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Uncitermes almeriae, a new termite species from Amazonia (Isoptera, Termitidae, Syntermitinae)

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Abstract

The Neotropical termite genus *Uncitermes* Rocha & Cancello, 2012 was known from a single species, *U. teevani* (Emerson, 1925). In this paper a new species, *Uncitermes almeriae* **sp. n.**, is described and illustrated from worker and soldier castes, along with observations on the *Uncitermes* nest. A distribution map with the occurrences of both species is presented. The new species is distinguished from its congener by the presence of short bristles covering the head capsule and frontal tube.

Keywords

Taxonomy, South America, Biological Notes

Introduction

The genus *Uncitermes* Rocha & Cancello, 2012 was described to accommodate the Amazonian species *Uncitermes teevani* (Emerson, 1925), previously included in *Armitermes* Wasmann, 1897. The genus can be distinguished from the other Syntermitinae genera by the strongly recurved soldier mandibles and lack of spines on the margins of pro-, meso- and metanotum, as well as the absence of a projection on the forecoxae (Rocha et al. 2012).

Previously hypothesized as sister group of *Rhynchotermes* Holmgren, 1912 by morphological similarities and a morphological phylogeny (Rocha et al. 2012), molecular data now suggest that *Uncitermes* should be more related to *Armitermes sensu stricto*, along with *Embiratermes heterotypus* (Silvestri, 1901) and *Macuxitermes* Cancello and Bandeira, 1992 (Maurício M. Rocha, personal communication).

Herein we describe, from Peruvian and Ecuadorian Amazonia, a second species of the genus, *Uncitermes almeriae* sp. n. The soldier and worker of the new species are described and an updated distribution map is given for both species.

Material and methods

The institutional collections acronyms cited in this paper are: **MZUSP**: Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; **UF**: Fort Lauderdale Research and Education Center, University of Florida, Davie, Florida, United States.

Images of the head capsule and digestive tube were taken with a Leica M205C stereomicroscope attached to a Leica DFC 425 digital camera. Specimens were placed in a plastic Petri dish containing 70% ethanol gel (Purell® hand sanitizer). A mirror was placed underneath the dish to highlight pilosity.

Mandibles and enteric valves were mounted on slides with PVA mounting medium (BioQuip #6371A) and the images were taken with a Leica DM5500B compound microscope attached to a Leica DFC 425 camera. All images were composed of multiple photomicrographs taken at different focal planes that were merged with Helicon Focus 6 software. Measurements were taken with an ocular micrometer fitted to an Olympus SZX9 stereomicroscope. Terms used for pilosity are comparative: long bristles are erect hairs with well-marked bases; short bristles are smaller than long bristles; and thick bristles are thicker than the other.

The following morphometric characters were measured, indicating in parenthesis the measurement as defined by Roonwal (1970): LH, length of head (9), LN, length of nasus (13), WH, width of head (18), LLM, length of left mandible (36), WP, maximum width of pronotum (68), LT, length of hind tibia (85). The distribution map was created using Quantum GIS 2.8.3.

Taxonomy

Uncitermes almeriae **Carrijo, sp. n.**
http://zoobank.org/093682C6-EDDD-4E9E-9155-43439AB1AB0C

Type-locality. ECUADOR. Orellana: Francisco de Orellana, Yasuni National Park, -0.6717, -76.3979.

Holotype. Soldier. 31.v.2011, R.H.Scheffrahn col., MZUSP 23117.

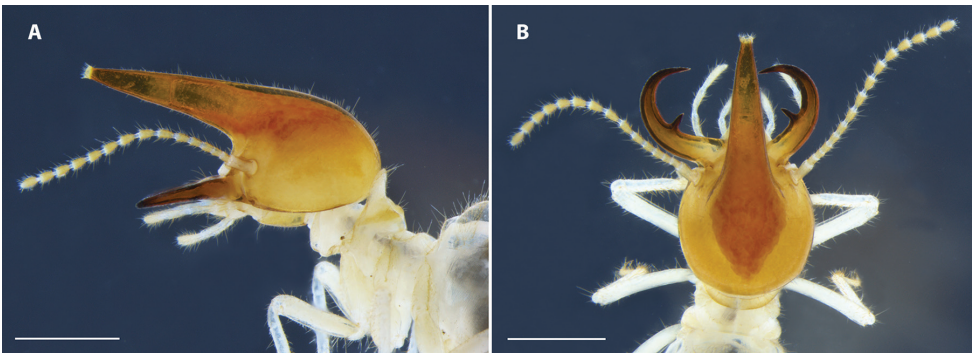

Figure 1. Soldier head capsule of *Uncitermes almeriae* sp. n. **A** lateral view **B** dorsal view. Scale: 1 mm.

Paratypes. ECUADOR. **MZUSP 23117**, same sample of holotype (2 soldiers, 13 workers); **UF EC1066**, same sample of holotype (16 soldiers, 20 workers); **UF EC1000**, same data of holotype (8 soldiers, 16 workers); PERU. **UF PU311**, 21 km South of Ciudad Constitución,-10.04915, -75.02859, 27.v.2014, R.H.Scheffrahn col. (17 soldiers, 12 workers); **MZUSP 23236,** duplicate of the previous (2 soldiers and 3 workers).

Imago. Unknown.

Soldier (Fig. 1). Monomorphic. Head capsule, in dorsal view, rounded. Antennae with 15 articles; relative length formula 1>2>3=4<5. In lateral view, nasus narrowly conical, forming a ca. 30° angle with base of head; dorsal margin of nasus undemarcated with margin of vertex and evenly curving along with occipital margin. Labrum rounded, anterior margin hyaline, without distinct tip. Postmentum subrectangular. Mandibles symmetrical, piercing, and hooked; narrow tooth subconical and approximately central on the inner margin. Molar region absent. When closed, in dorsal view, mandibles overlap nearly completely. Pronotum with length of anterior lobe longer than posterior lobe. Tibial spur formula 2:2:2. Head capsule covered of short bristles and sparse long bristles. Nasus covered of many short bristles and tip of nasus crowned with short bristles. Pronotum with long and short bristles along margins, denser on lateral margins, some short bristles on anterior lobe. Meso- and metanotum with long and short bristles on posterior margins; tergites and sternites completely covered by a dense layer of long bristles. Legs with many long and short bristles; thick bristles on inner face of tibia. Range and mean of measurements (mm) of six soldiers from three colonies: LH 1.30–1.40 (1.35); LN 1.43–1.58 (1.50); LLM 0.93–1.00 (0.96); WH 1.35–1.43 (1.38); WP 0.80–0.88(0.84); LT 1.68–1.80 (1.74).

Remarks. When alive (Fig. 2) the frontal gland coloration of both *Uncitermes* spp. is the same as the surrounding head capsule. After ethanol preservation, the frontal gland of both species turns to a dark reddish color in contrast to the remainder of the head capsule. In some preserved soldiers, a clear, hardened defensive secretion can be seen as droplets clinging to the nasus. Unlike some Nasutitermitinae that squirt their

Figure 2. Live habitus of *Uncitermes almeriae* sp. n.

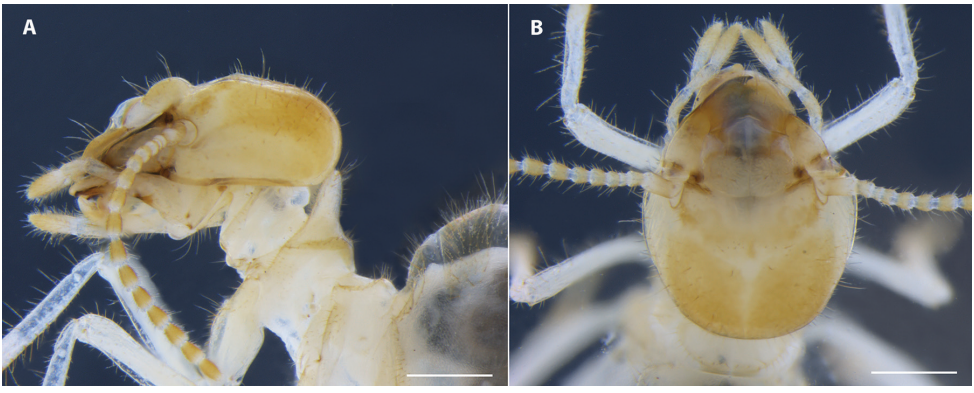

Figure 3. Worker head capsule of *Uncitermes almeriae* sp. n. **A** lateral view **B** dorsal view. Scale: 0.5 mm.

secretion several body lengths, this genus and probably all syntermitids exude their defensive secretion with little force.

Worker (Figs 3, 4). As described and illustrated for genus by Rocha et al. (2012). Range and mean of measurements (mm) of twelve workers from three colonies: LH 0.75 – 1.00 (0.94); WH 1.13 – 1.30 (1.21); LT 1.33 – 1.50 (1.43).

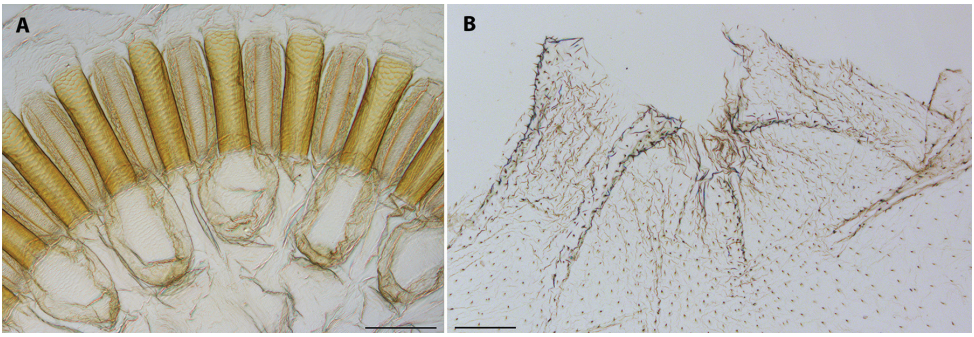

Figure 4. Digestive tube of worker of *Uncitermes almeriae* sp. n. **A** gizzard **B** enteric valve. Scale: 0.1 mm.

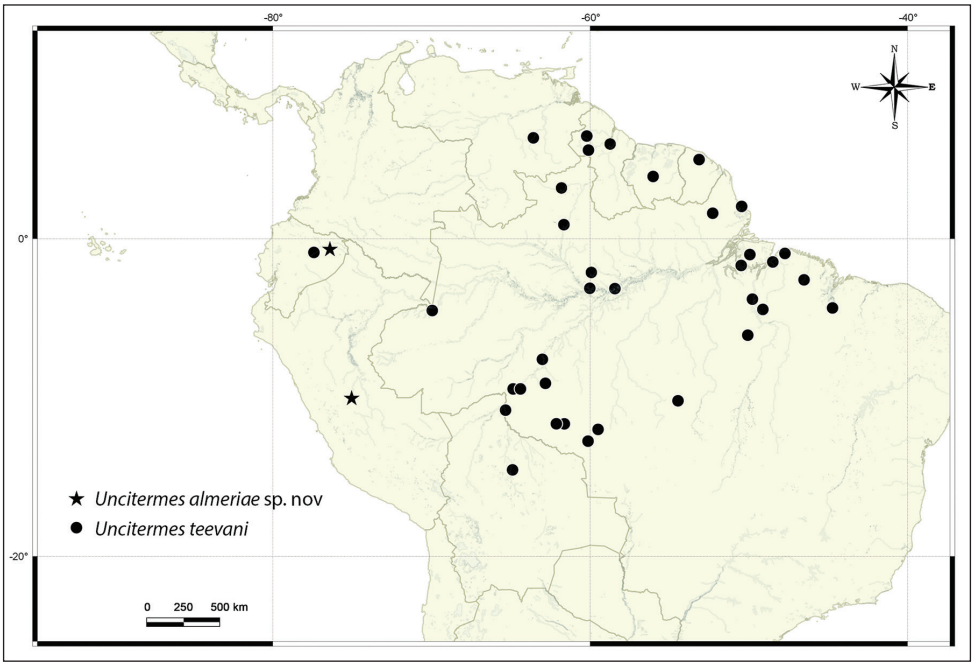

Figure 5. Distribution map of *Uncitermes* spp. Data for *U. teevani* available in Davies (2003), Rocha et al. (2012), Carrijo (2013) and this paper.

Etymology. The species name is a latinized noun in the genitive case. *Uncitermes almeriae* sp. n. is named in honour of Almeri Fernandes Sousa, TFC's mother.

Biological notes. There are no biological data published for *Uncitermes almeriae* sp. n. However, *Uncitermes teevani* is commonly sampled in rotten wood, litter, soil, dry palm tree stipes and clumps of roots, probably foraging in a soil-litter interface. There is a report of a nest of *U. teevani* from French Guiana under a dead trunk (in the hollow cylinder section), the nest structure was about a meter long, and the royal cell was attached to the wood, asymmetrically in the oval shaped nest structure (Jan Šobotník, personal communication).

Comparisons. The soldier of *U. almeriae* sp. n. has short bristles covering all the head capsule and frontal tube, while *U. teevani* has only sparse long bristles on head capsule and the frontal tube is glabrous.

New records of *U. teevani* (Fig. 5). BOLIVIA. **UF BO458**, N. San Javier, -14.5491, -64.8896, 29.v.2013, J.A. Chase col. ECUADOR. **UF EC210**, Yasuni National Park (P.U.C.E. Research Station), 20.iii.2006, B.W. Bahder col. **UF EC999**, 1001, 31.v.2011, J.R. Mangold col. **UF EC1163, 1176, 1177**, Tiputini river, stop 2, -0.67530, -76.36864, 01.vi.2011.

