>1</sup>

<sup>1</sup> Department of Entomology, South China Agricultural University, Tianhe, Guangzhou, 510642, China

Corresponding author: Hong-Wei Chen ([hongweic@scau.edu.cn](mailto:hongweic@scau.edu.cn))

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## Abstract

A new species group, the *riverata* species group, is established within the genus *Scaptodrosophila* based on morphological and molecular evidence for five known and five new species from China: *S. abdentata* **sp. nov.**, *S. cederholmi* (Okada, 1988), *S. crocata* (Bock, 1976), *S. paracubata* (Sundaran & Gupta, 1991), *S. platyrhina* **sp. nov.**, *S. puncticeps* (Okada, 1956), *S. riverata* (Singh & Gupta, 1977), *S. serrateifoliacea* **sp. nov.**, *S. sinuata* **sp. nov.** and *S. tanyrhina* **sp. nov.** A key to this group is provided. Furthermore, 51 mtDNA *COI* sequences belonging to *S. puncticeps*, *S. riverata* and the five new species are used for verifying species boundaries defined by the morphological data.

## Keywords

cryptic species, DNA barcoding, integrative taxonomy, molecular research, new species group

## Introduction

A total of 12 species groups have been erected within the genus *Scaptodrosophila* (Duda 1923): *albifrontata* group (Wheeler and Takada 1966); *aterrima* group (Tsacas et al. 1988); *barkeri* group (Bock and Parsons 1978); *brunnea* group (Tsacas and Chassagnard 1976; Liu et al. 2017); *brunneipennis* group (Bock and Parsons 1978); *bryani*



group (Throckmorton 1962); *coracina* group (Mather 1955; Liu and Chen 2018); *inornata* group (Parsons and Bock 1978); *latifasciaeformis* group (Burla 1954); *rufifrons* group (Papp et al. 1999); *saba* group (Burla 1954) and *victoria* group (Wheeler 1949). Together, these taxa include ca 300 species. Here we describe five new species from China that are morphologically similar to five known, yet unplaced, species: *S. cederholmi* (Okada, 1988) from Sri Lanka; *S. crocata* (Bock, 1976) from Australia; *S. paraclubata* (Sundaran & Gupta, 1991) from India; *S. puncticeps* (Okada, 1956) from China, Kuril Islands, Korea, Japan; and *S. riverata* (Singh & Gupta, 1977) from China, India, Myanmar. These ten species all have a yellowish-brown body; an arista with two dorsal and one ventral branch in addition to a terminal bifurcation; a large facial carina; and developed prescutellar setae. This morphological group is also supported by molecular data for the five new species and two of the five previously described taxa. The combined morphological and molecular evidence supports the establishment of a new species group, the *riverata* species group, based on five known and five new species from China.

DNA barcoding technology was employed to investigate the relationship of the *riverata* species group. Based on the results of the phylogenetic reconstruction, 51 barcode sequences of the *COI* (mitochondrial cytochrome *c* oxidase subunit I) gene belonging to two known and five new species were used to evaluate these species boundaries.

## Materials and methods

### Specimens

The *riverata* group species were collected by net sweeping from tussocks and tree trunks. All the examined specimens were preserved in 75% ethanol.

### Species identification

Total DNA was extracted from the abdominal tissue of samples after the dissection of the genitalia, using the TIANGEN™ DNA extraction kit following the recommended protocol. The *COI* fragments were amplified using the cycle protocol as in Zhao et al. (2009). The PCR sequencing primer pair was 5'-CGCCTAAACTTCAGCCACTT-3' (Wang et al. 2006) and 5'-TAAACTTCAGGGTGACCAAAAAATCA-3' (Folmer et al. 1994). All sequences generated in this study were supplied with BOLD Process ID and GenBank accession numbers (Table 1).

A total of 51 *COI* sequences of the *riverata* group were examined and aligned with MEGA 7.0 (Kumar et al. 2016). Intra- and interspecific genetic distances were calculated for species of the *riverata* group using the *p*-distance model (Nei and Kumar 2000). We also conducted character-based species barcoding where fixed sites of one species differed from those of the others; these were manually selected as diagnostic sites (i.e., “pure” diagnostics, Sarkar et al. 2002; Desalle et al. 2005). Three known species: *S. melanogaster* (GenBank accession number: KR070823), *S. rhina* (KR070845) and

**Table 1.** Specimens of *brunnea* species used for molecular study.

	<b>BOLD Process ID</b>	<b>GenBank accession number</b>	<b>Collection sites</b>
<i>S. puncticeps</i> –1	BDORM010–14	KJ841771	Shennongjia, Hubei
<i>S. puncticeps</i> –2	BDORM011–14	KJ841770	Danba, Ganzizhou, Sichuan
<i>S. puncticeps</i> –3	BDORM012–14	KJ841766	Tianmushan, Linan, Zhejiang
<i>S. puncticeps</i> –4	BDORM013–14	KJ841769	Daozhen, Zunyi, Guizhou
<i>S. puncticeps</i> –5	BDORM014–14	KJ841768	Ailaoshan, Jingdong, Yunnan
<i>S. puncticeps</i> –7	BDORM004–14	KJ841761	Shennongjia, Hubei
<i>S. puncticeps</i> –8	BDORM005–14	KJ841762	Miyaluo, Abazhou, Sichuan
<i>S. riverata</i> –1	BDORM008–14	KJ841773	Banli, Chongzuo, Guangxi
<i>S. riverata</i> –2	BDORM009–14	KJ841772	Ailaoshan, Jingdong, Yunnan
<i>S. riverata</i> –3	SDLY001–19	MK335597	Likan, Ximeng, Yunnan
<i>S. riverata</i> –4	SDLY002–19	MK335598	Likan, Ximeng, Yunnan
<i>S. riverata</i> –5	SDLY003–19	MK335599	Likan, Ximeng, Yunnan
<i>S. riverata</i> –6	SDLY004–19	MK335600	Huanglianshan, Lvchun, Yunnan
<i>S. riverata</i> –7	SDLY005–19	MK335601	Huanglianshan, Lvchun, Yunnan
<i>S. abdentata</i> sp. nov. –1	BDORM019–14	KJ841758	Nanling, Shaoguan, Guangdong
<i>S. abdentata</i> sp. nov. –2	BDORM020–14	KJ841757	Muotuo, Lingzhi, Xizang
<i>S. abdentata</i> sp. nov. –3	BDORM021–14	KJ841755	Wangtianshu, Mengla, Yunnan
<i>S. abdentata</i> sp. nov. –4	SDLY006–19	MK335586	Muyiji, Ximeng, Yunnan
<i>S. abdentata</i> sp. nov. –5	BDORM023–14	KJ841759	Wuzhishan, Ledong, Hainan
<i>S. abdentata</i> sp. nov. –6	BDORM024–14	KJ841756	Muotuo, Lingzhi, Xizang
<i>S. abdentata</i> sp. nov. –7	SDLY007–19	MK335587	Muyiji, Ximeng, Yunnan
<i>S. abdentata</i> sp. nov. –8	SDLY008–19	MK335588	Mengdong, Cangyuan, Yunnan
<i>S. abdentata</i> sp. nov. –9	SDLY009–19	MK335589	Mengdong, Cangyuan, Yunnan
<i>S. platyrhina</i> sp. nov. –1	BDORM016–14	KJ841765	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –2	BDORM017–14	KJ841764	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –3	BDORM018–14	KJ841763	Jiangcheng, Simao, Yunnan
<i>S. platyrhina</i> sp. nov. –4	SDLY010–19	MK335590	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –5	SDLY011–19	MK335591	Guanleigang, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –6	SDLY012–19	MK335592	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –7	SDLY013–19	MK335593	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –8	SDLY014–19	MK335594	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –9	SDLY015–19	MK335595	Menglun, Mengla, Yunnan
<i>S. platyrhina</i> sp. nov. –10	SDLY016–19	MK335596	Menglun, Mengla, Yunnan
<i>S. serrateifoliacea</i> sp. nov. –1	BDORM006–14	KJ841775	Hesong, Menghai, Yunnan
<i>S. serrateifoliacea</i> sp. nov. –2	BDORM007–14	KJ841774	Hesong, Menghai, Yunnan
<i>S. serrateifoliacea</i> sp. nov. –3	SDLY017–19	MK335602	Mengdong, Cangyuan, Yunnan
<i>S. sinuata</i> sp. nov. –1	SDLY024–19	MK335603	Dayangcha, Kuangdian, Liaoning
<i>S. sinuata</i> sp. nov. –2	SDLY025–19	MK335604	Dayangcha, Kuangdian, Liaoning
<i>S. sinuata</i> sp. nov. –3	SDLY026–19	MK335605	Laobiangou, Benxi, liaoning
<i>S. sinuata</i> sp. nov. –4	SDLY027–19	MK335606	Laobiangou, Benxi, liaoning
<i>S. sinuata</i> sp. nov. –5	SDLY028–19	MK335607	Laobiangou, Benxi, liaoning
<i>S. sinuata</i> sp. nov. –6	SDLY029–19	MK335608	Guojiapuzi, Kuangdian, Liaoning
<i>S. sinuata</i> sp. nov. –7	SDLY030–19	MK335609	Guojiapuzi, Kuangdian, Liaoning
<i>S. sinuata</i> sp. nov. –8	SDLY031–19	MK335610	Guojiapuzi, Kuangdian, Liaoning
<i>S. tanyrhina</i> sp. nov. –1	SDLY018–19	MK335611	Menglun, Mengla, Yunnan
<i>S. tanyrhina</i> sp. nov. –2	SDLY019–19	MK335612	Menglun, Mengla, Yunnan
<i>S. tanyrhina</i> sp. nov. –3	SDLY020–19	MK335613	Wangtianshu, Mengla, Yunnan
<i>S. tanyrhina</i> sp. nov. –4	SDLY021–19	MK335614	Wangtianshu, Mengla, Yunnan
<i>S. tanyrhina</i> sp. nov. –5	SDLY022–19	MK335615	Guanleigang, Mengla, Yunnan
<i>S. tanyrhina</i> sp. nov. –6	SDLY023–19	MK335616	Wangtianshu, Mengla, Yunnan

*S. scutellimargo* (KR070847), were used as outgroup taxa in the phylogenetic analyses. The alignment was subsequently employed to reconstruct a phylogenetic tree using the Neighbor-joining (NJ) method with *p*-distance model implemented in MEGA 7.0.26 (Kumar et al. 2016). Nodal support values (bootstrap percentages, BPs) were inferred by bootstrapping with 1000 replicates and other default settings.