Acknowledgments

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RESEARCH ARTICLE

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A new erythroneurine leafhopper genus from Thailand (Hemiptera, Cicadellidae, Typhlocybinae), with description of three new species

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Abstract

A new genus of tribe Erythroneurini from Thailand, *Thaioneura* **gen. n.**, including three new species: *Thaioneura nigrilinea* **sp. n.** (type species), *Thaioneura sinuata* **sp. n.** and *Thaioneura suphanburia* **sp. n.**, is described and illustrated and a key to species is provided. The new genus exhibits a pattern of interspecific variation in the hind wing venation that has not been observed in other genera of the tribe.

Keywords

Homoptera, Auchenorrhyncha, morphology, taxonomy, new taxa

Introduction

The tribe Erythroneurini Young (1952) is the largest tribe in the subfamily Typhlocybinae, comprising 193 genera and 1848 described species worldwide (Dmitriev 2016). The erythroneurine fauna of southeast Asia is particularly diverse, but many genera and species remain undescribed. Study of recently collected samples from Thailand revealed the presence of a new genus, *Thaioneura* gen. n., here established based on distinctive characteristics.

Material and methods

Morphological terminology used in this work follows Dietrich (2005). Habitus photos were taken using a Canon EOS 5D Mark II camera and the Camlift V2.7.0 software. Multiple photographs of each specimen were compressed into final images with Zerene Stacker (64-bit) software. Body length was measured from the apex of vertex to the tip of forewings. Abdomens were removed from specimens and cleared in cold 10% KOH solution overnight. The cleared material was rinsed with water and stored in glycerine. An Olympus SZX12 dissecting microscope was used for specimen study and Olympus BX41 and BX53 stereoscopic microscopes were used alternately for drawing of the dissected male genitalia and wings. Holotypes of the new species are deposited at the Queen Sirikit Botanical Garden, Chiang Mai, Thailand and additional specimens examined are deposited at the Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign, USA.

Results

***Thaioneura* gen. n.**
http://zoobank.org/696D483C-D605-4FB6-8B0F-2BD62C9C949F

Type species. *Thaioneura nigrilinea* sp. n.

Description. Vertex with single dark medial spot at apex. Forewing with symmetrical, multilobed, transcommissural brown longitudinal marking.

Head in dorsal view roundly produced, slightly longer medially than next to eye, wider than pronotum. Face with anteclypeus of male broader and more convex than that of female. Pronotum broad, moderately long, with posterior margin concave. Mesonotum with basal triangles and scutellar suture distinct. Forewing with inner apical cell wide, base oblique; outer apical cell very short; second apical cell widened distally; claval vein not delimited. Hind wing with CuA either confluent with MP for short distance and separate distally (Fig. 2), or completely confluent (Fig. 12), vein CuP connected to CuA or free.

Male 2S abdominal apodemes large, broad, extended to or beyond middle of 4th sternite.

Male genitalia. Male pygofer side with posterodorsal margin bluntly angulate, dorsal appendage movably articulated basally, tapered distally, not extended beyond pygofer apex; ventral appendage long, slender, rugose, extended along posteroventral margin of lobe to point slightly beyond posterodorsal apex of lobe; basolateral setae distinctly enlarged, long fine setae sparse; microtrichia near posterodorsal margin well developed. Subgenital plate narrow in lateral view, broad basally and tapered distally in ventral view, without angulate basolateral projection and stout basolateral setae, with 4–5 macrosetae near lateral margin medially and row of short rigid microsetae from middle to subapex, apex darkly pigmented. Style with apex truncate and slightly

expanded, preapical lobe prominent but not acutely angulate, base slim in lateral view. Connective central lobe broad, lateral arms short, stem long. Aedeagus with dorsal apodeme expanded laterad, shaft arched near base in lateral view, gonopore terminal, on ventral surface.

Distribution. Thailand.

Diagnosis. The new genus is similar to *Balanda* Dworakowska, 1979 and *Tautoneura* Anufriev, 1969 in body shape, the presence of both dorsal and ventral appendages and a group of long stout basolateral macrosetae on the male pygofer, and the presence of a median anterior lobe on the connective, but differs in having the apex of the style truncate, the subgenital plate with reduced chaetotaxy basolaterally and the smoky brown commissural markings on the forewings. The latter color pattern, which is very unusual among Erythroneurini, closely resembles that of the type species of *Jalalia* Ahmed 1970, described from Pakistan, but that genus has the head narrower than the pronotum, lacks a ventral pygofer appendage, and has the style apex acuminate.

Etymology. The new genus name was formed by combining the name of the country in which all known specimens were collected, "Thailand" with the common suffix for generic names in this tribe, "-neura". The gender is feminine.

Key to species of *Thaioneura* (males)

1 Aedeagal shaft with processes **2**
– Aedeagal shaft without process (Figs 19, 20) ..... ***Thaioneura sinuata* sp. n.**
2 Aedeagal shaft with pair of sub-apical processes (Figs 29, 30) ..... ***Thaioneura suphanburia* sp. n.**
– Aedeagal shaft without sub-apical process (Figs 9, 10) ..... ***Thaioneura nigrilinea* sp. n.**

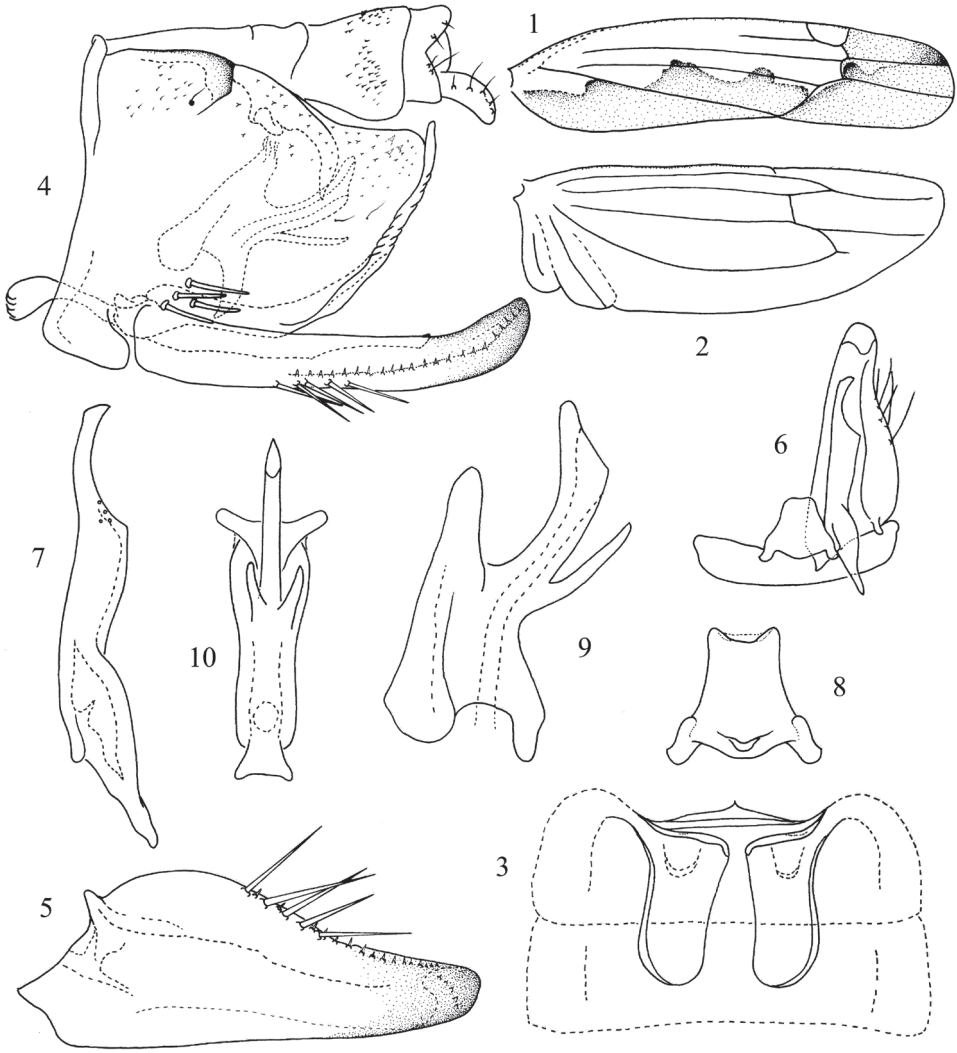
***Thaioneura nigrilinea* sp. n.**
http://zoobank.org/DB18AD07-9EE5-4715-A726-C492BF2CD299
Figs 1–10, 31A–D

Description. Male length 2.3–2.4 mm.

Vertex milky yellow, with indistinct reddish cruciform mark medially; coronal suture weakly delimited (Fig. 31A, C). Face pale, anteclypeus with distal half reddish (Fig. 31D). Pronotum mostly dark brown with small pale submedial spots on anterior and posterior margins (Fig. 31A, C). Mesonotum brown, basal triangles and area between basal triangles dark brown; scutellum dark brown (Fig. 31A, C). Forewing with smoky brown markings as in Fig. 31A.

Hind wing vein CuA confluent with MP for short distance, then diverging and joining CuP near apex (Fig. 2).

Male abdominal apodemes extended to middle of 4th sternite (Fig. 3).



Figures 1–10. *Thaioneura nigrilinea* sp. n. **1** Forewing **2** Hind wing; **3** Abdominal apodemes **4** Genital capsule **5** Subgenital plate **6** Subgenital plate, Style, Connective and the 9th sternite **7** Style **8** Connective **9** Aedeagus, lateral view **10** Aedeagus, ventral view.

Pygofer side with dorsal appendage falcate; ventrolateral setal group with 4 macrosetae (Fig. 4). Subgenital plate with 5 marginal macrosetae (Figs 4, 5). Style apex slightly curved and obliquely truncate, preapical lobe sharply angulate (Figs 6, 7). Connective stem bilobed apically (Figs 6, 8). Aedeagal shaft compressed, curved dorsad distally, slightly expanded and footlike apically, with pair of slightly divergent fingerlike processes basally; preatrium short (Figs 9, 10).

Material examined. Holotype: ♂, Thailand, Chaiyaphum, Tat Tone NP Dry Dipterocarp Forest, 15°59.037'N; 102°2.103'E, 250 m, Malaise trap, 21–28.vi.2006, coll. Lumyai Ittichan. Paratypes: 1♂, Thailand, Sakon Nakhon, Phu Phan NP, Behind national park office, 17°3.488'N;103°58.497'E, 318 m, Malaise trap, 5–11.i.2007, coll. Sailom Tongboonchai; 4♂♂, Thailand, Kanchanaburi, Khuean Srinagarindra NP, Behind tourist center, 14°38.155'N; 98°59.85'E, 210 m, Malaise trap, 11–18. ix.2008, coll. Chatchawan & Boonkam; 3♂♂, Thailand, Kanchanaburi, Khuean Srinagarindra NP, Huai Mae Kamint/50m/SW of Tourist center, 14°29.972'N; 98°53.035'E, Malaise trap, 18–25.ix.2008, coll. Somboon & Daorueng; 1♂, Thailand, Kanchanaburi, Khuean Srinagarindra NP, Huai Mae Kamint/Head Quarter, 14°38.123'N; 98°59.657'E, Malaise trap, 9–16.x.2008, coll. Somboon & Daorueng; 1♂, Thailand, Suphanburi, Pu Toei NP, Huai-Tapern/next to waterfall, 14°58.934'N; 99°19.31'E, Malaise trap, 14–21.xi.2008, coll. Wangkum P.

Remarks. This species can be distinguished from the other species of this genus by the pair of fingerlike aedeagal processes, the short preatrium and the expanded apex of aedeagal shaft in lateral view (Figs 9, 10).

Etymology. The specific name is derived from the Latin words "nigra" (black) and "linea" (line), referring to the brown longitudinal marking on the fore wing (Fig. 1).

***Thaioneura sinuata* sp. n.**
http://zoobank.org/14CDF145-288F-447D-97AB-45BC7C70C4F6
Figs 11–20, 31E–H

Description. Male length 2.2–2.3 mm, female length 2.3–2.4 mm.

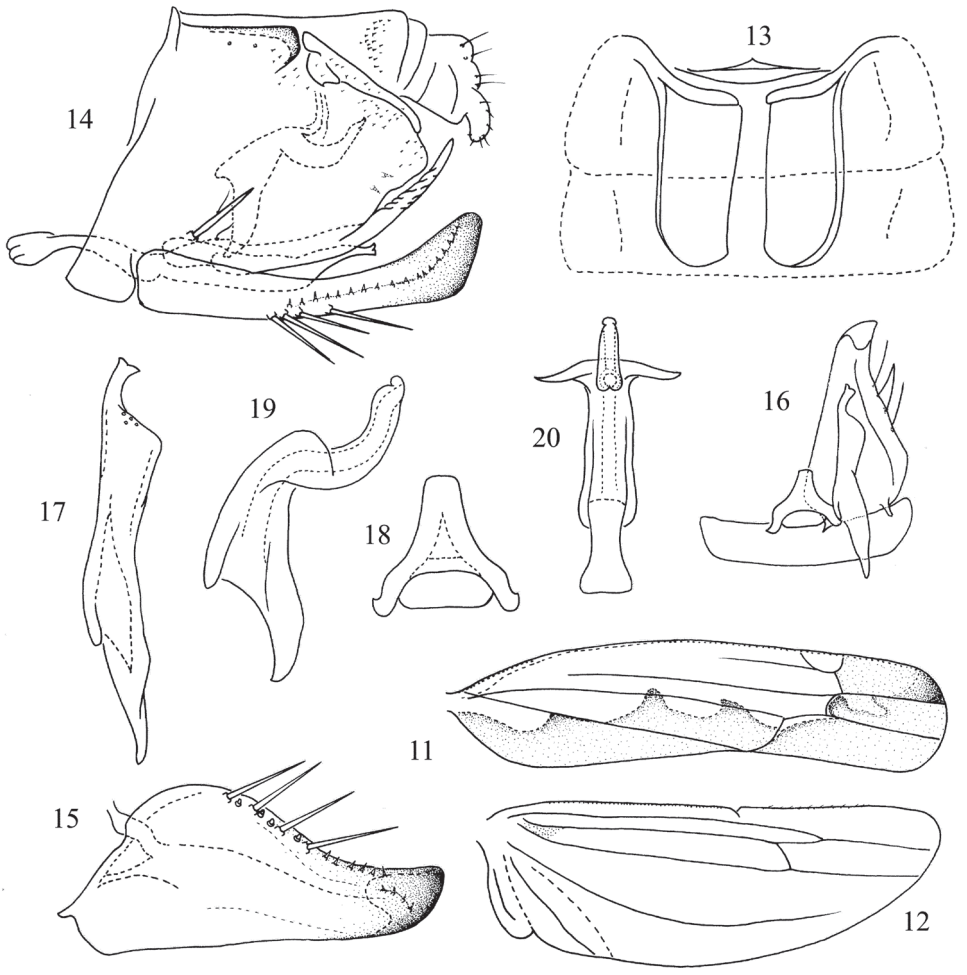
Color pattern very similar to that of *Thaioneura nigrilinea* (Fig. 31E–G), face with anteclypeus pale, without reddish color (Fig. 31H).

Hind wing vein CuA completely confluent with MP distally, CuP free distally (Fig. 12).

Male abdominal apodemes extended to hind margin of 4th sternite (Fig. 13).

Pygofer dorsal appendage slender, digitiform, only weakly curved ventrad, with one large basolateral macroseta (Fig. 14). Subgenital plate with 4 marginal macrosetae (Figs 14, 15). Style apex slightly curved and truncate with medial notch, preapical lobe bluntly angulate (Figs 16, 17). Connective stem narrow and truncate apically (Fig. 18). Aedeagal shaft tubular, curved dorsad, without processes, preatrium moderately developed (Figs 19, 20).

Material examined. Holotype: ♂, Thailand, Sakon Nakhon, Phu Phan NP, Dry evergreen near house no.1567, 16°48.627'N; 103°53.511'E, 512 m, Malaise trap, 4–10.vi.2007, coll. Winlon Kongnara. Paratypes: 3♂♂, Thailand, Phetchabun, Khao Kho NP Mix deciduous, 16°39.589'N; 101°8.185'E, 168 m, Malaise trap, 5–12.i.2007, coll. Somchai Chachumnan & Saink Singtong; 6♂♂, Thailand, Suphanburi, Pu Toei NP Huai Mongpae/red road, 14°56.985'N; 99°26.78'E, 300 m, Malaise trap, 16-23.vii.2008, coll. Saunbua.L.; 5♂♂, Thailand, Kanchanaburi, Khuean

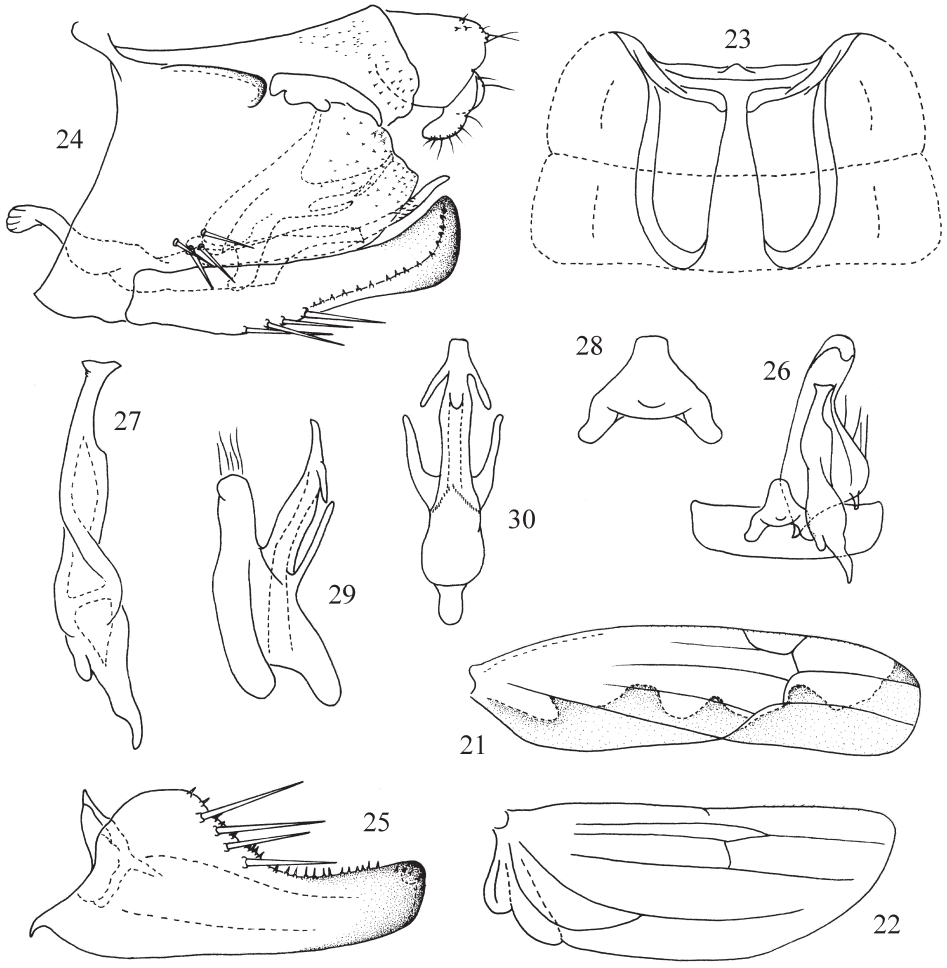


Figures 11–20. *Thaioneura sinuata* sp. n. **11** Forewing **12** Hind wing **13** Abdominal apodemes **14** Genital capsule **15** Subgenital plate **16** Subgenital plate, style, connective and the 9th sternite **17** Style **18** Connective **19** Aedeagus, lateral view **20** Aedeagus, ventral view.

Srinagarindra NP, Huai Mae Kamint/50m/SW of Tourist center, 14°29.972'N; 98°53.035'E, Malaise trap, 18–25.ix.2008, coll. Somboon & Daorueng; 3♂♂, Thailand, Chaiyaphum, Tat Tone NP Pha Eang waterfall, 15°57.24'N; 101°54.72'E, 301 m, Malaise trap, 12–19.iv.2007, coll. Tawit Jaruphan.

Remarks. This species is similar to *Thaioneura nigrilinea* on external appearance and genital structures, but can be distinguished by the aedeagal shaft without processes, the longer preatrium (Figs 19, 20) and the more slender, less curved pygofer dorsal appendage (Fig. 14).

Etymology. The specific name is derived from the Latin word "sinuate" (curved in and out), referring to the sinuate aedeagal shaft in lateral view (Fig. 19).

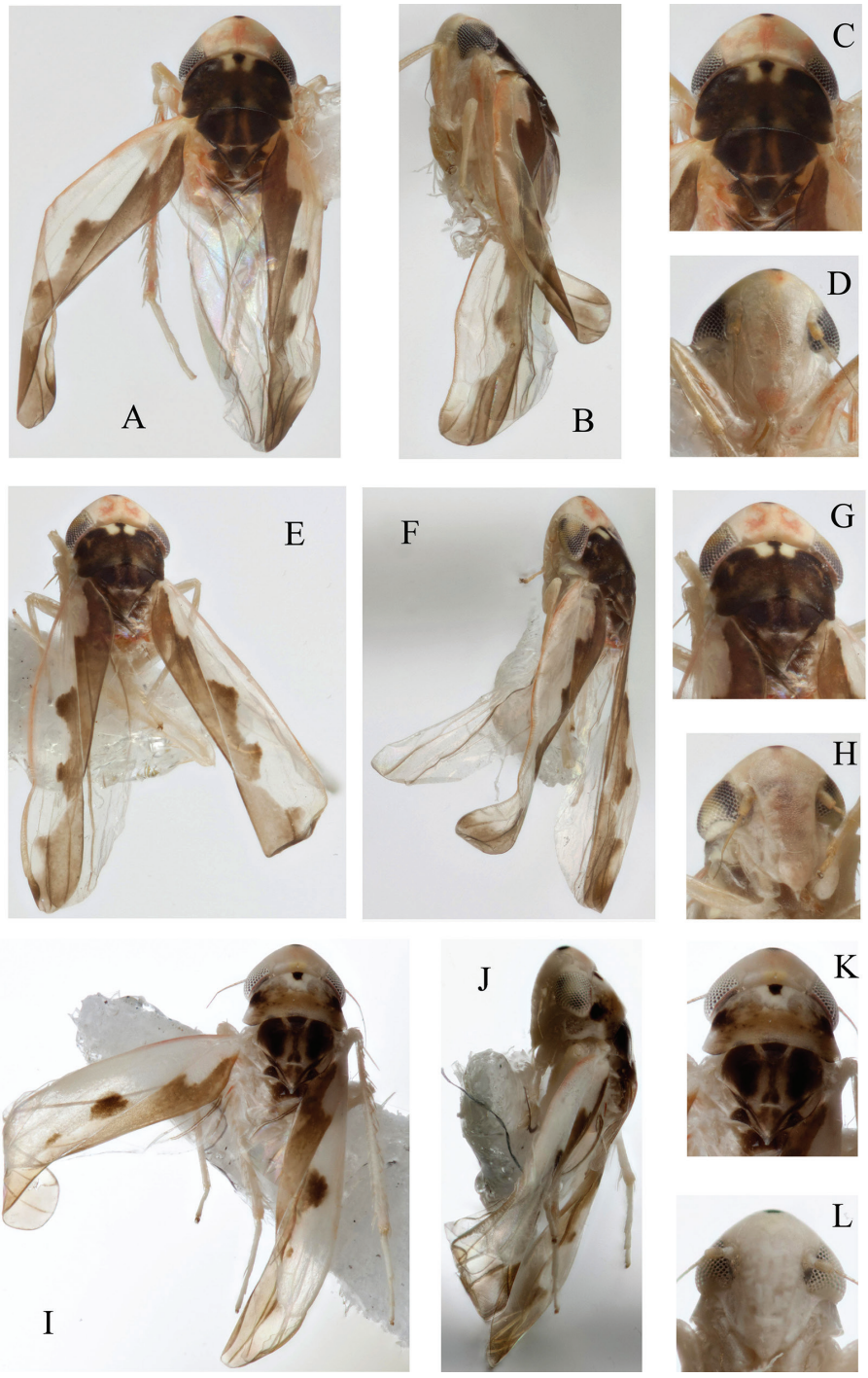


Figures 21–30. *Thaioneura suphanburia* sp. n. **21** Forewing **22** Hind wing **23** Abdominal apodemes **24** Genital capsule **25** Subgenital plate **26** Subgenital plate, style, connective and the 9th sternite **27** Style **28** Connective **29** Aedeagus, lateral view **30** Aedeagus, ventral view.

***Thaioneura suphanburia* sp. n.**
http://zoobank.org/92CD2FEB-8875-497D-9248-12A3BD5074BA
Figs 21–30, 31I–L

Description. Male length 2.3 mm.

Color similar to other congeners (Fig. 31A–D; E–G). Vertex milky yellow, with longitudinal milky white bandlike stripe medially (Fig. 31I). Face with anteclypeus pale (Fig. 31L). Pronotum dark color faded, with three dark spots on anterior margin and both sides (Fig. 31I). Mesonotum light brown, basal triangles dark brown, with irregular dark marking in area between basal triangles; scutellum light brown (Fig. 31I).



Figures 31. A–D *Thaioneura nigrilinea* sp. n. **E–H** *Thaioneura sinuata* sp. n. **I–L** *Thaioneura suphanburia* sp. n. **A, E, I** Habitus, dorsal view; **B, F, J** Habitus, lateral view **C, G, K** Head and thorax, dorsal view **D, H, L** Face.

Hind wing vein CuA completely confluent with MP distally, CuP free distally (Fig. 22).

Male abdominal apodemes extended to hind margin of 4th sternite (Fig. 23).

Pygofer dorsal appendage digitiform, but short; ventrolateral setal group with 4 macrosetae (Fig. 24). Subgenital plate with 4 marginal macrosetae (Figs 24, 25). Style apex slightly curved and truncate with medial notch, preapical lobe bluntly angulate (Figs 26, 27). Connective stem narrow and truncate apically (Fig. 28). Aedeagal shaft tubular, truncate apically in ventral view, with pair of long slender divergent processes arising near base and extended distad, pair of shorter apical processes extended basolaterad, preatrium short (Figs 29, 30).

Material examined. Holotype: ♂, Thailand, Suphanburi, Pu Toei NP Phu Toei hill top/road, 14°57.32'N; 99°26.972'E, 650 m, Malaise trap, 24–31.viii.2008, coll. Saunbua. L. Paratype: 1♂, same data as holotype.

Remarks. This species can be distinguished from the other species of this genus by the two pairs of aedeagal processes, the short preatrium and the truncate apex of the aedeagal shaft in ventral view (Figs 29, 30).

Etymology. This new species is named from the type locality, Suphanburi, Thailand.