Description of species

An Mshot Camera was used to photomicrograph all the examined species. All photographs, illustrations, and line drawings were processed with the software Adobe Photoshop 7.0 and Easy PaintTool SAI Ver.1.0.0. The morphological terminology follows McAlpine (1981) and the definitions of measurements, indices, and abbreviations follow Chen & Toda (2001).

The type specimens were deposited in Department of Entomology, South China Agricultural University, Guangzhou, China (SCAU).

Results

The alignment of the 51 *COI* sequences spans 632 nucleotide sites, with 131 variable sites, 122 of which were parsimony informative. Intra- and interspecific *p*-distances were provided in Table 2. The results show that the largest intraspecific *p*-distances within the *riverata* species group was 0.032 detected in *S. puncticeps*, followed by 0.016 in *S. platyrhina* sp. nov. while the minimum interspecific variation was 0.014 detected between *S. abdentata* sp. nov. and *S. tanyrhina* sp. nov.

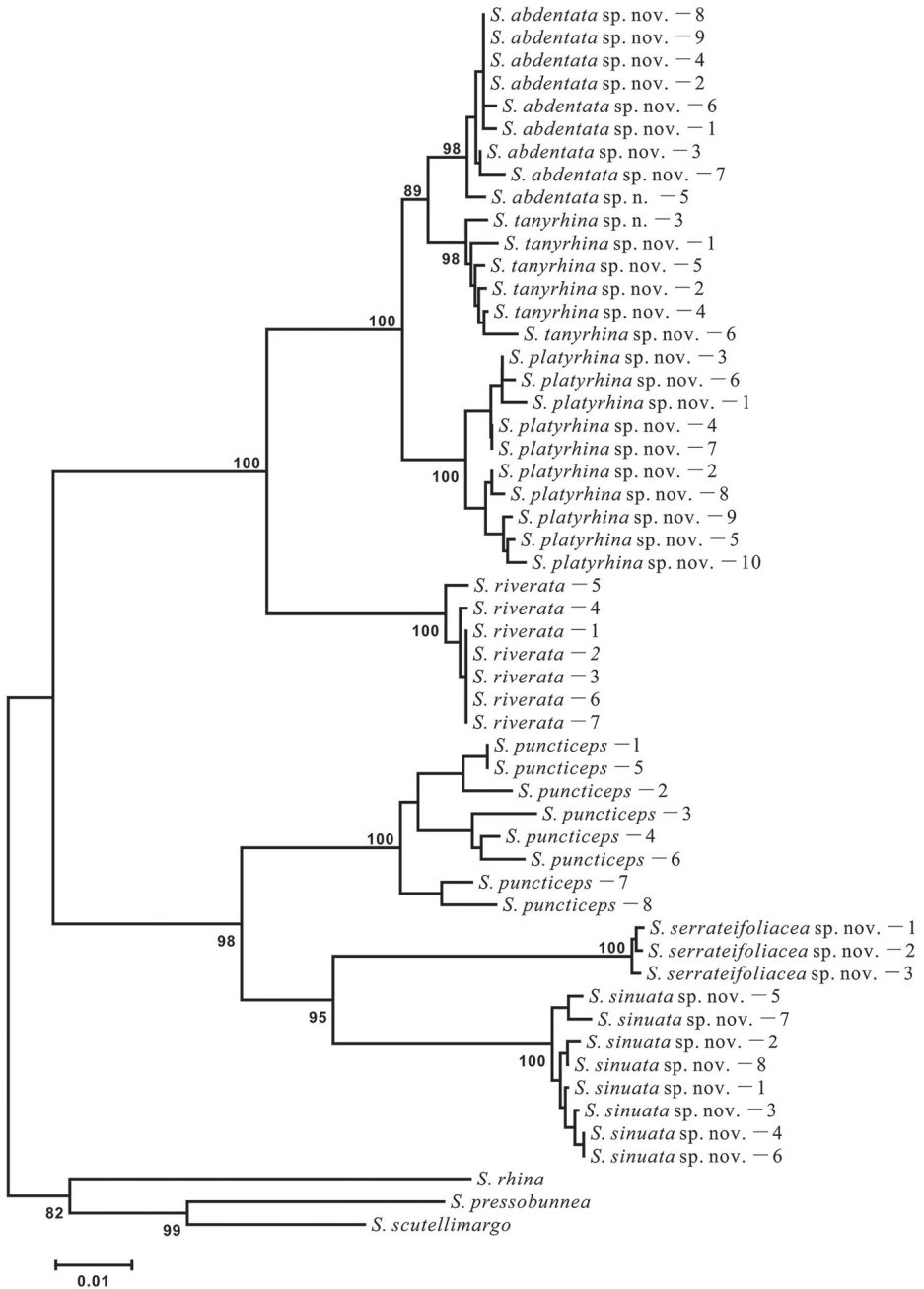
The NJ (Fig. 1) tree shows that this new group is monophyletic with respect to the outgroups. Figure 2 shows nucleotides representing “pure” diagnostic sites for all species of the *riverata* group; at least one diagnostic site was recognized for each species. For example, site 21 is diagnostic for *S. serrateifoliacea* sp. nov. with a fixed status of C (Cytosine), rather than T (Thymidine) in the other species.

**Table 2.** Summary of intra- and interspecific genetic distances.

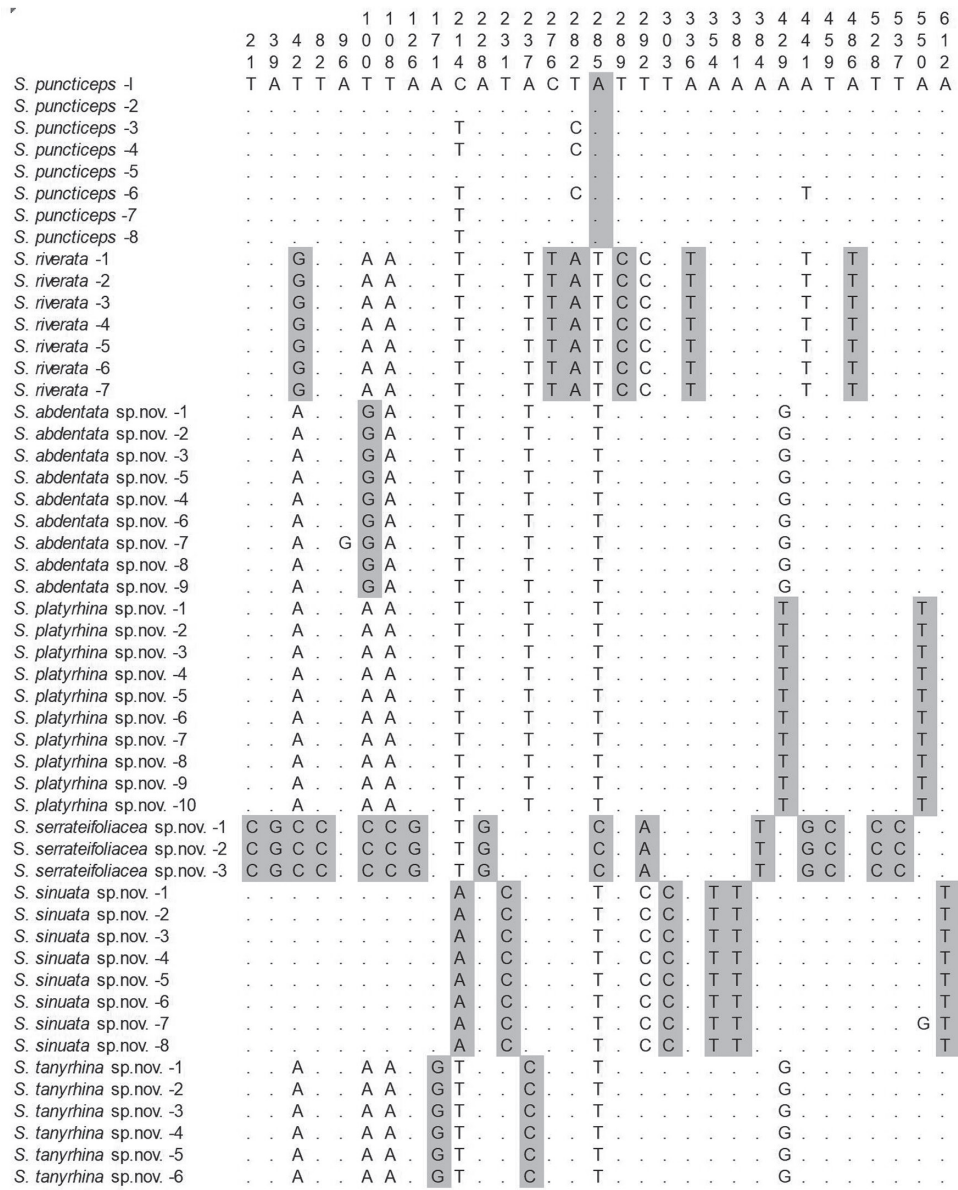
Species	N	intraspecific genetic distances	interspecific genetic distances
		Min. /Max. /Mean ± SD	Min. /Max. /Mean ± SD
<i>S.puncticeps</i>	8	0.000/ 0.032/0.020 ± 0.008	0.071/0.127/0.107 ± 0.017
<i>S. riverata</i>	7	0.000/ 0.006/0.002 ± 0.002	0.049/0.138/0.084 ± 0.032
<i>S. abdentata</i>	9	0.000/ 0.006/0.003 ± 0.002	0.014/0.136/0.073 ± 0.048
<i>S. platyrhina</i>	10	0.000/ 0.016/0.007 ± 0.004	0.022/0.136/0.078 ± 0.046
<i>S. serrateifoliacea</i>	3	0.002/ 0.003/0.002 ± 0.001	0.070/0.138/0.116 ± 0.026
<i>S. sinuata</i>	8	0.000/0.009/0.005 ± 0.003	0.070/0.134/0.113 ± 0.023
<i>S. tanyrhina</i>	6	0.003/ 0.009/0.005 ± 0.002	0.014/0.134/0.070 ± 0.048

N, the numbers of *COI* sequences involved in distance calculation; Min., minimum; Max., maximum; SD, standard deviation; NA, no applicable.