Discussion

Study of 31 leafhopper specimens representing 3 new species revealed that the new genus described here exhibits two different patterns of hind wing venation that are stable within species but variable between species. Hind wing vein CuA of *Thaioneura nigrilinea* separates from MP distally and is connected to CuP near the wing apex (Fig. 2). This is the usual venational pattern seen in the vast majority of Erythroneurini. However, the other two new species (*Thaioneura sinuata*; *Thaioneura suphanburia*) have vein CuA of the hind wing completely confluent with MP distally and vein CuP free distally (Figs 12, 22). This latter pattern also occurs in the Oriental genera *Diomma* Motschulsky (see Chiang and Knight 1990) and *Watara* Dworakowska. The two known species of *Watara* show the pattern consistently but some species of *Diomma* have CuA completely confluent with MP while others have these two veins divergent near the wing apex. Therefore, variation in hind wing venation is known to occur but is rare in other genera of Erythroneurini. Despite the observed variation in hind wing venation, placement of the three new species described here into a single genus is strongly justified by the unique dorsal color pattern and combination of features of the male genitalia. Nevertheless, the particular pattern of variation exhibited among *Thaioneura* species is not known to occur in other erythroneurine genera and further collecting and morphological study is needed to determine whether such variation occurs in other genera. The type species of *Thaioneura*, *T. nigrilinea*, has the usual venational pattern found in other Erythroneurini and, therefore, presumably represents the plesiomorphic condition for the new genus while the other two species are more apomorphic. This hypothesis should be tested by future phylogenetic analyses of Erythroneurini.

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We are indebted to Dr. D. A. Dmitriev (Illinois Natural History Survey, University of Illinois, USA) for his detailed remarks and suggestions on the manuscript. We also thank Dr. Viraktamath, C. A. (University of Agricultural Sciences, GKVK, Bangalore, India) for reviewing the manuscript as one of the referees. The study was partly supported by the Key Project in the National Key Technology R&D Program of China during the Twelfth Five-year Plan Period (2011BAC09B01-08), the National Natural Science Foundation of China (31301866), the Chinese Government Scholarship Sponsoring Study Abroad (201308525113), the Special Foundation for the Excellent Youth Science and Technology Scholars of Guizhou Province (Qian Ke He Ren Zi, No. [2015] 17) and the Natural Science Research Project of Education Department of Guizhou Province (Qian Jiao He KY Zi, No. [2015] 357).

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A taxonomic account of the genus *Stenodynerus* from China, with descriptions of five new species (Hymenoptera, Vespidae, Eumeninae)

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Abstract

In this paper, 20 species of the genus *Stenodynerus* are reviewed and identified from China, including five new species: *S. ninglangensis* Ma & Li, **sp. n.**, *S. reflexus* Ma & Li, **sp. n.**, *Stenodynerus similibaronii* Ma & Li, **sp. n.**, *S. strigatus* Ma & Li, **sp. n.**, and *S. tenuilamellatus* Ma & Li, **sp. n.**, and five new records: *S. baronii* Giordani Soika, *S. bluethgeni* van der Vecht, *S. picticrus* (Thomson), *S. pullus* Gusenleitner and *S. nepalensis* Giordani Soika. The five new species are described and illustrated in detail. Moreover, the diagnostic characters of all new records and known species from China are provided, with a key to the Chinese species of *Stenodynerus*.

Keywords

Hymenoptera, Vespidae, Eumeninae, *Stenodynerus*, new species, China, distribution

Introduction

The genus *Stenodynerus* of potter wasps was established by de Saussure (1863). This genus includes 161 species with 26 subspecies worldwide, and is distributed in the Nearctic, Neotropic, Palearctic and Oriental regions. These known species were described or revised by Bohart (1943, 1944, 1948, 1949, 1966, 1980), Buck (2008), Gusenleitner

(1981, 1985, 2004, 2008, 2001a, 2001b, 2012), Giordani Soika (1972, 1975, 1976a, 1976b, 1979, 1981, 1985, 1986, 1994), Kim and Yamane (1999, 2004), and so on. So far, ten species with two subspecies have been recorded from China (de Saussure 1863, 1867; André 1884; Morawitz 1889; Giordani Soika 1976; Kurzenko 1977; Giordani Soika 1979; Li 1985; Gusenleitner 2003, 2012; Kim and Yamane 2004). In this study, a total of 20 species of *Stenodynerus* is recognized, including five new species and five newly recorded species. These five new species are described and illustrated in detail, and the diagnostic characters of new records and all known species from China provided. In addition, a key to the Chinese species of *Stenodynerus* is updated. The diagnostic characters and the key were produced based on specimen examination and the information extracted from the literature.

Materials and methods

Descriptions were made under a stereomicroscope (Olympus SZ61). Measurements were taken as the maximal length of body parts under an image analyzer (LY-M-Tupuwiew), and all figures were taken with a stereomicroscope (LY-WN-YH) attached to a computer. The ratios used throughout the descriptions were measured in the same magnification of the stereomicroscope. Body length was measured from the anterior margin of head to the posterior margin of metasomal tergum II. For the density description of punctures, "sparsely" means that the interspaces are larger than one puncture diameter, "moderately" means equal to the diameter, and "densely" means the interspaces are less than one puncture diameter. Terminology principally follows Carpenter (1982) and Kim and Yamane (2004). Specimens examined are deposited in the Institute of Entomology and Molecular Biology, Chongqing Normal University, Chongqing, China (CQNU).

Taxonomy

Stenodynerus de Saussure, 1863

Stenodynerus de Saussure, 1863: 228; Gusenleitner 1981: 221; Giordani Soika 1994: 133.
Nannodynerus Blüthgen, 1938 (1937): 281.
Parhypodynerus Giordani Soika, 1973: 110.

Type species. *Odynerus chinensis* de Saussure, 1863, designated by Bohart, 1939.

Diagnosis. Body generally small and slender (Figs 1, 7, 14–15, 23, 30, 37, 63, 73); anterior surface of pronotum usually with a pair of median foveae, which sometimes contiguously forms U-shaped (Fig. 69), V-shaped (Figs 3, 18, 40, 48, 52, 57, 60, 65, 75) or a transverse fovea; tegula campanulate, broadest in the middle, length

somewhat more than width; parategula just reaching apex of tegula; tergum I generally without a basal transverse carina (Figs 5, 10, 26, 33, 50, 59, 71, 78), but in some Nearctic species present; tergum II without an acarinarium; the terminal segment of male antenna bent backward like a hook, apex usually reaching the base or middle of the segment XI (Fig. 19). This genus is similar in some characters to *Parancistrocerus* Bequaert, which can be distinguished by the presence of an acarinarium on the metasomal tergum II in *Parancistrocerus*.

Distribution. Nearctic, Neotropic, Palearctic and Oriental regions.

***Stenodynerus ninglangensis* Ma & Li, sp. n.**
http://zoobank.org/E2130F59-2C6F-494A-891D-A0E2597FFFCD
Figs 1–6

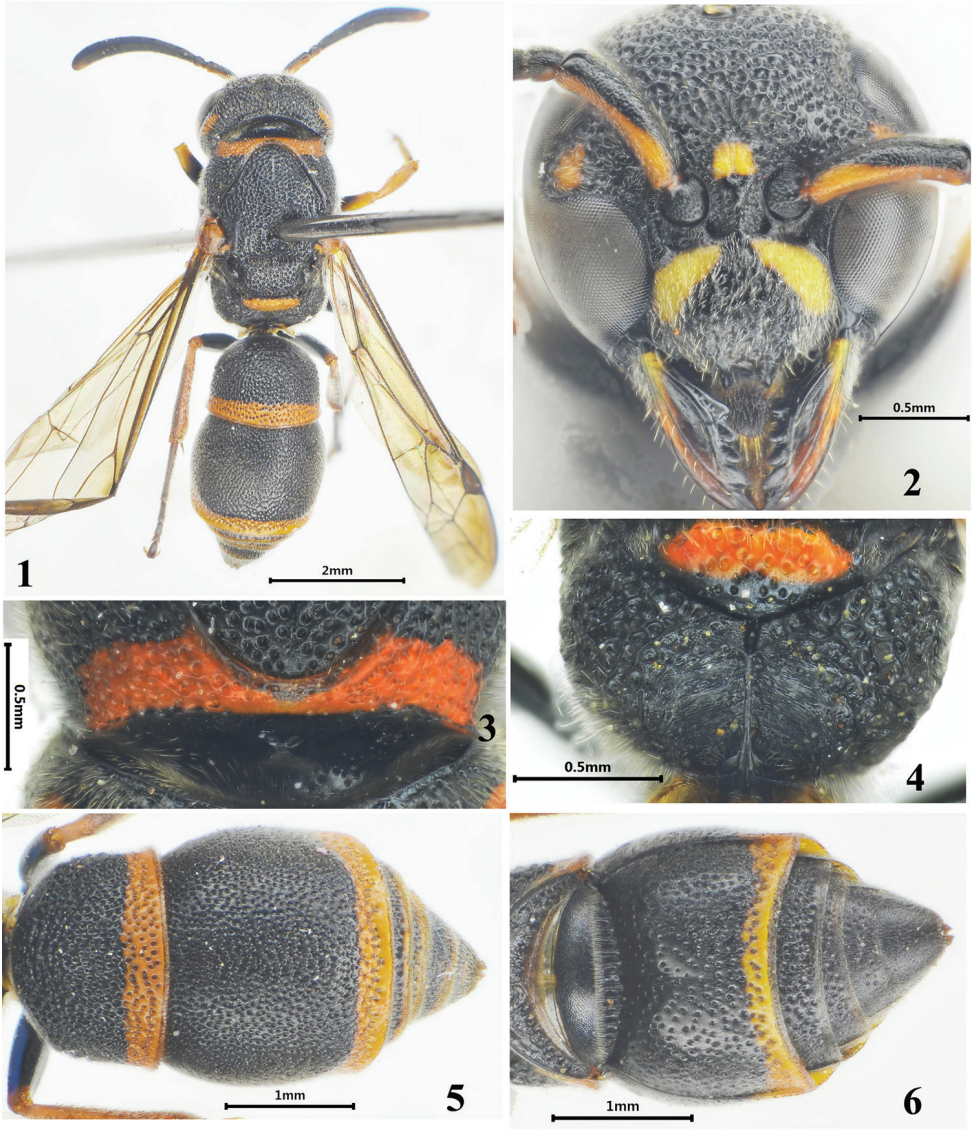
Material examined. Holotype, ♀, China, Yunnan Prov., Lijiang City, Ninglang County, Daxing Town, 27°16'37.68"N, 100°51'03.11"E, 2252 m, 26.VII. 2011, Tingjing Li, No. 1004068 (CQNU). Paratype: 1♀, same data as holotype, No. 1004069 (CQNU).

Description. Female (Figs 1–6): body length 7.2 mm, forewing length 5.6 mm. Black; a basal band on clypeus except median interruption (Fig. 2) and inter-antennal spot yellow; the outer margin of mandible yellow to brown; the spots pale ferruginous: ventral scape, apex of ocular sinus (Fig. 2), transverse post-ocular spot, a band on dorsal surface of pronotum, mesepisternal spot, parategula, metanotum except posterior apex ventrally, apexes of femora, all tibiae and tarsi, and apical bands on metasomal terga I–II and sternum II; tegula brown.

Head. Clypeus strongly punctate, with dense setae, its width much more than length (width 1.25 × length), apex emarginated, apical width: emargination depth = 0.20: 0.04, total width: apical width = 0.86: 0.20 (Fig. 2); frons densely punctate, punctures on vertex somewhat sparser than those on frons; frons and vertex with very sparse and short setae; cephalic fovea obsolete.

Mesosoma. Pronotum, mesoscutum and scutellum densely punctate and reticulate, punctures somewhat larger and sparser than those on the head; punctures on metanotum sparser than those on other parts of the mesosoma. Anterior surface of pronotum shining, almost vertical, with few minute punctures, median foveae contiguous and V-shaped, pronotal carina complete (Fig. 3); scutellum distinct convex; metanotum oblique; dorsal and lateral surfaces of propodeum reticulate-punctate, dorsal surface broad with a weak shelf, posterior surface concave with long and transverse rugae and a median longitudinal carina (Fig. 4).

Metasoma. In dorsal view, tergum I domed, densely punctate, width 1.31 ×length and 0.85 × width of tergum II; tergum II with smaller and sparser punctures than tergum I, apex with deeper and denser punctures than other parts of tergum II, and apical margin without a distinct lamella, (Fig. 5); sternum II sparsely punctate, with a long median longitudinal furrow basally, and its anterior surface sloping (Fig. 6).



Figures 1–6. Female of *Stenodynerus ninglangensis* Ma & Li, sp. n. **1** habitus of holotype (dorsal view) **2** clypeus **3** anterior surface of pronotum **4** metanotum and propodeum **5** metasoma (dorsal view) **6** metasomal (ventral view).

Male. Unknown.

Remarks. This species is easily distinguished from all the other members of *Stenodynerus* by the following character combinations: a basal band on clypeus except median interruption yellow (Fig. 2), apex of ocular sinus ferruginous (Fig. 2), apical margin of tergum II without a distinct lamella (Fig. 5), sternum II with a long median longitudinal furrow basally, and its anterior surface sloping (Fig. 6).

Distribution. China (Yunnan).

Etymology. The specific name *ninglangensis* is the Latin adjective of the region from which the type specimens were collected.

***Stenodynerus reflexus* Ma & Li, sp. n.**
http://zoobank.org/18D6BDFC-DD54-4DAA-8B2D-38E7B0670C63
Figs 7–13

Material examined. Holotype, ♀, China, Yunnan Prov., Baoshan City, Tengchong County, Beihai Village, 25°16'48.82"N, 98°34'49.16"E, 1783 m, 13.VII.2011, Xin Zhou, No. 1004070 (CQNU).

Description. Female (Figs 7–13): body length 7.4 mm, forewing length 5.8 mm. Black; with the following spots ferruginous: clypeus except median interruption basally (Fig. 8), inter-antennal spot, ventral scape, post-ocular spot, a broad band on the pronotal dorsum, mesepisternal spot, parategula, metanotum except posterior apex ventrally, apical bands on metasomal terga I–II and sternum II, a long band on the dorsal surface of the fore tibia; tegula brown.