**Figure 1.** Neighbor-joining (NJ) tree of the *riverata* group. The numbers around the nodes are bootstrap (BP) percentages. BP values lower than 50 are not shown.



**Figure 2.** Diagnostic nucleotide sites in the alignment of *COI* sequences of the *riverata* species group. Numbers at the top show the positions of the sites in the *COI* alignment (584–687 bp in length). Shaded sites are diagnostic for each species. Dashes (–) indicate missing data.

Taxonomy

*Scaptodrosophila riverata* species group

**Diagnosis.** Body mostly yellow to yellowish brown, without patches; arista with two dorsal branches and one ventral branch in addition to the terminal bifurcation; facial

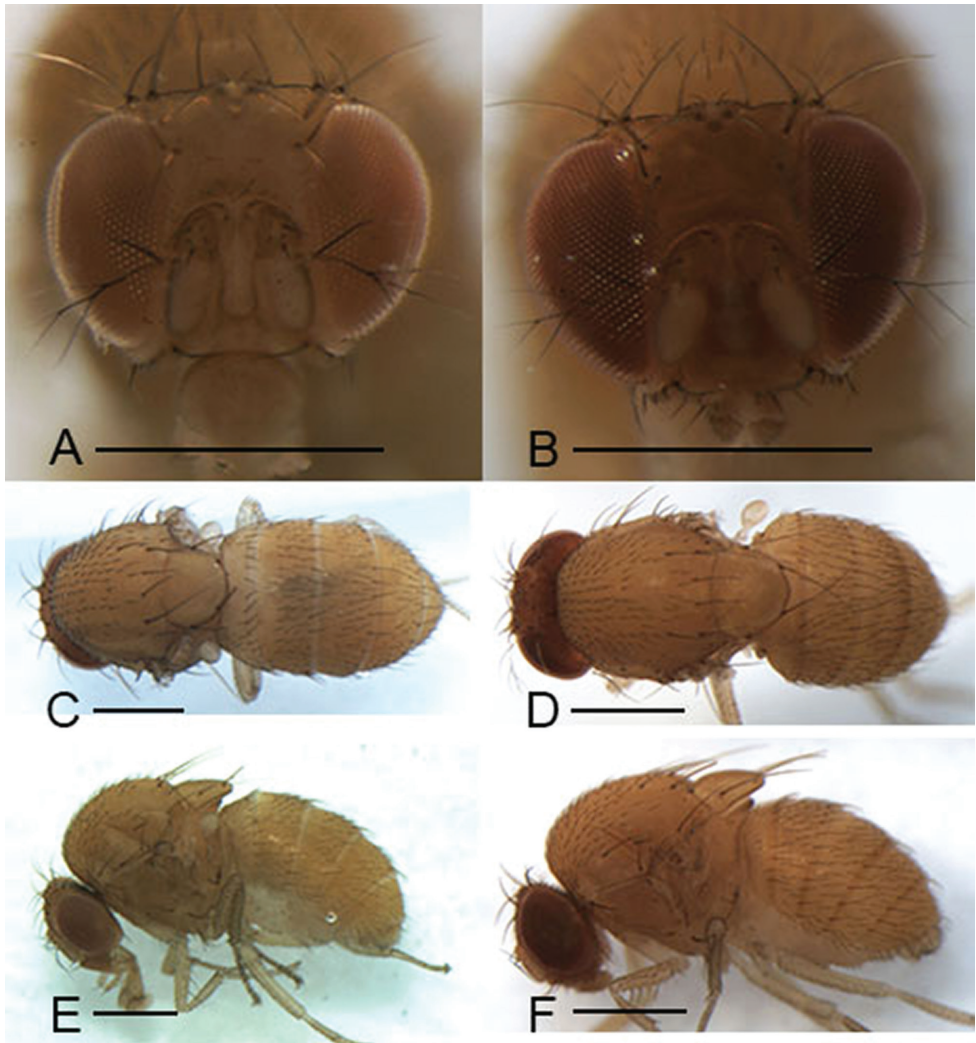


**Figure 3.** Head, mesonotum, scutellum, pleura and abdomen of male. **A, C, E** *S. riverata* (Singh & Gupta, 1977) **B, D, F** *S. puncticeps* (Okada, 1956). Scale bars: 0.5 mm.

carina large; prescutellar setae usually large, as long as anterior dorsocentral setae; hypandrium usually with a pair of long paramedian setae.

**Description.** Male and female: **Head** (Figs 3, 4, 5A, B, 6A): Eyes red. Ocellar triangle yellowish brown, with 4–6 setae above ocellar setae. Frons about 1/3 width of head, largely yellowish brown to brown, with a few minute setulae medially. Fronto-orbital pale yellowish brown; anterior reclinate orbital seta usually lateral to and about 1/3 length of proclinate orbital seta; posterior reclinate orbital seta larger than other two orbital setae. Pedicel yellowish brown to brown, with a few of fine setae; first flagellomere pale yellowish. Face yellowish brown. Clypeus mostly yellow. Vibrissa prominent; subvibrissal setae small. Gena and postgena narrow, yellowish brown. Palpus yellow to yellowish brown with several setae.



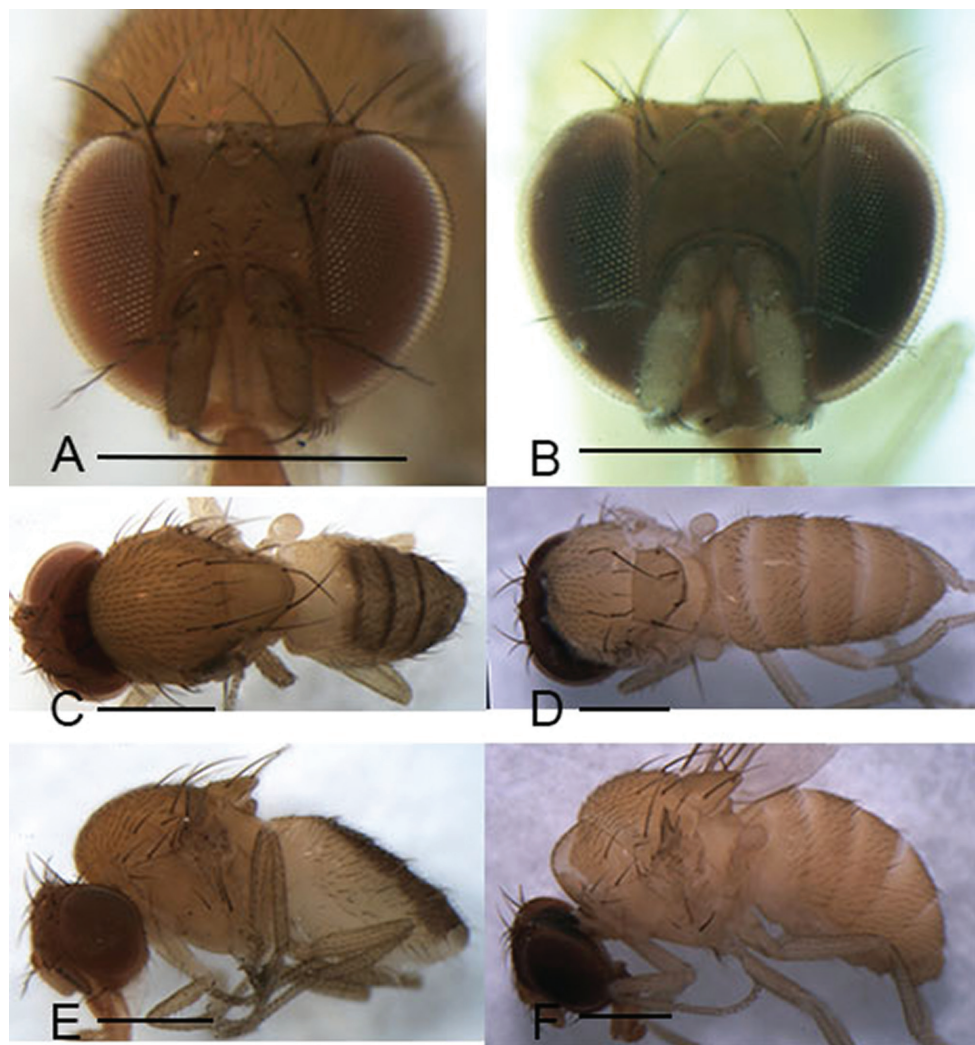


**Figure 4.** Head, mesonotum, scutellum, pleura and abdomen of male. **A, C, E** *S. abdentata* sp. nov. **B, D, F** *S. platyrhina* sp. nov. Scale bars: 0.5 mm.

**Thorax** (Figs 3, 4, 5C–F, 6B, C): Mesonotum yellow to yellowish brown uniformly. Postpronotal lobe yellow with 2–3 long setae, and a few of shorter setae. Acrostichal setulae in ca 8–10 regular rows. Prescutellar setae usually as long as anterior dorsocentral setae. Pleura yellow to yellowish brown uniformly. Katepisternal setae usually subequal. Wing hyaline, sometimes infusate, lacking patch. Basal medial-cubital crossvein absent.  $R_{4+5}$  nearly parallel distally with  $M_1$ . Halter pale yellowish. Legs mostly yellow.