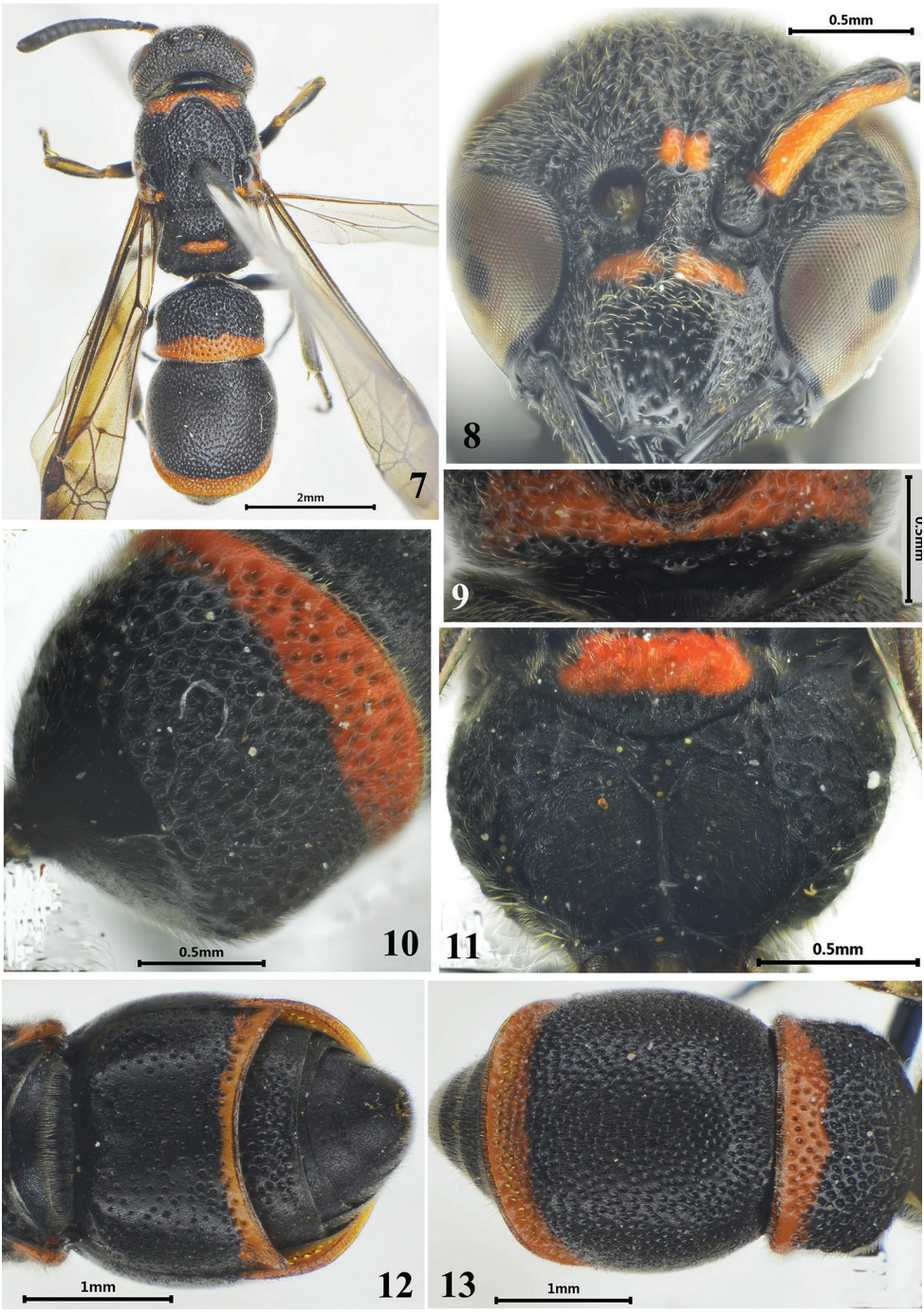
Head. Clypeus with sparse punctures, and with setae basally and laterally, its width much more than length (width 1.24 × length), apex moderately emarginated, apical width: emargination depth = 0.25: 0.08, total width: apical width = 0.88: 0.25 (Fig. 8); frons densely punctate, punctures on vertex somewhat weaker than those on frons; frons and vertex with dense setae; cephalic fovea obsolete.

Mesosoma. Masosoma densely punctate and reticulate except metanotum, punctures generally larger than those on the head; punctures on metanotum sparser and shallower than those on other parts of the mesosoma. Anterior surface of pronotum slightly sloping, distinctly punctate, and with a pair of round separated median foveae, the interspace between these two median foveae less than one fovea diameter, pronotal carina complete (Fig. 9); scutellum distinctly convex; metanotum nearly vertical; dorsal and lateral surface of propodeum reticulate-punctate, dorsal surface narrow with a developed shelf, posterior surface concave with long and transverse rugae and a median longitudinal carina (Fig. 11).

Metasoma. In dorsal view, tergum I campanulate, coarsely punctate, width 1.37 × length and 0.85 × width of tergum II, anterior surface vertical, almost impunctate, and with a median longitudinal carina in upper half (Fig. 10); tergum II with smaller and sparser punctures than tergum I, and with a broad reflex apical lamella, dense and deep punctures forming a wide transverse groove on the base of lamella (Fig. 13); sternum II sparsely punctate, basally with a very short median longitudinal furrow, and its anterior surface almost vertical (Fig. 12).

Male. Unknown.

Remarks. This species is similar to *S. pappi* by having the propodeal shelf developed, a median longitudinal carina on propodeal concavity (Fig. 11, 81), anterior vertical surface of tergum I with a longitudinal median carina in upper half (Fig. 10). It



Figures 7–13. Female of *Stenodynerus reflexus* Ma & Li, sp. n. **7** habitus of holotype (dorsal view) **8** clypeus **9** anterior surface of pronotum **10** metasomal tergum I (dorsal view) **11** metanotum and propodeum **12** metasomal (ventral view) **13** metasoma (dorsal view).

is different from *S. pappi* and other members of the genus in the following characters: clypeus basally ferruginous except median interruption (Fig. 8), a broad band on pronotum (Fig. 9), and sternum II with a very short median longitudinal furrow basally, and its anterior surface almost vertical (Fig. 12).

Distribution. China (Yunnan).

Etymology. The specific name is the Latin adjective *reflexus*, which refers to the apical lamella of metasomal tergum II broadly reflexed.

***Stenodynerus similibaronii* Ma & Li, sp. n.**
http://zoobank.org/3B9079BB-25FC-4436-8C61-9A2AFE5E7CC1
Figs 14–22, 45

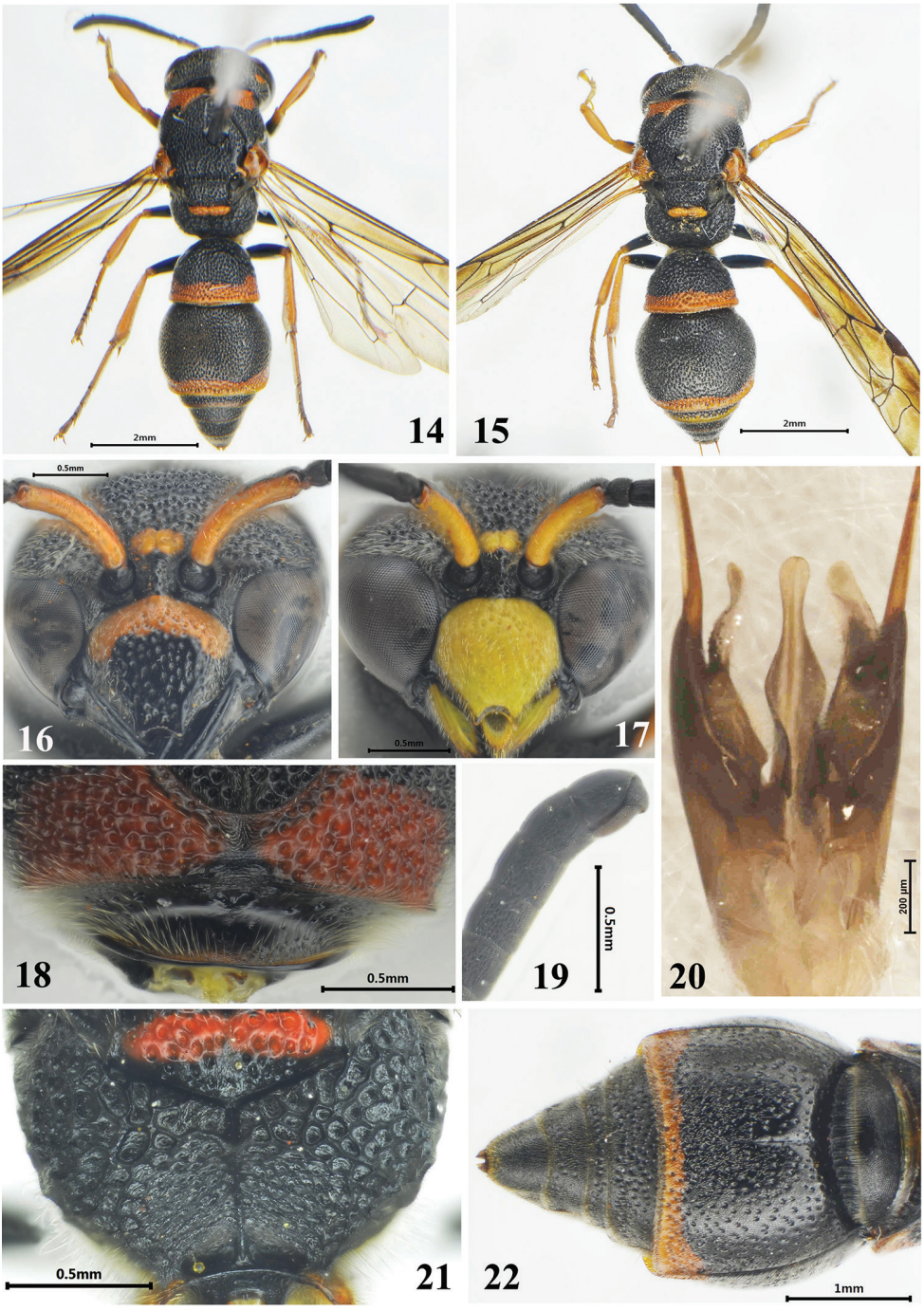
Material examined. Holotype, ♀, China, Yunnan Prov., Baoshan City, Tengchong County, Shangying Village, 25°0'54.72"N, 98°39'12.86"E, 1823 m, 31.VII.2015, Zhenxia Ma & Long Li, No. 1004071 (CQNU). Paratypes: 1♀♀2♂♂, the same data as holotype, Nos. 1004072, 10040743, 1004074 (CQNU).

Description. Female (Figs 14, 16, 18, 21–22, 45): body length 7.0 mm, forewing length 6.5 mm. Black; with the following spots pale ferruginous: a basal band of clypeus (Fig. 16), ventral scape, inter-antennal spot, post-ocular spot, spots on outsides of tegula anteriorly and posteriorly, parategula, apexes of femora to terminal tarsi, and apical bands on metasomal terga I–II and sternum II; a band on dorsal surface of pronotum except median interruption (Fig. 18), and metanotum except posterior apex ventrally dark ferruginous (Fig. 21); tegula brown.

Head. Clypeus with moderate punctures, lateral surface with sparse setae, its width somewhat more than length (width 1.09 × length), apex slightly emarginated, apical width: emargination depth = 0.33: 0.07, total width: apical width = 1.00: 0.33 (Fig. 16); frons and vertex densely punctate and reticulate; frons with sparse and very short setae, setae on vertex denser than those on frons.

Mesosoma. Masosoma densely punctate and reticulate; punctures generally larger than those on the head; punctures on pronotal dorsum and mesoscutum somewhat denser than those on other parts of the masosoma (Fig. 14). Anterior surface of pronotum almost vertical with few small punctures, median foveae contiguous and V-shaped, a few short transverse carinae above median foveae, pronotal carina interrupted medially (Fig. 18); scutellum distinctly convex; metanotum oblique; dorsal and lateral surfaces of propodeum reticulate-punctate, dorsal surface broad with a weak shelf, posterior surface concave with long and transverse rugae and a median longitudinal carina (Fig. 21).

Metasoma. In dorsal view, tergum I domed, densely punctate, width 1.35 × length and 0.84 × width of tergum II; tergum II with smaller and sparser punctures than tergum I, apex with deeper and denser punctures than other parts of tergum II, and apical margin without a distinct lamella (Fig. 45); sternum II sparsely punctate, with a long median longitudinal furrow basally, and its anterior surface sloping (Fig. 22).



Figures 14–22. *Stenodynerus similibaronii* Ma & Li, sp. n. **14, 16, 18, 21-22** female, **15, 17, 19–20** male. **14** habitus of holotype (dorsal view) **15** habitus of paratype (dorsal view) **16** clypeus **17** clypeus **18** anterior surface of pronotum **19** antennal segment (lateral view) **20** genitalia (ventral view) **21** metanotum and propodeum **22** metasoma (ventral view).

Male (Figs 15, 17, 19, 20): body length 6.8 mm, forewing length 5.6 mm. Sculpture, punctuation, setae and coloration similar to those of female except the follows: entire clypeus, mandible except apical portion, ventral scape and inter-antennal spot yellow; clypeus strongly, convex medially, with sparse and small punctures, its width equal to length, apex deeply emarginated and U-shaped, apical width: emargination depth = 0.27: 0.12, total width: apical width = 0.8: 0.27 (Fig. 17); punctures on apex of tergum II deeper than those in female; width of tergum I 1.45 × length and 0.79 × width of tergum II; the terminal segment of antenna bent backward like a hook, apex reaching the base of segment XI (Fig. 19). Male genitalia as in Fig. 20, volsella with setae and slightly truncate apically, parallel spines elongate without setae, penis valve rounded apically.

Remarks. This species is similar to *S. baronii* by a basal band of clypeus (Fig. 16), metasomal sternum II with a long median longitudinal furrow basally (Fig. 22), and propodeal concavity with a median longitudinal carina (Fig. 21). It is different from *S. baronii* and other members of the genus in the following characters: anterior surface of pronotum with wider V-shaped median foveae (Fig. 18), punctures on apex of metasomal tergum II sparser (Fig. 45), and male volsella of genitalia narrower and slightly truncate apically than the corresponding parts in *S. baronii* (Figs 20, 41).

Distribution. China (Yunnan).

Etymology. The specific name *similibaronii* is a Latin adjective which refers to the similar species of *S. baronii*.

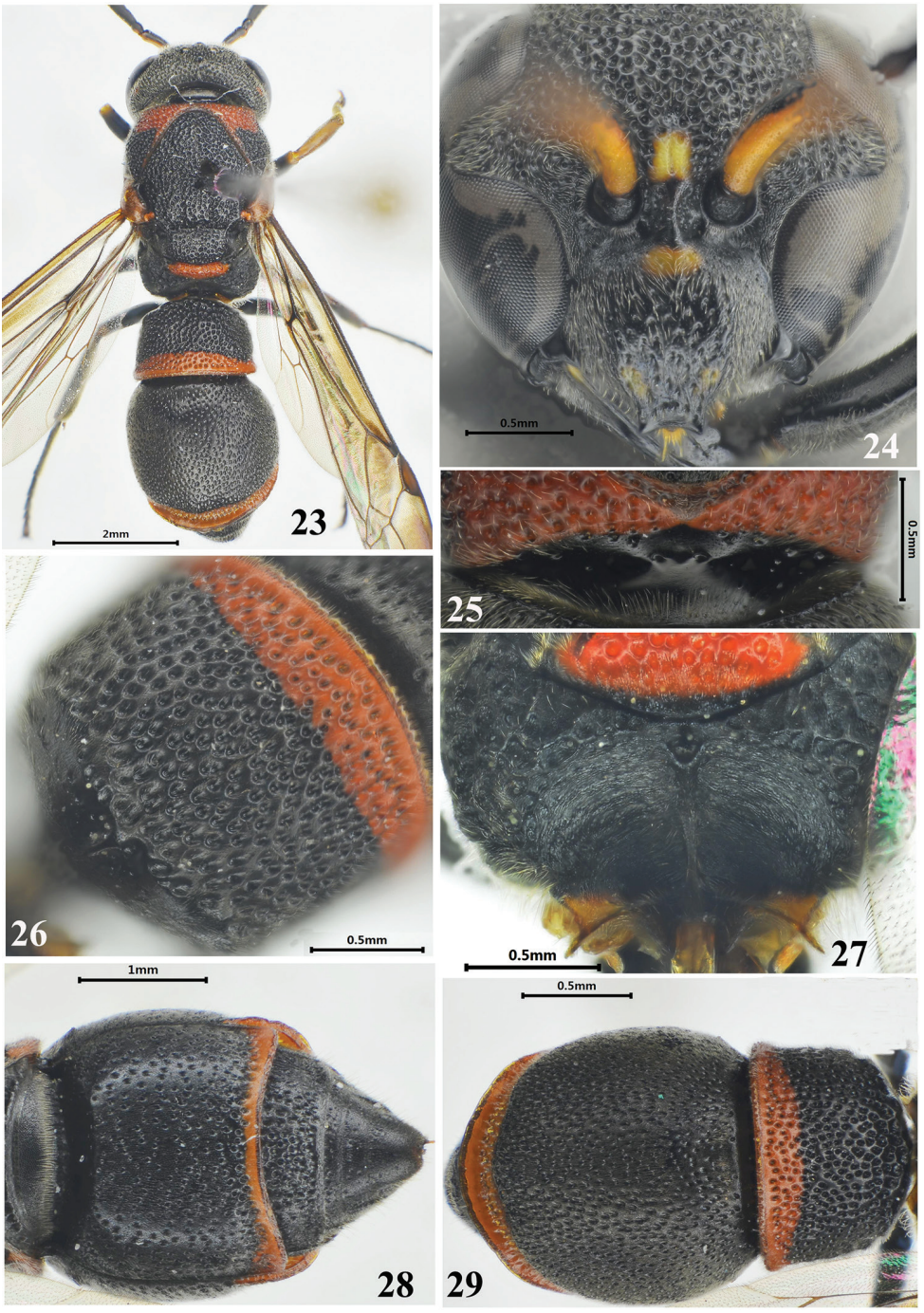
***Stenodynerus strigatus* Ma & Li, sp. n.**
http://zoobank.org/45B4C174-8CAA-4972-8642-91F292686599
Figs 23–29

Material examined. Holotype, ♀, China, Shaanxi Prov., Ankang City, Langao County, Huanli Town, 32°12'52.77"N, 109°0'17.90"E, 1808 m, 7.VIII.2015, Yan Peng & Wenkai Zhou, No. 1004075 (CQNU).

Description. Female (Figs 23–29): body length 8.3 mm, forewing length 7.7 mm. Black; the following spots yellow: a basal transverse median spot and two small obscure apical spots on clypeus (Fig. 24), inter-antennal spot, and scape ventrally; small postocular spot, pronotal dorsum except posterior apex, mesepisternal spot, parategula, metanotum largely (Fig. 27), apical bands on metasomal terga I–II and sternum II, and a long band on fore and mid tibiae dorsally ferruginous; tegula brown.

Head. Clypeus convex medially, moderately punctate, somewhat reticulate, with sparse and short setae, its width more than length (width 1.25 × length), apex slightly emarginated, apical width: emargination depth = 0.29: 0.06, total width: apical width = 1.02: 0.29 (Fig. 24); frons and vertex densely punctate, with short setae; cephalic fovea obsolete.

Mesosoma. Masosoma densely punctate and reticulate, punctures generally larger than those on the head; punctures on pronotal dorsum denser than those on others



Figures 23–29. Female of *Stenodynerus strigatus* Ma & Li, sp. n. **23** habitus of holotype (dorsal view) **24** clypeus **25** anterior surface of pronotum **26** metasomal tergum I (dorsal view) **27** metanotum and propodeum **28** metasomal (ventral view) **29** metasoma (dorsal view).

parts of the masosoma (Fig. 23). Anterior surface of pronotum sloping, shinning, with few punctures and a pair of round separated median foveae, the interspace between these two median foveae much more than one diameter, pronotal carina complete (Fig. 25); scutellum distinctly convex; metanotum nearly vertical; dorsal and lateral surfaces of propodeum reticulate-punctate, dorsal surface narrow with a weak shelf, posterior surface concave with long and transverse rugae and a median longitudinal carina (Fig. 27).

Metasoma. In dorsal view, tergum I campanulate, coarsely punctate, width 1.58 × length and 0.81 × width of tergum II, anterior surface vertical, almost impunctate, and with a median longitudinal carina and two transverse striations (Fig. 26); tergum II with smaller and sparser punctures than tergum I, and with a broad reflex apical lamella, dense and deep punctures forming a wide transverse groove on the base of lamella (Fig. 29); sternum II sparsely punctate, without a median longitudinal furrow basally, and its anterior surface almost vertical (Fig. 28).

Male. Unknown.

Remarks. This species is similar to *S. pappi* by a median longitudinal carina on propodeal concavity (Fig. 27), anterior vertical surface of tergum I with a longitudinal median carina in upper half (Fig. 26), and tergum II with a broad reflex apical lamella (Fig. 29). It is different from *S. pappi* and other members of the genus in the following characters: a transverse median spot and two obscure apical spots on clypeus basally yellow (Fig. 24), pronotal dorsum mostly ferruginous (Fig. 25), the interspace of pronotal median foveae much more than one fovea diameter (Fig. 25), anterior vertical surface of tergum I with two transverse striations (Fig. 26), and sternum II without a median longitudinal furrow basally, and its anterior surface almost vertical (Fig. 28).

Distribution. China (Shaanxi).

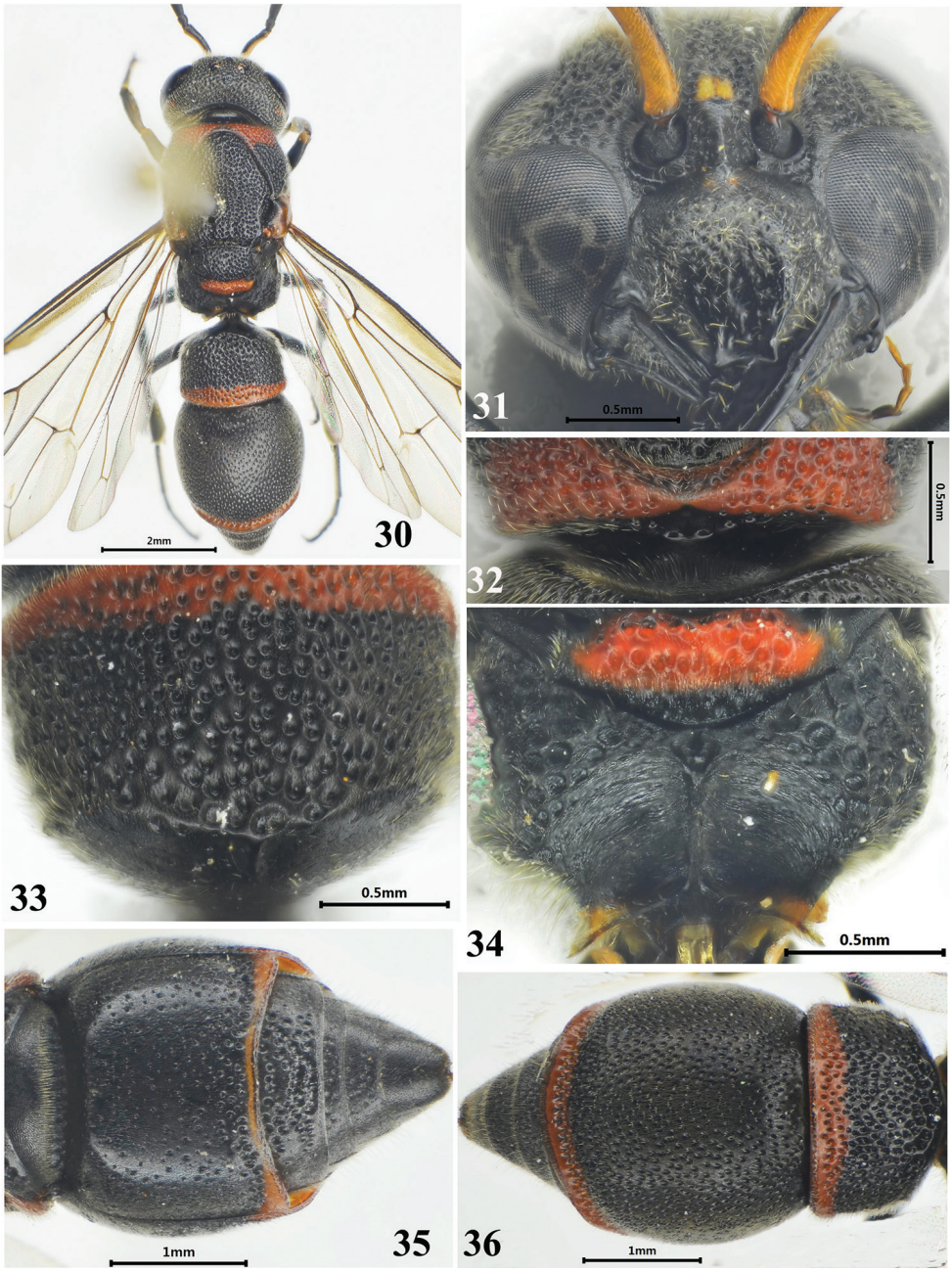
Etymology. The specific name is the Latin adjective *strigatus*, which refers to the anterior vertical surface of tergum I with two transverse striations.

Stenodynerus tenuilamellatus Ma & Li, sp. n.

http://zoobank.org/3691DE51-0508-4583-913B-C873FC5E66AD
Figs 30–36

Material examined. Holotype, ♀, China, Yunnan Prov., Baoshan City, Tengchong County, Zhonghe Village, 25°31'55.10"N, 98°23'44.21"E, 1663 m, 29.VII.2015, Zenghui Huang & Siyu Xie, No. 1004076 (CQNU). Paratype: 1♀, China, Yunnan Prov., Baoshan City, Tengchong County, Jietou Village, 25°25'11.18"N, 98°39'42.75"E, 1631 m, 15.VII.2006, Li Ma, No. 1004077 (CQNU).

Description. Female (Figs 30–36): body length 8.0 mm, forewing length 6.7 mm. Black; a minute spot on clypeus basally, inter-antennal spot, and scape ventrally yellow; with the following parategula, metanotum except posterior apex ventrally, apical bands on metasomal terga I–II and sternum II, and the dorsal surface of fore femur; tegula brown.



Figures 30–36. Female of *Stenodynerus tenuilamellatus* Ma & Li, sp. n. **30** habitus of holotype (dorsal view) **31** clypeus **32** anterior surface of pronotum **33** metasomal tergum I (dorsal view) **34** metanotum and propodeum **35** metasomal (ventral view) **36** metasoma (dorsal view).

Head. Clypeus convex medially with sparse punctures and setae, its width somewhat more than length (width 1.08 × length), apex slightly emarginated, apical width: emargination depth = 0.26: 0.07, total width: apical width = 0.96: 0.26 (Fig. 31); frons and vertex densely punctate and reticulate, with short setae; cephalic fovea obsolete.

Mesosoma. Masosoma densely punctate and reticulate, punctures generally larger than those on the head; punctures on pronotal dorsum denser than those on other parts of the masosoma (Fig. 30). Anterior surface of pronotum somewhat sloping, with a few punctures and a pair of round separated median foveae, the interspace between two median foveae almost equal to one fovea diameter, pronotal carina complete (Fig. 32); scutellum distinctly convex; metanotum nearly vertical; dorsal and lateral surfaces of propodeum reticulate-punctate; dorsal surface narrow with a moderate shelf; posterior surface concave with long and transverse rugae and a median longitudinal carina (Fig. 34).