**Abdomen** (Figs 3, 4, 5C–F, 6B, C): Tergites yellow to yellowish brown, lacking patches.

**Male terminalia** (Figs 7–12, 13A–D): Epandrium pubescent, with several setae near posterior margin and ventral corner on each side. Surstylus usually with several

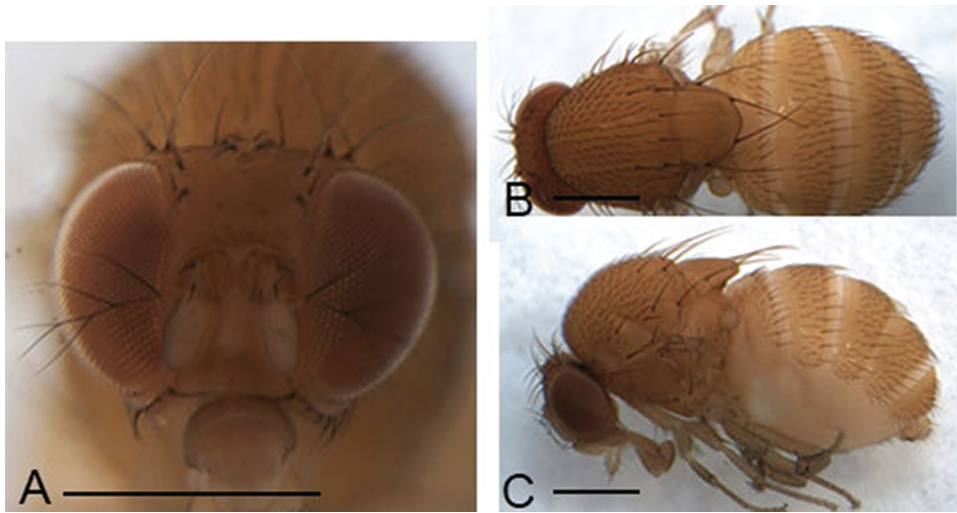


**Figure 5.** Head, mesonotum, scutellum, pleura and abdomen of male. **A, C, E** *S. serrateifoliacea* sp. nov. **B, D, F** *S. sinuata* sp. nov. Scale bars: 0.5 mm.

peg-like prenisetae on caudal margin, and several setae on outer and inner surface. Hypandrium shallow, usually with a couple of paramedian setae distally. Cercus separated from epandrium, pubescent and setigerous. Paramere developed, with few sensillae. Gonopods (as dorsal extension of the hypandrium, see Ashley and Sinclair 2017) fused with each other, broadened to hood-shaped. Aedeagus bifid, glabrous.

**Female terminalia** (Figs 7–10, 11E, 13E): Oviscapt mostly yellowish brown to brown, broadened subapically.

In the following descriptions, only those characters differing from the above description were provided.



**Figure 6.** Head, mesonotum, scutellum, pleura and abdomen of male. **A–C** *S. tanyrhina* sp. nov. Scale bars: 0.5 mm.

***Scaptodrosophila riverata* (Singh & Gupta, 1977)**

Figs 3A, C, E, 7

*Drosophila riverata* Singh & Gupta, 1977: 240.

**Material examined.** CHINA: 2♂ (SCAU, Nos 126828, 29), Banli, Chongzuo, Guangxi, alt. 160 m, 21.viii.2004, HW Chen; 1♀ (SCAU, No. 126830), Ailaoshan, Jingdong, Yunnan, 24°32'N, 101°00'E, alt. 2100 m, 21.vi.2009, T Li; 3♂ (SCAU, Nos 110913–15), Likan, Ximeng, Yunnan, 22°39'N, 99°36'E, alt. 844 m, 1.v.2016, YQ Liu; 1♂, 1♀ (SCAU, Nos 110916, 17), Huanglianshan, Lüchun, Yunnan, 23°20'N, 102°23'E, alt. 600 m, 28.x.2018, HW Chen.

**Diagnosis.** Surstylus bifid, the upper lobe with about 5 thin, peg-like prensisetae and 1 fine seta, the below one with 1 thin, peg-like prensiseta and 2 fine setae (Fig. 7A, B); gonopods undeveloped (Fig. 7C, D).

**Description.** (♂, ♀) **Head** (Fig. 3A): Frons yellowish brown. Pedicel and first flagellomere maple. Facial carina yellowish, short, 1/3 length as face.

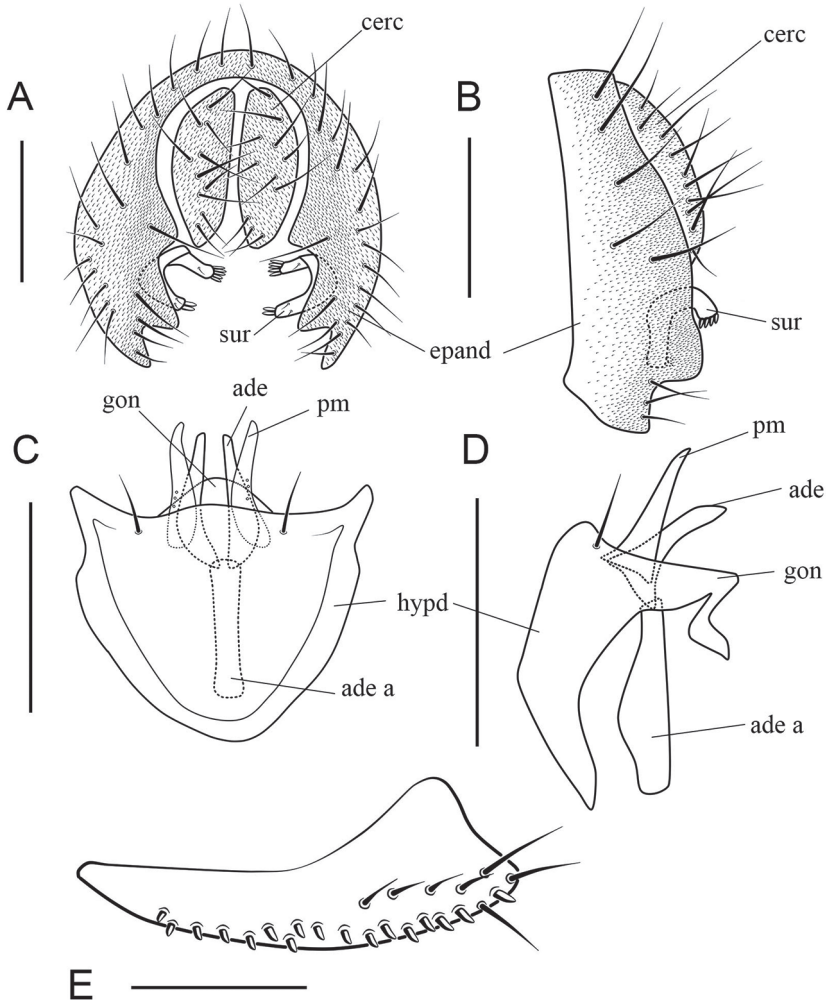
**Thorax** (Fig. 3C, E): Mesonotum and scutellum yellowish. Acrostichal setulae in ca 8 regular rows. Wings hyaline.

**Abdomen** (Fig. 3C, E): Tergites and sternites yellowish.

**Male terminalia:** Epandrium with ca 14 setae near posterior margin and ventral corner on each side (Fig. 7A, B). Hypandrium glabrous (Fig. 7C, D). Paramere slender and curved apically, with 3 sensillae subbasally (Fig. 7C, D).

**Female terminalia** (Fig. 7E): Oviscapt with 2 long subapical trichoid ovisensilla, 17 peg-like ovisensilla on each side on ventral margins and 5 trichoid ovisensilla on dorsal.





**Figure 7.** *Scaptodrosophila riverata* (Singh & Gupta, 1977) ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** surstylus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view) **E** oviscapt (lateral view). Scale bars: 0.1 mm.

**Measurements** (range in 2♂, 1♀, in mm): BL = (1.73–2.07, 1.93 mm), ThL = (0.80–1.07, 0.80), WL = (1.80–2.27, 1.93), WW = (0.67–0.93, 0.80).

**Indices:** arb = 2/1, avd = 0.60–1.00, adf = 2.00–2.50, flw = 2.00, FW/HW = 0.45–0.48, ch/o = 0.08, prorb = 0.80–0.83, rcorb = 0.40–0.60, vb = 0.33–0.50, dcl = 0.54–0.60, presctl = 0.45–0.60, sctl = 1.00–1.10, sterno = 0.67–0.75, orbito = 0.67–0.75, dcp = 0.30–0.40, sctlp = 0.83, C = 2.42–2.92, 4c = 1.00–1.20, 4v = 2.17–2.60, 5x = 1.50–2.00, ac = 2.40–3.00, M = 0.67–0.80, C3F = 0.25–0.33.