Metasoma. In dorsal view, tergum I campanulate, coarsely punctate, width 1.59 × length and 0.81 × width of tergum II, anterior surface vertical, almost impunctate, and with a median longitudinal carina in upper half (Fig. 33); tergum II with smaller and sparser punctures than tergum I, and with a narrow reflex apical lamella, a row of deep and dense punctures forming a narrow transverse groove on the base of lamella (Fig. 36); sternum II sparsely punctate, without a median longitudinal furrow basally, and its anterior surface vertical (Fig. 35).

Male. Unknown.

Remark. This species is similar to *S. pappi* by a median longitudinal carina on propodeal concavity (Fig. 34), and anterior vertical surface of tergum I with a longitudinal median carina in upper half (Fig. 33). It is different from *S. pappi* and other members of the genus in the following characters: clypeus with a minute spot basally (Fig. 31); propodeal shelf moderately (Fig. 34); apical lamella of metasomal tergum II distinctly narrower than that of *S. pappi* (Figs 36, 82), and sternum II without a median longitudinal furrow basally, and its anterior surface vertical (Fig. 35).

Distribution. China (Yunnan).

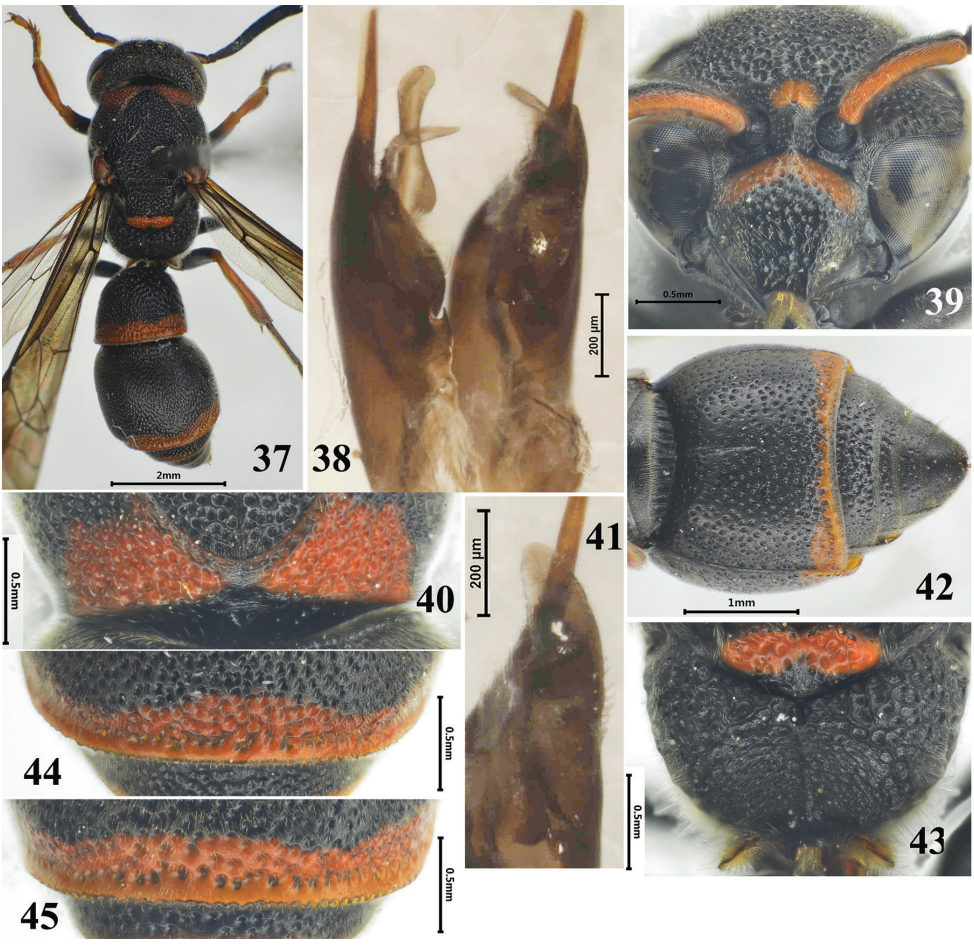
Etymology. The specific name *tenuilamellatus* is derived from two Latin words: *tenuis* (= narrow) and *lamellatus* (= lamella), which refers to metasomal tergum II with a narrow apical lamella.

Stenodynerus baronii **Giordani Soika, 1975, new record**

Figs 37–44

Stenodynerus baronii Giordani Soika, 1975: 387; 1994: 133, 137.

Material examined. 1♀2♂♂, China, Tibet Autonomous Region, Nyingchi City, Medog County, Medog Town, 27.VII.2014, Tingjing Li.



Figures 37–45. *Stenodynerus baronii*, **45** *Stenodynerus similibaronii*. **37, 39–40, 42–45** female, **38, 41** male **37** habitus (dorsal view) **38** genitalia (ventral view) **39** clypeus **40** anterior surface of pronotum **41** volsella (ventral view) **42** metasomal (ventral view) **43** metanotum and propodeum **44** apex of metasomal tergum II **45** apex of metasomal tergum II.

Diagnosis. A basal band of clypeus ferruginous (Fig. 39), with moderate punctures, its width more than length; anterior surface of pronotum almost vertical, with few small punctures, median foveae small and V-shaped, a few short transverse carinae above median foveae, pronotal carina interrupted medially (Fig. 40); propodeal shelf almost obsolete, propodeal concavity with a long median longitudinal carina (Fig. 43); punctures on apex of metasomal tergum II strongly dense, deep and irregular (Fig. 44); and sternum II with a long median longitudinal furrow basally (Fig. 42); male genitalia as in Fig. 38, volsella with rounded apically, penis valve rounded apically.

Distribution. China (new record: Tibet), Bhutan.

***Stenodynerus bluethgeni* van der Vecht, 1971, new record**
Figs 46–50

Odynerus pictus Herrich-Schaeffer, 1839: 13, 32.
Odynerus dentisquama: Morawitz 1895: 462.
Euodynerus dentisquama: Blüthgen 1938 (1937): 281.
Nannodynerus dentisquama: Blüthgen 1952: 2; 1961: 107, 111; Blüthgen and Königsmann 1969: 928.
Stenodynerus dentisquama: Giordani Soika 1970: 110.
Stenodynerus bluethgeni van der Vecht, 1971: 131; van der Vecht and Fischer 1972: 65; Gusenleitner 1981: 217, 221.

Material examined. 3♀♀1♂, China, Shaanxi Prov., Ankang City, Jianming Town, 16.VIII.2012, Xin Zhou & Cheng Yang; 1♀, China, Jilin Prov., Yanji City, Xiaoying Town, Mingzhu Village, 3.VII.2012, Ju You & Yuan Bai.

Diagnosis. Body with pale yellow spots (Figs 46–50). Cephalic fovea distinct, width less than the distance between posterior ocelli; clypeus black, medially convex (Fig. 46); anterior surface of pronotum almost vertical, with a few small punctures, median foveae V-shaped, pronotal carina complete (Fig. 48); propodeal shelf absent, propodeal concavity with a very short median longitudinal carina (Fig. 47); metasomal tergum II with very small and shallow punctures, without a distinct apical lamella (Fig. 50); sternum II black except lateral surface, without a median longitudinal furrow basally, and its anterior surface sloping (Fig. 49).

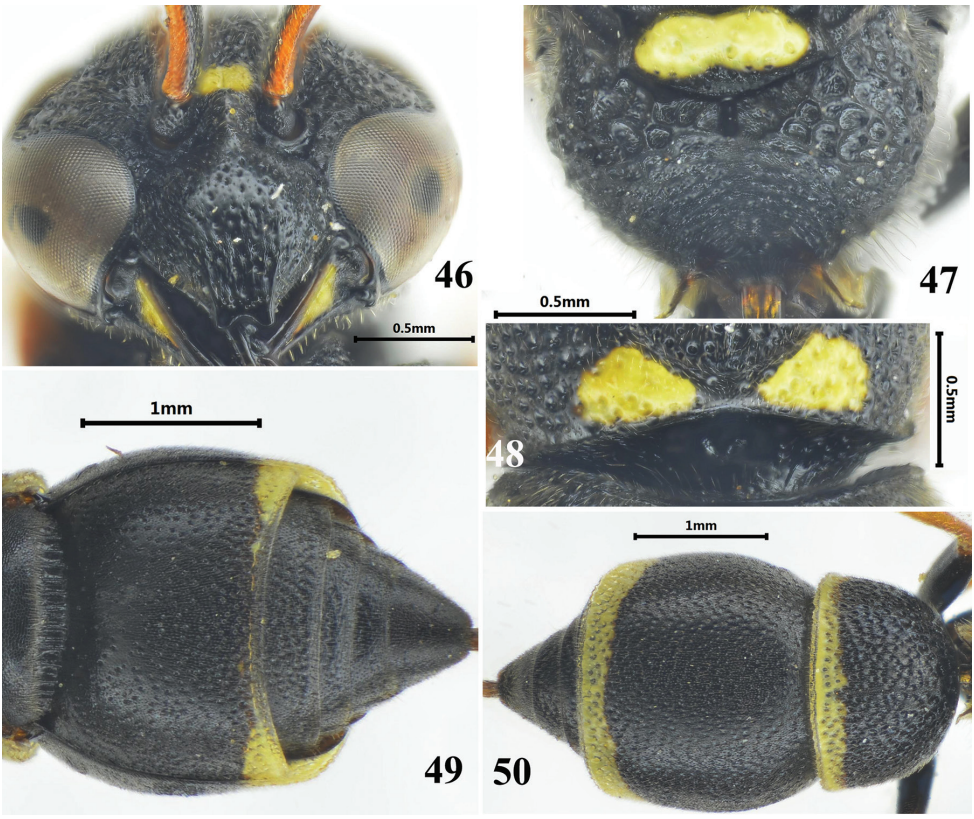
Distribution. China (new record: Jilin, Shaanxi), Netherlands, Belgium, Germany, France, Spain, Italy, Switzerland, Austria, Hungary, Czechoslovakia, Belarus, Russia, Serbia, Bulgaria, Albania, Greece, Cyprus, Turkey, Iran.

***Stenodynerus nepalensis* Giordani Soika, 1985, new record**
Figs 51–55

Stenodynerus nepalensis Giordani Soika, 1985: 37, 40; 1994: 135, 143; Gusenleitner 1987: 255; 2001b: 659.

Material examined. 5♀♀5♂♂, China, Yunnan Prov., Diqing Zang Autonomous Prefecture, Deqin County, Fushan Town, 22.VII.2014, Tingjing Li; 3♀♀5♂♂, China, Yunnan Prov., Diqing Zang Autonomous Prefecture, Deqin County, Yunling Town, 21.VII.2014, Tingjing Li.

Diagnosis. Clypeus with strong punctures, width somewhat more than length (Fig. 51); anterior surface of pronotum vertical, with few punctures, median foveae V-shaped, pronotal carina interrupted medially (Fig. 52); propodeal shelf absent (Fig. 54); metasomal tergum II without a distinct apical lamella, punctures on apex deep,



Figures 46–50. Female of *Stenodynerus bluethgeni*. **46** clypeus **47** metanotum and propodeum **48** anterior surface of pronotum **49** metasomal (ventral view) **50** metasomal (dorsal view).

dense and irregular (Fig. 55); sternum II with a long median longitudinal furrow basally, and its anterior surface sloping (Fig. 53).

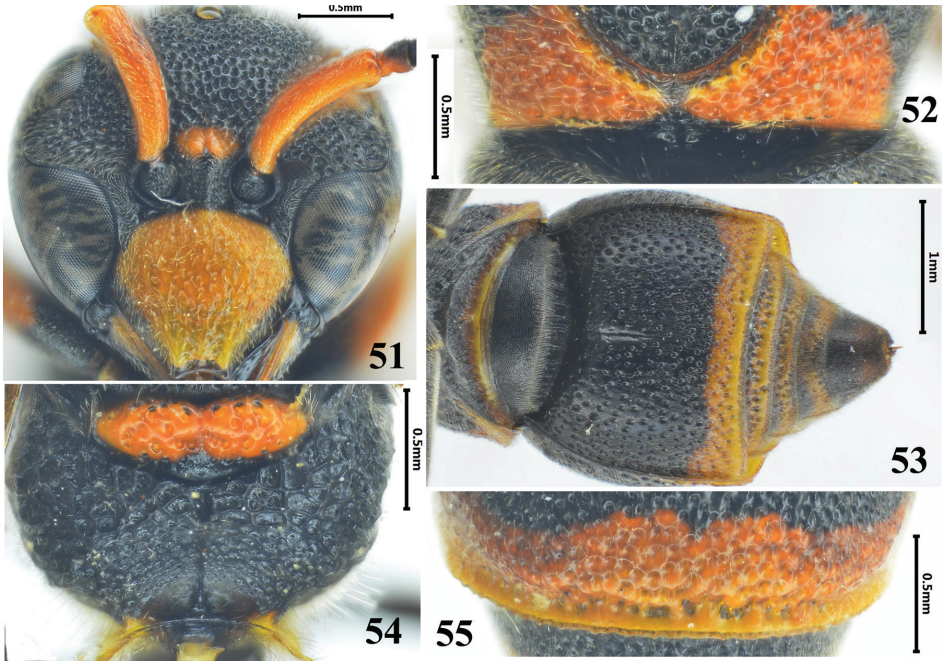
Distribution. China (new record: Yunnan), Nepal, India, Thailand.