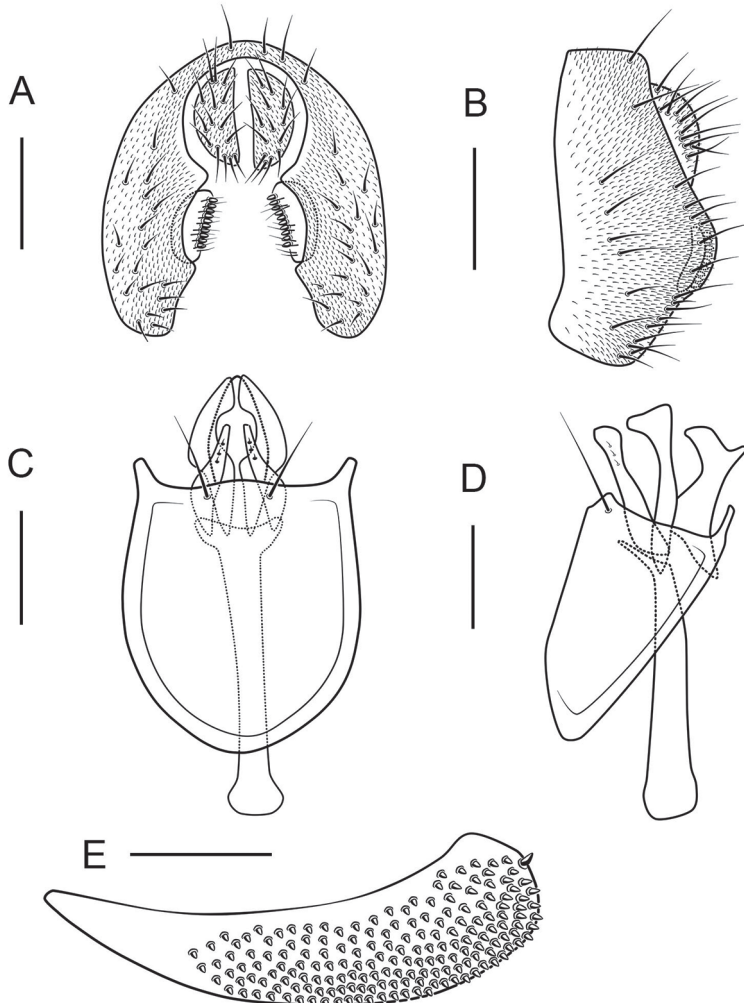
**Distribution.** China (Guangxi, Yunnan), India, Myanmar.

***Scaptodrosophila puncticeps* (Okada, 1956)**

Figs 3B, D, F, 8

*Drosophila puncticeps* Okada, 1956: 94.

**Material examined.** CHINA: 6♂, 5♀ (SCAU, Nos 126796–804, 830), Shennongjia, Hubei, 31°49'N, 109°41'E, alt. 1900 m, 31.vii. 2004, 6.viii.2005, HW Chen, HZ Cao; 1♂ (SCAU, No. 126831), Tianmushan, Linan, Zhejiang, 30°20'N, 119°25'E, alt. 800 m, 30.vi.–2.viii.2011, tussocks, ZF Shao, SJ Yan; 1♂ (SCAU, No. 126825), Miyalu, Aba, Sichuan, alt. 2650 m, 14.ix.2005, MF Xu.



**Figure 8.** *Scaptodrosophila puncticeps* (Okada, 1956) ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** epandrium, surstylus and cercus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view) **E** oviscapt (lateral view). Scale bars: 0.1 mm.

**Diagnosis.** Clypeus reddish brown; palpus pale yellow; gonopods roundly expanded in lateral view. (Fig. 7C, D).

**Description.** (♂, ♀) **Head** (Fig. 3B): Frons reddish brown. Pedicel yellowish brown. Facial carina creamy white, short, 1/3 length as face.

**Thorax** (Fig. 3D, F): Mesonotum and scutellum yellow. Acrostichal setulae in ca 7 irregular rows. Halter yellowish brown. Wing greyish.

**Abdomen** (Fig. 3D, F): Tergites yellowish brown.

**Male terminalia:** Epandrium with ca 21 setae near posterior margin and ventral corner on each side (Fig. 8A, B). Surstylus small with 10 peg-like prenisetae on caudal margin, and ca 16 setae on outer and inner surface (Fig. 8A, B). Hypandrium pubescent near paramedian setae (Fig. 8C, D). Paramere broadened medially with ca 3 sensilla (Fig. 8C, D). Aedeagus broadened apically, curved medially, sickle-shaped anteriorly in lateral view (Fig. 8C, D).

**Female terminalia** (Fig. 8E): Oviscap densely covered with peg-like ovisensilla.

**Measurements** (range in 6♂, 5♀, in mm): BL = 1.87–3.87, 2.20–2.67, ThL = 0.80–1.13, 0.80–1.00, WL = 2.13–2.93, 2.13–2.73, WW = 0.73–1.20, 0.86–1.07.

**Indices:** arb = 2/1, avd = 0.25–1.00, adf = 1.50–2.00, flw = 2.00–4.00, FW/HW = 0.41–0.50, ch/o = 0.07–0.13, prorrb = 0.71–1.00, rcorb = 0.29–0.50, vb = 0.33–0.75, dcl = 0.45–0.70, presctl = 0.33–0.57, sctl = 0.85–1.22, sterno = 0.30–0.67, orbito = 0.50–0.75, dcp = 0.44–0.56, sctlp = 0.71–1.25, C = 2.75–4.00, 4c = 0.60–0.92, 4v = 1.40–2.08, 5x = 1.20–1.67, ac = 0.86–2.33, M = 0.40–0.60, C3F = 0.30–0.38.

**Distribution.** China (Zhejiang, Hubei, Hunan, Sichuan, Guizhou, Yunnan), Kuril Islands, Korea, Japan (Kanto).

***Scaptodrosophila abdentata* sp. nov.**

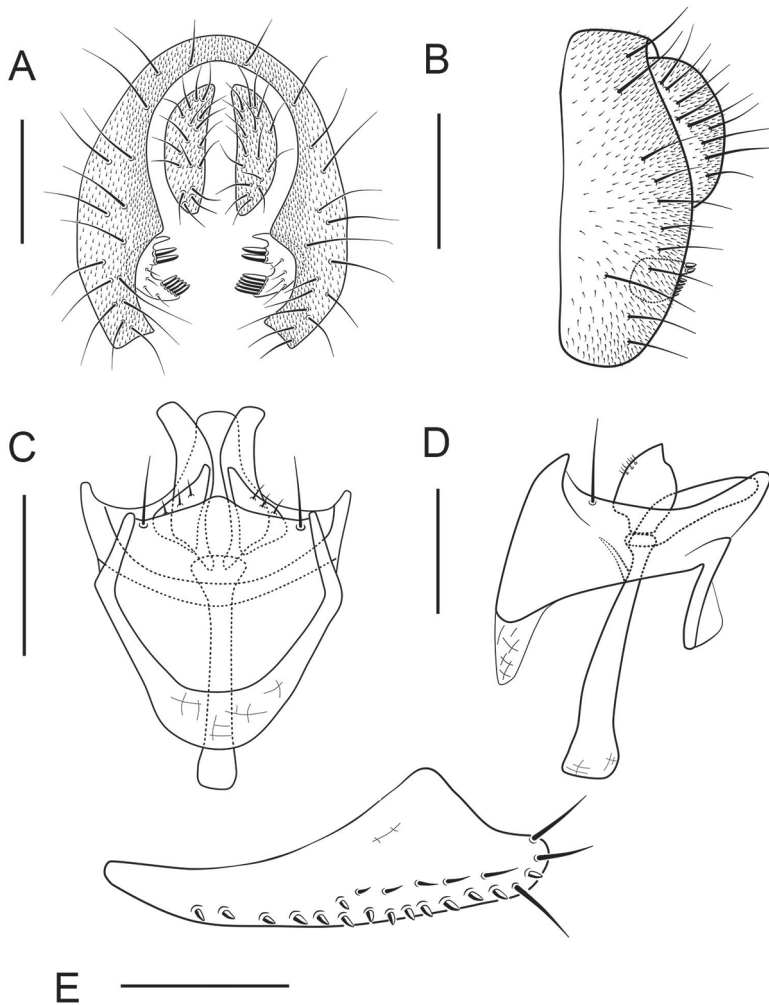
<http://zoobank.org/426657F1-40A2-4E11-BFB1-BBCB8B7A2D42>

Figs 4A, C, E, 9

**Material examined. Holotype.** CHINA: ♂ (SCAU, No. 127162), Nanling, Shao-guan, Guangdong, 24°38'N, 112°40'E, alt. 800 m, 3.iii.2004, MF Xu. **Paratypes.** CHINA: 1♂, 2♀ (SCAU, Nos 127163–65), Nanling, Ruyuan, Guangdong, 24°38'N, 112°40'E, alt. 800 m, 3.iii.2004, MF Xu; 1♂, 2♀ (SCAU, Nos 127166–68), Jian-fengling, Ledong, Hainan, 18°41'N, 108°52'E, alt. 700 m, 23.iv.2007, HW Chen; 1♂, 1♀ (SCAU, Nos 127169–70), Beibeng, Motuo, Xizang, 29°19'N, 95°20'E, alt. 780 m, 4.x.2010, YR Su; 2♂ (SCAU, Nos 127171–72), Wangtianshu, Mengla, Yunnan, 21°28'N, 101°38'E, alt. 580 m, 23.iv.2007, HW Chen; 1♂ (SCAU, No. 110918), Muyiji, Ximeng, Yunnan, 22°37'N, 99°35'E, alt. 1100 m, 23.iv.2007, HW Chen; 1♂ (SCAU, No. 110919), Muyiji, Ximeng, Yunnan, 22°37'N, 99°35'E, alt. 1203 m, 30.iv.2016, YQ Liu; 2♂ (SCAU, Nos 110920, 21), Mengdong, Cangyuan, Yunnan, 23°10'N, 99°13'E, alt. 1323 m, 6.v.2016, YQ Liu.

**Diagnosis.** Surstylus with a row of ca 9 long, peg-like prenisetae on caudal margin, and ca 6 setae on outer surface (Fig. 9A, B); paramere leaf-shaped in lateral view, with ca 3 sensillae and a row of fine setae (Fig. 9C, D); aedeagus broadened apically (Fig. 9C, D).





**Figure 9.** *Scaptodrosophila abdentata* sp. nov. ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** epandrium, surstylus and cercus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view) **E** oviscapt (lateral view). Scale bars: 0.1 mm.

**Description.** (♂, ♀) **Head** (Fig. 4A): Frons yellowish brown. Pedicel brown. First flagellomere yellowish. Facial carina brownish, short, 1/3 length as face.

**Thorax** (Fig. 4C, E): Mesonotum and scutellum yellowish brown. Acrostichal setulae in ca 8 regular rows. Halter hazel. Wings yellowish.

**Abdomen** (Fig. 4C, E): Tergites creamy white.

**Male terminalia:** Epandrium with ca 15 setae near posterior margin and ventral corner on each side (Fig. 9A, B). Hypandrium glabrous (Fig. 9C, D).

**Female terminalia** (Fig. 8E): Oviscapt with 3 long subapical trichoid ovisensilla, 15 peg-like ovisensilla on each side on ventral margins and 5 trichoid ovisensilla on dorsal.

**Measurements** [holotype ♂ (range in 5♂, 5♀), in mm]: BL = 2.20 (1.73–1.93, 2.00–2.27), ThL = 1.07 (0.80–1.00, 1.00–1.13), WL = 2.40 (1.87–2.20, 2.20–2.33), WW = 0.93 (0.67–0.87, 0.87–0.93).

**Indices:** arb = 2/1 (2/1), avd = 0.60 (0.60–1.00), adf = 2.50 (2.00–2.50), flw = 2.00 (1.50–2.50), FW/HW = 0.39 (0.41–0.50), ch/o = 0.07 (0.08–0.10), prorb = 0.83 (0.71–1.00), rcorb = 0.50 (0.33–0.50), vb = 0.50 (0.50–0.67), dcl = 0.58 (0.54–0.75), presctl = 0.50 (0.38–0.55), sctl = 1.25 (1.00–1.31), sterno = 0.78 (0.60–0.72), orbito = 0.67 (0.67), dcp = 0.33 (0.31–0.44), sctlp = 1.83 (0.80–1.00), C = 3.23 (2.21–3.00), 4c = 0.93 (0.92–1.20), 4v = 2.43 (2.21–3.00), 5x = 1.60 (1.60–2.00), ac = 2.60 (2.40–3.00), M = 0.57 (0.57–0.82), C3F = 0.38 (0.31–0.38).

**Etymology.** A combination of the Latin words: “*ab-*” + “*dentatus*”, referring to the surstylus with a line discontinuous of prensisetae.

**Distribution.** China (Guangdong, Hainan, Yunnan, Xizang).

***Scaptodrosophila platyrhina* sp. nov.**

<http://zoobank.org/E1397E1F-B748-41DE-B651-B8727E27AD34>

Figs 4B, D, F, 10

**Material examined. Holotype.** CHINA: ♂ (SCAU, No. 126838), Menglun, Mengla, Yunnan, 21°41'N, 101°25'E, alt. 680 m, 17.iv. 2007, HW Chen. **Paratypes.** CHINA: 4♂, 7♀ (SCAU, Nos 126839–47), Menglun, Mengla, Yunnan, 21°41'N, 101°25'E, alt. 680 m, 17.iv.2007, HW Chen; 1♂ (SCAU, No. 127161), Niuluohe, Jiangcheng, Yunnan, alt. 800 m, 22°30'N, 101°34'E, 21.iv.2010, HW Chen; 1♂ (SCAU, No. 110923), Guanlei, Mengla, Yunnan, 21°38'N, 101°10'E, alt. 620 m, 21.iv.2016, YQ Liu; 2♂, 2♀ (SCAU, Nos 110924, 26–28), Menglun, Mengla, Yunnan, 24°41'N, 101°25'E, alt. 554 m, 12.iv.2010, HW Chen.

**Diagnosis.** Facial carina short; paramere finger-like in lateral view, with ca 4 sensillae basally (Fig. 10C, D); aedeagus bifid apically (Fig. 10C, D); gonopods undeveloped (Fig. 10C, D).

**Description. Head** (Fig. 4B): Frons yellowish brown. Pedicel yellowish brown. First flagellomere yellowish. Facial carina hazel, short, 1/3 length as face.

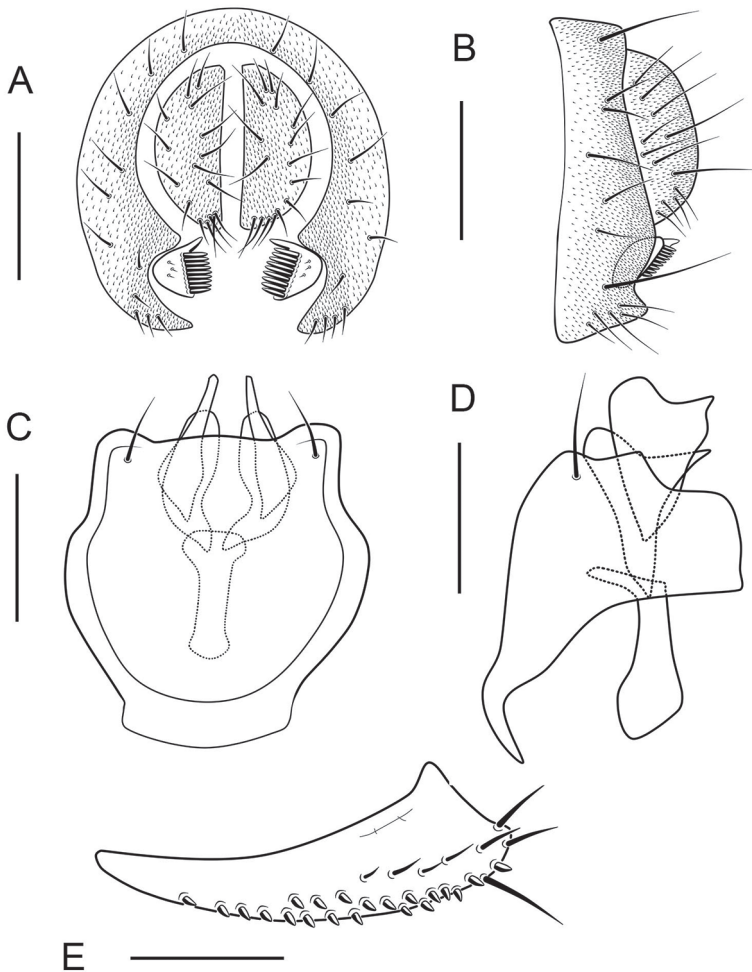
**Thorax** (Fig. 4D, F): Mesonotum and scutellum yellowish. Acrostichal setulae in ca 8 regular rows. Halter hazel. Wings yellowish.

**Abdomen** (Fig. 4D, F): Tergites yellowish.

**Male terminalia:** Epandrium with ca 11 setae near posterior margin and ventral corner per side (Fig. 10A, B). Surstylus with ca 10 long, peg-like prensisetae on caudal margin, and ca 3 setae on outer surface (Fig. 10A, B). Hypandrium glabrous (Fig. 10C, D).

**Female terminalia** (Fig. 10E): Oviscapt with 3 long subapical trichoid ovisensilla, ca 21 peg-like ovisensilla on each side on ventral margins and 5 trichoid ovisensilla on dorsal.

**Measurements** [holotype ♂ (range in 5♂, 5♀), in mm]: BL = 2.27 (2.00–2.33, 1.93–2.13), THL = 1.13 (0.80–1.07, 1.00–1.07), WL = 2.47 (2.20–2.40, 2.20–2.40), WW = 0.93 (0.80–0.93, 0.80–0.93).



**Figure 10.** *Scaptodrosophila platyrrhina* sp. nov. ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** epandrium, surstylus and cercus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view) **E** oviscapt (lateral view). Scale bars: 0.1 mm.

**Indices:** arb = 2/1 (2/1), avd = 0.60 (0.60–0.80), adf = 2.50 (2.00–2.50), flw = 2.00 (2.00), FW/HW = 0.43 (0.41–0.45), ch/o = 0.08 (0.08–0.09), prorb = 0.83 (0.40–1.00), rcorb = 0.50 (0.33–0.60), vb = 0.40 (0.40–0.50), dcl = 0.71 (0.50–0.73), presctl = 0.43 (0.40–0.50), sctl = 1.00 (0.85–1.27), sterno = 0.89 (0.70–0.89), orbito = 0.67 (0.67), dcp = 0.36 (0.31–0.36), sctlp = 1.00 (0.71–1.00), C = 2.86 (2.64–2.79), 4c = 1.00 (0.93–1.08), 4v = 2.36 (2.00–2.46), 5x = 1.67 (1.50–1.80), ac = 2.80 (2.80–3.00), M = 0.71 (0.64–0.71), C3F = 0.36 (0.29–0.36).

**Etymology.** A combination of the Latin words: “*platys*” + “*rhinos*”, referring to the flat carina.

**Distribution.** China (Yunnan).

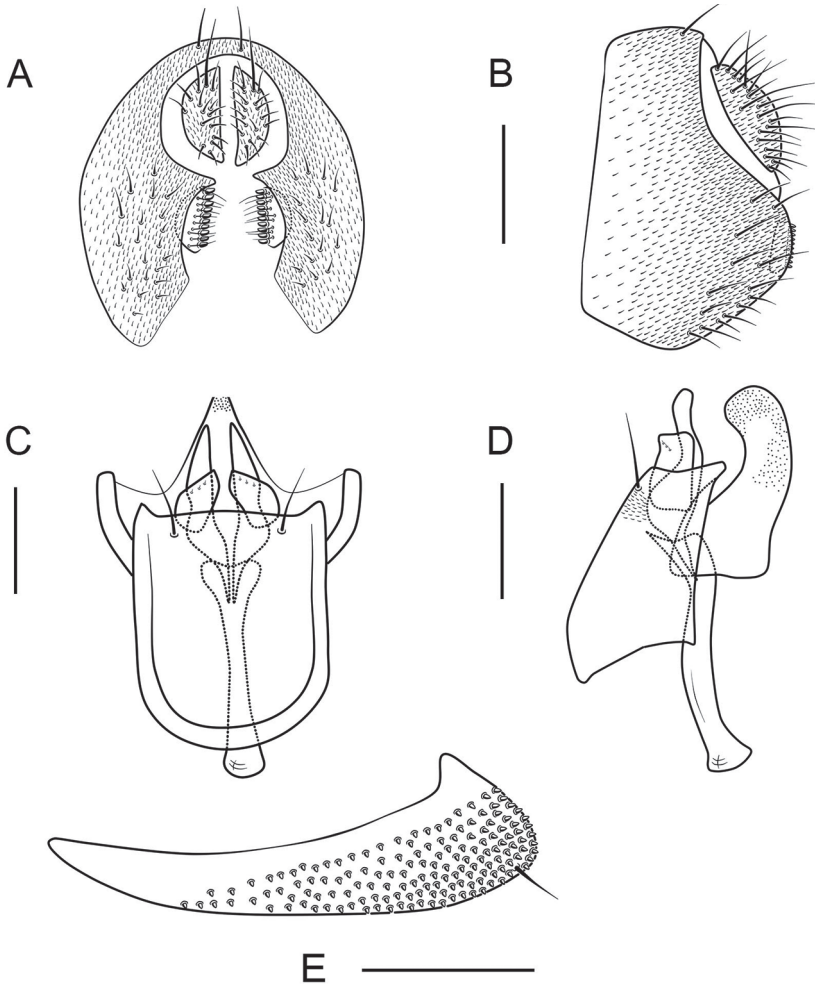


***Scaptodrosophila serrateifoliacea* sp. nov.**

<http://zoobank.org/9DC99991-AE49-4AC7-854B-C6CBC6AC9E88>

Figs 5A, C, E, 11

**Material examined. Holotype.** CHINA: ♂ (SCAU, No. 126826), Hesong, Menghai, Yunnan, 21°49'N, 100°06'E, alt. 1900 m, 11.iv. 2011, JM Lu, YR Su, ZF Shao, SJ Yan. **Paratypes.** CHINA: 1♂ (SCAU, No. 126827), Hesong, Menghai, Yunnan, 21°50'N, 100°06'E, alt. 1900 m, 11.iv.2011, JM Lu, YR Su, ZF Shao, SJ Yan. 1♂ (SCAU, No. 110929), Mengdong, Cangyuan, Yunnan, 23°10'N, 99°13'E, alt. 1323 m, 6.v.2016, YQ Liu.



**Figure 11.** *Scaptodrosophila serrateifoliacea* sp. nov. ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** epandrium, surstylus and cercus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view) **E** oviscapt (lateral view). Scale bars: 0.1 mm.

**Diagnosis.** Paramere quadrangle-shaped in lateral view, with ca 3 sensillae medially (Fig. 11C, D); gonopods developed, arm-shaped, with many finely acanthoid processes (Fig. 11C, D); aedeagus beanpod-shaped in lateral view (Fig. 11C, D).

**Description.** (♂, ♀) **Head** (Fig. 5A): Frons yellowish brown. Pedicel yellow. First flagellomere yellowish. Facial carina yellowish, short, 1/2 length as face.

**Thorax** (Fig. 5C, E): Mesonotum and scutellum dark brown. Acrostichal setulae in ca 8 irregular rows. Halter yellowish brown. Wings hazel.

**Abdomen** (Fig. 5C, E): First tergite and second tergite yellow. Third to sixth tergites brown.

**Male terminalia:** Epandrium with ca 19 setae near posterior margin and ventral corner on each side (Fig. 11A, B). Surstylus broad, with ca 10 fine peg-like prenisetae on caudal margin, and numerous setae on outer and inner surfaces (Fig. 11A, B). Hypandrium pubescent near paramedian setae (Fig. 11C, D).

**Female terminalia** (Fig. 11E): Oviscapt with 1 long subapical trichoid ovisensillum on ventral margins and densely covered with peg-like ovisensilla.

**Measurements** [holotype ♂ (range in 1♂, 1♀), in mm]: BL = 1.93 (2.22, 1.80), ThL = 0.93 (0.889, 1.00), WL = 2.13 (2.44, 2.13), WW = 0.87 (0.978, 0.93).

**Indices:** arb = 2/1 (2/1), avd = 0.67 (0.67–0.73), adf = 1.00 (1.09–1.50), flw = 1.33 (1.59–2.50), FW/HW = 0.45 (0.344–0.48), ch/o = 0.15 (0.11–0.13), prorb = 1.00 (0.71–1.40), rcorb = 0.40 (0.20–0.43), vb = 0.50 (0.59–0.67), dcl = 0.50 (0.59–0.64), presctl = 0.33 (0.36–0.37), sctl = 0.92 (1.22–1.08), sterno = 0.50 (0.33–0.45), orbito = 0.67 (0.65–0.67), dcp = 0.44 (0.42–0.44), sctlp = 0.83 (1.20–1.25), C = 2.92 (2.93–4.30), 4c = 0.81 (0.55–0.82), 4v = 1.88 (1.66–1.76), 5x = 1.75 (0.94–1.33), ac = 2.60 (1.59–2.33), M = 0.44 (0.34–0.47), C3F = 0.38 (0.50–0.60).

**Etymology.** A combination of the Latin words “*serratus*” (= serrated) + “*foliaceus*” (= folium), referring to the gonopods with numerous finely serrated processes.

**Distribution.** China (Yunnan).

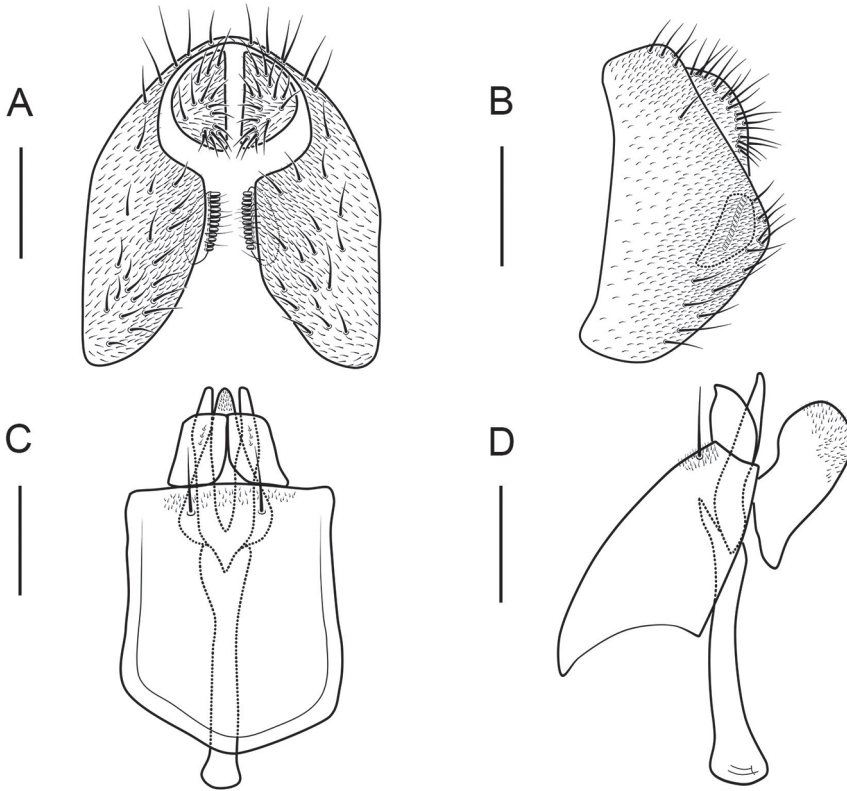
### *Scaptodrosophila sinuata* sp. nov.

<http://zoobank.org/972ED4E8-7F80-4F9C-9610-B9922E4EBF4B>

Figs 5B, D, F, 12

**Material examined. Holotype.** CHINA: ♂ (SCAU, No. 110939), Laobiangou, Benxi, Liaoning, 41°04'N, 124°30'E, alt. 575 m, 21.vi.2018, Y Lin. **Paratypes.** CHINA: 2♂ (SCAU, Nos 110936, 37), Dayangcha, Kuangdian, Liaoning, 41°01'N, 124°37'E, alt. 485 m, 23.vi.2018, L Gong; 2♂ (SCAU, Nos 110938, 40), Laobiangou, Benxi, Liaoning, 41°04'N, 124°30'E, alt. 575 m, 21.vi.2018, Y Lin; 3♂ (SCAU, Nos 110941, 42, 43), Guojiapuzi, Kuangdian, Liaoning, 40°46'N, 124°45'E, alt. 342 m, 26.vi.2018, L Gong.

**Diagnosis.** Paramere quadrangle-shaped in lateral view, with ca 3 sensillae medially (Fig. 12A, B); gonopods large, with many finely acanthoid processes (Fig. 12C, D); aedeagus beanpod-shaped in lateral view (Fig. 12C, D).



**Figure 12.** *Scaptodrosophila sinuata* sp. nov. ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** epandrium, surstylus and cercus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view). Scale bars: 0.1 mm.

**Description.** (♂) **Head** (Fig. 5B): Frons yellowish brown. Pedicel yellow. First flagellomere yellowish brown. Arista weak. Facial carina yellowish, developed, 1/2 length as face.

**Thorax** (Fig. 5D, F): Mesonotum and scutellum yellowish. Acrostichal setulae in ca 8 irregular rows. Halter yellowish brown. Wings light brown and appreciably hyaline.

**Abdomen** (Fig. 5D, F): Tergites yellowish.

**Male terminalia** (Fig. 12): Epandrium with ca 23 setae near posterior margin and ventral corner on each side (Fig. 12A, B). Surstylus broad, with ca 12 fine peg-like prensisetae on caudal margin, and numerous setae on outer and inner surface (Fig. 12A, B). Hypandrium pubescent near paramedian setae (Fig. 12C, D).

**Measurements** [holotype ♂ (range in 3♂), in mm]: BL = 2.36 (2.33–2.44), ThL = 0.978 (1.02–1.07), WL = 2.33 (2.07–2.30), WW = 0.99 (0.99–1.02).

**Indices:** arb = 2/1 (2/1), avd = 0.88 (0.67–0.88), adf = 0.97 (0.97–0.99), flw = 1.56 (1.51–1.62), FW/HW = 0.36 (0.35–0.37), ch/o = 0.12 (0.11–0.13), prorb = 0.82 (0.95–0.98), rcorb = 0.50 (0.50–0.52), vb = 0.73 (0.47–0.52), dcl = 0.57 (0.71–0.72), presctl = 0.36 (0.42–0.44), sctl = 1.873 (1.62–1.72), sterno = 0.43 (0.41–0.43), or-



bito = 0.48 (0.48–1.07), dcp = 0.41 (0.40–0.42), sctlp = 0.77 (0.76–0.82), C = 3.79 (3.76–4.09), 4c = 0.59 (0.53–0.60), 4v = 1.69 (1.72–1.80), 5x = 0.86 (0.86–0.95), ac = 1.36 (1.35–1.71), M = 0.31 (0.29–0.32), C3F = 0.60 (0.56–0.58).

**Etymology.** From the Latin word: “*sinuatus*”, referring to the paramere, which is curved subbasally.

**Distribution.** China (Liaoning).

***Scaptodrosophila tanyrhina* sp. nov.**

<http://zoobank.org/20E556DF-CD47-4ACD-AB29-F9C8ADCA351B>

Figs 6A, B, C, 13

**Material examined. Holotype.** CHINA: ♂ (SCAU, No. 126401), Menglun, Mengla, Yunnan, 21°41'N, 101°25'E, alt. 780 m, 17.iv.2007, HW Chen, JJ Gao. **Paratypes.** CHINA: 7♂, 5♀ (SCAU, Nos 126402–11, 110930–31), Menglun, Mengla, Yunnan, 21°41'N, 101°25'E, alt. 780 m, 17.iv.2007, HW Chen, JJ Gao; 2♂, 1♀ (SCAU, Nos 110932, 33, 35), Wangtianshu, Mengla, Yunnan, 21°28'N, 101°38'E, alt. 600 m, 23.iv.2007, HW Chen; 1♂ (SCAU, No. 110934), Guanglei, Mengla, Yunnan, 21°38'N, 101°10'E, alt. 620 m, 21.iv.2016, YQ Liu.

**Diagnosis.** Paramere broadened basally, finger-like in lateral view, with ca 6 sensillae subbasally and fine setae medially (Fig. 13C, D); gonopods undeveloped; aedeagus broadened apically, curved in lateral view (Fig. 13C, D).

**Description.** (♂, ♀) **Head** (Fig. 6A): Frons yellowish brown. Pedicel yellowish brown. First flagellomere yellowish. Facial carina yellowish, short, 1/3 length as face.

**Thorax** (Fig. 6B, C): Mesonotum and scutellum yellowish brown. Acrostichal setulae in ca 8 regular rows. Halter yellowish brown. Wings yellowish.

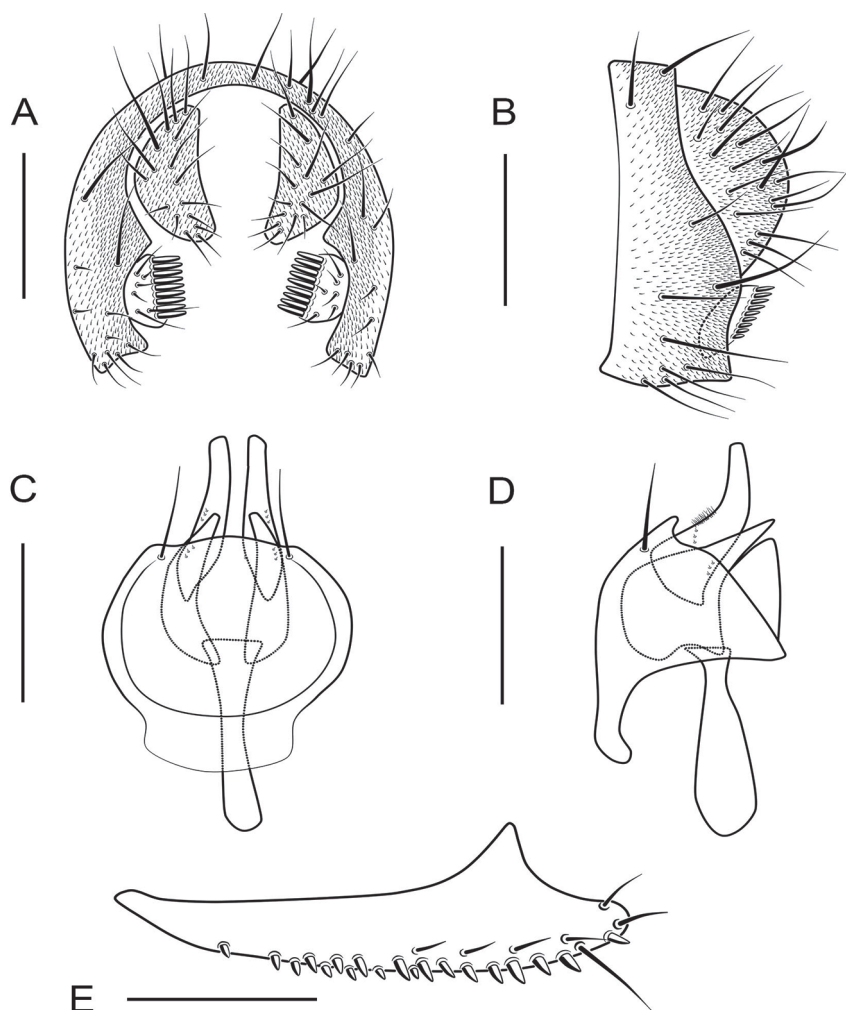
**Abdomen** (Fig. 6B, C): Tergite yellowish brown. Sternites yellowish.

**Male terminalia:** Epandrium with ca 13 setae near posterior margin and ventral corner on each side (Fig. 13A, B). Surstylus small with ca 9 peg-like prensisetae on caudal margin, and ca 6 setae on outer and inner surface (Fig. 13A, B). Hypandrium glabrous (Fig. 13C, D).

**Female terminalia** (Fig. 13E): Oviscapt with 3 long subapical trichoid ovisensilla, ca 19 peg-like ovisensilla on each side on ventral margins and 4 trichoid ovisensilla on dorsal.

**Measurements** [holotype ♂ (range in 5♂, 5♀), in mm]: BL = 1.87 (1.80–2.07, 1.80–2.13), ThL = 0.93 (0.93–1.00, 0.93–1.00), WL = 2.00 (2.00–2.20, 2.00–2.20), WW = 0.80 (0.80–0.87, 0.73–0.80).

**Indices:** arb = 2/1 (2/1), avd = 0.75 (0.60–1.00), adf = 2.00 (1.50–2.50), flw = 2.00 (1.50–2.50), FW/HW = 0.44 (0.40–0.47), ch/o = 0.10 (0.09–0.10), prorb = 1.00 (0.67–1.00), rcorb = 0.40 (0.33–0.50), vb = 0.30 (0.25–0.50), dcl = 0.70 (0.60–0.80), presctl = 0.60 (0.40–0.64), sctl = 1.18 (1.08–1.25), sterno = 0.60 (0.50–0.78), orbito = 0.80 (0.50–0.67), dcp = 0.27 (0.30–0.36), sctlp = 0.67 (0.67–1.00), C = 2.92 (2.71–3.27), 4c = 1.00 (0.85–1.18), 4v = 2.33 (2.15–2.58), 5x = 1.60 (1.33–1.80), ac = 3.00 (2.20–2.67), M = 0.67 (0.57–0.73), C3F = 0.25 (0.25–0.38).



**Figure 13.** *Scaptodrosophila tanyrhina* sp. nov. ♂. **A** Epandrium, surstylus and cercus (posterior view) **B** epandrium, surstylus and cercus (lateral view) **C** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (ventral view) **D** hypandrium, aedeagus, aedeagal apodeme, paramere and gonopods (lateral view) **E** oviscapt (lateral view). Scale bars: 0.1 mm.

**Etymology.** A combination of the Latin words: “*tanaos*” + “*rhinos*”, referring to the developed carina.

**Distribution.** China (Yunnan).

### Key to examined species of the *riverata* group

#### Adults (males)

- |   |                                                     |                              |
|---|-----------------------------------------------------|------------------------------|
| 1 | Frons reddish brown; clypeus reddish brown .....    | <i>S. puncticeps</i> (Okada) |
| – | Frons yellowish brown; clypeus yellowish brown..... | 2                            |

2	Surstylus bifurcated (Fig. 7A, B) .....	<b><i>S. riverata</i> (Singh &amp; Gupta)</b>
–	Surstylus not bifurcated .....	<b>3</b>
3	Dorsal 2 peg-like prenisetae of surstylus separated from each other (Fig. 9A, B).....	<b><i>S. abdentata</i> sp. nov.</b>
–	Surstylus peg-like prenisetae continuous .....	<b>4</b>
4	Gonopods with many finely acanthoid processes .....	<b>5</b>
–	Gonopods lacking finely acanthoid processes .....	<b>6</b>
5	Third to sixth tegites brown (Fig. 5C) .....	<b><i>S. serrateifoliacea</i> sp. nov.</b>
–	Third to sixth tegites yellowish (Fig. 5D) .....	<b><i>S. sinuata</i> sp. nov.</b>
6	Paramere black.....	<b><i>S. cederholmi</i> (Okada)</b>
–	Paramere hyaline.....	<b>7</b>
7	Paramere broadened distally in lateral view (Fig. 10C, D) .....	<b><i>S. platyrhina</i> sp. nov.</b>
–	Paramere long in lateral view .....	<b>8</b>
8	Paramere club-shaped .....	<b><i>S. paraclubata</i> (Sundaran &amp; Gupta)</b>
–	Paramere finger-like in lateral view.....	<b>9</b>
9	Paramere with fine setae medially (Fig. 13C, D) .....	<b><i>S. tanyrhina</i> sp. nov.</b>
–	Paramere lacking fine setae.....	<b><i>S. crocata</i> (Bock)</b>

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