Stenodynerus pullus Gusenleitner, 1981, new record

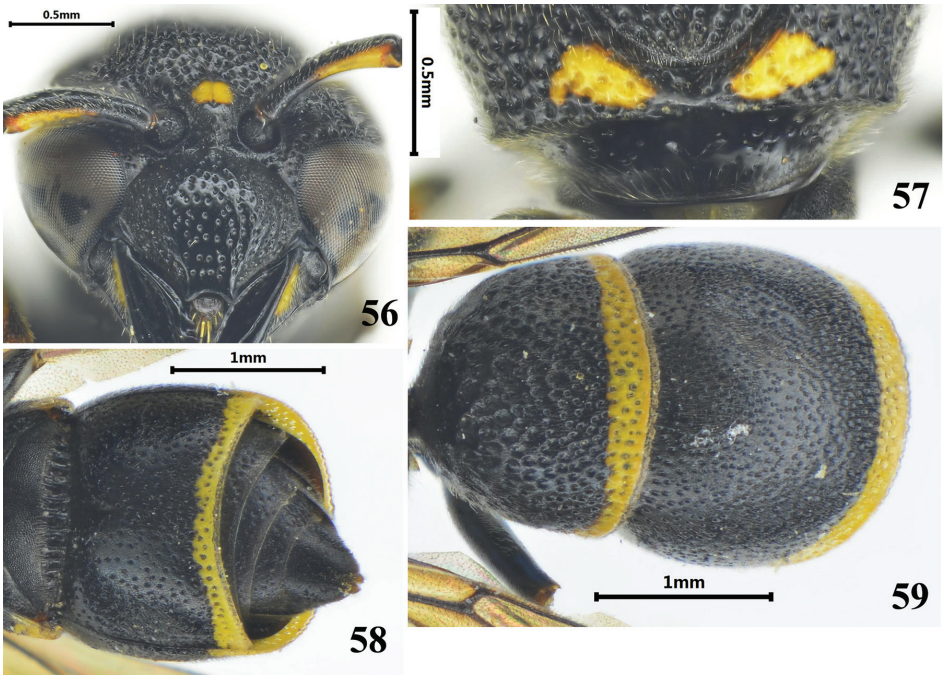
Figs 56–59

Stenodynerus pullus Gusenleitner, 1981: 209, 220, 246; Kim 1999: 348, 352; Kim and Yamane 2004: 240, 260–262.

Material examined. 2♀♀, China, Inner Mongolia Autonomous Region, Helan Mountain, Gulabenxiaosong Hills, 30.VII.2010, Zejian Li & Junzhe Xue; 1♂, China, Inner Mongolia Autonomous Region, Helan Mountain, Shuimogou, 27.VII.2010, Fangzhou Ma.



Figures 51–55. Female of *Stenodynerus nepalensis*. **51** clypeus **52** anterior surface of pronotum **53** metasomal (ventral view) **54** metanotum and propodeum **55** apex of metasomal tergum II.



Figures 56–59. Female of *Stenodynerus pullus*. **56** clypeus **57** anterior surface of pronotum **58** metasomal (ventral view) **59** metasomal (dorsal view).

Diagnosis. Cephalic fovea obsolete; clypeus black, medially convex, with small punctures (Fig. 56); pronotal dorsum with a pair of spots, anterior surface almost vertical, with a few small punctures, median foveae V-shaped, pronotal carina complete (Fig. 57); propodeum without shelf, propodeal concavity with a very short median longitudinal carina; metasomal tergum II without a distinct apical lamella (Fig. 59); sternum II with a very short median longitudinal furrow basally, and its anterior surface sloping (Fig. 58).

Distribution. China (new record: Inner Mongolia), Turkey, Russia, Mongolia, Korea.

Stenodynerus tergitus Kim, 1999, new record

Figs 60–62

Stenodynerus tergitus Kim, 1999: 349, 352; Kim and Yamane 2004: 238-239, 250.

Material examined. 1♀3♂♂, China, Shaanxi, Prov., Weinan City, Luonan County, Mantoushan, 8.VIII.2012, Xin Zhou & Cheng Yang.

Diagnosis. Cephalic fovea small and shallow, width less than the distance between posterior ocelli; clypeus black, medially convex, its width somewhat more than length; anterior surface of pronotum sloping, with a few small punctures, median foveae V-shaped, prontoal carina complete (Fig. 60); tergum II with a broad reflex lamella apically, deep and dense punctures forming a broad transverse groove on the base of lamella (Fig. 61); sternum II with a median longitudinal furrow basally, and its anterior surface sloping (Fig. 62).

Distribution. China (new record: Shaanxi), Korea.

Stenodynerus chinensis chinensis (de Saussure, 1863)

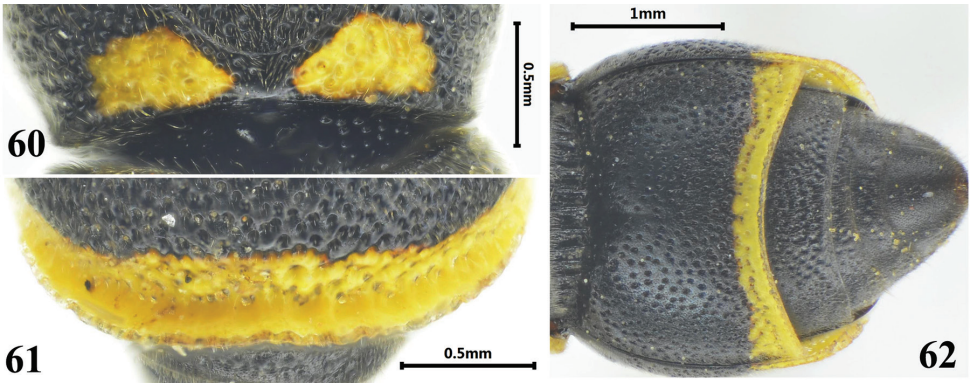
Figs 63–68

Odynerus chinensis de Saussure, 1863: 230; von Schulthess 1934: 91; van der Vecht 1967: 32; Opinion 1970: 187, 189–191.

Stenodynerus chinensis: van der Vecht and Fischer 1972: 65; Giordani Soika 1972: 105; Gusenleitner 1981: 220, 289; Li 1985: 138; Yamane and Gusenleitner 1996: 43-44.

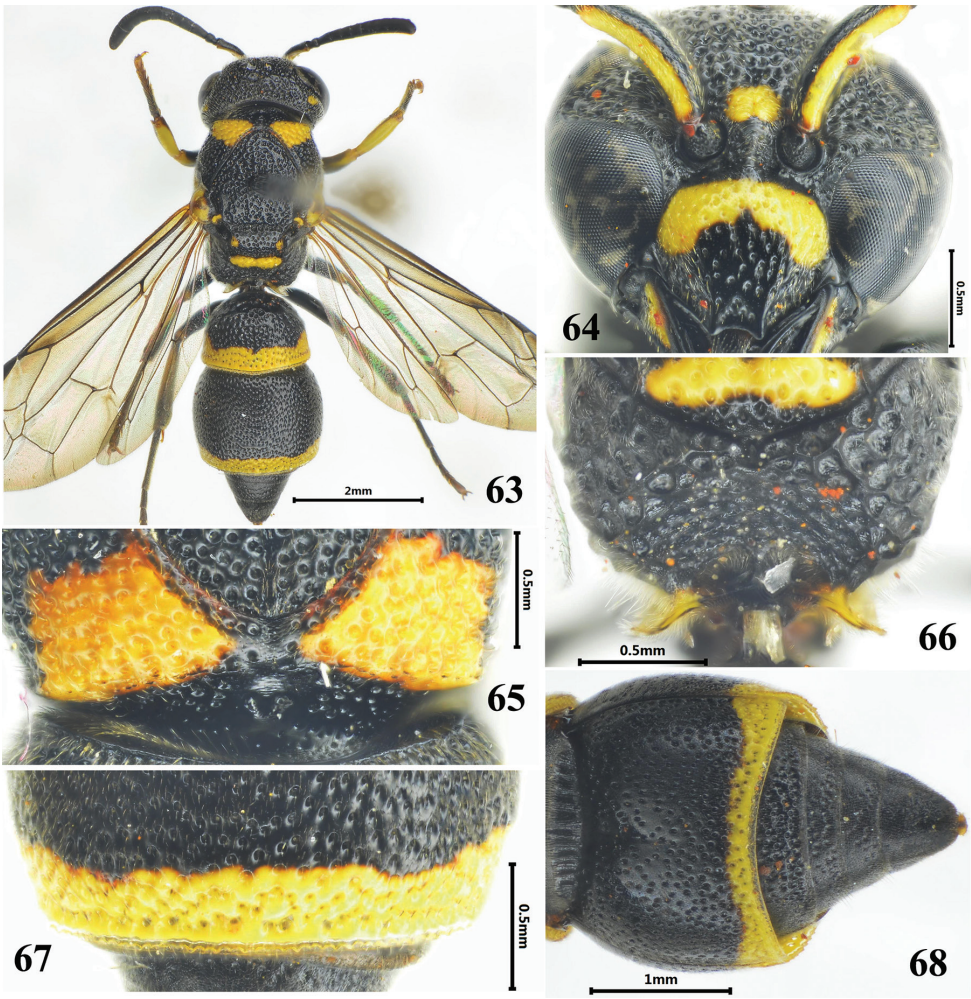
Stenodynerus chinensis chinensis: Giordani Soika 1986: 124; Kim and Yamane 2004: 239, 256-257.

Material examined. 2♀♀, China, Henan Prov., Sanmenxia City, Lushi County, Wulichuan Town, 9.VIII.2012, Ju You & Yuan Bai; 4♀♀, China, Henan Prov., NanYang City, Yuanyang County, Sangping Town, Huangsha Village; 5♀♀1♂, China, Shaanxi Prov., Ankang City, Langao County, Huanli Town, 7.VIII.2015, Zhenxia Ma & Yan



Figures 60–62. Female of *Stenodynerus tergitus*. **60** anterior surface of pronotum **61** apex of metasomal tergum II **62** metasomal (ventral view).

Peng; 2♀♀3♂♂, China, Shaanxi Prov., Ankang City, Zhenping County, Zengjia Town, 10.VIII.2015, Zhenxia Ma & Yan Peng; 4♀♀2♂♂, China, Shaanxi Prov., Weinan City, Hua County, Jindui Village 7.VIII.2012, Xin Zhou & Cheng Yang; 3♀♀1♂, China, Shaanxi Prov., Baoji City, Mei County, Huaiya Town, 16.VIII.2015, Zhenxia Ma & Yan Peng; 1♀4♂♂, China, Shannxi Prov., Xian City, Hongqing Town, 19.VIII.2015, Zhenxia Ma & Yan Peng; 7♀♀1♂, China, Shaanxi Prov., Baoji City, Mei County, Jinqu Town, 14.VIII.2015, Zhenxia Ma & Lingquan Zeng; 14♀♀7♂♂, China, Shaanxi Prov., Baoji City, Mei County, Qinghua Town, Jinjiazhuang Village, 15.VIII.2015, Zhenxia Ma & Yan Peng; 8♀♀18♂♂, China, Sichuan Prov., Leshan City, Emeishan County, Huangwan Town, Miaoergang Village, 10.VIII.2011, Tingjing Li; 3♀♀1♂, China, Sichuan Prov., Leshan City, Emeishan County, Longchi Town, Longchi Village, 12.VIII.2011, Tingjing Li & Zhenhu Wu; 3♀♀3♂♂, China, Sichuan Prov., Leshan City, Emeishan County, Zhanggou Village, 8.VIII.2011, Tingjing Li; 12♀♀3♂♂, China, Sichuan Prov., Chongzhou City, Tianshun Village, 17.VIII.2011, Tingjing Li & Zhenhu Wu; 2♀♀1♂, China, Sichuan Prov., Leshan City, Emeishan County, Dawei Town, 13.VIII.2011, Tingjing Li; 4♀♀3♂♂, China, Chongqing Municipality, Youyang County, Banqiao Town, Shuangqiao Village, 26.VIII.2012, Cheng Yang; 6♀♀3♂♂, China, Chongqing Municipality, Jiangjin, Heiwan Village, 23.VI.2012, Xin Zhou; 1♀2♂♂, China, Chongqing Municipality, Liangping County, Bishan Town, Xinyuan Village, 5.IX.2014, Chunfa Chen; 1♀2♂♂, China, Chongqing Municipality, Chengkou County, Bashan Town, Lianmen Village, 7.VIII.2015, Tingjing Li & Chunfa Chen; 1♀2♂♂, China, Chongqing Municipality, Chengkou County, Xianyi Town, Shuangqiao Village, 4.VIII.2015, Tingjing Li & Chunfa Chen; 3♀♀2♂♂, China, Chongqing Municipality, University Town, Xiyongtuanjie, 5.VII.2011, Xin Zhou; 7♀♀11♂♂, China, Chongqing Municipality, Chongqing Normal University, 10.VII.2015, Tingjing Li & Zhenxia Ma; 3♂♂, China, Guizhou Prov., Kaili City, Leishan County, Fangxiang Town, Pingxiang Village, 24.VI.2015, Tingjing Li & Yan Peng.



Figures 63–68. Female of *Stenodynerus chinensis chinensis*. **63** habitus (dorsal view) **64** clypeus **65** anterior surface of pronotum **66** metanotum and propodeum **67** apex of metasomal tergum II **68** metasomal (ventral view).

Diagnosis. Almost whole body covered with large and dense punctures, strongly sculptured (Fig. 63). Cephalic fovea small and shallow, width less than the distance between posterior ocelli; basal half of clypeus yellow, with sparse punctures (Fig. 64); anterior surface of pronotum sloping, with distinct and strong punctures, median foveae V-shaped (Fig. 65); propodeal shelf weak, posterior surface concave, with a median longitudinal carina in lower half (Fig. 66); metasomal tergum II without a distinct apical lamella, apex with deep punctures (Fig. 67); sternum II with a long median longitudinal furrow basally, and its anterior surface sloping (Fig. 68).

Distribution. China (Hebei, Sichuan; Shannxi, Henan, Yunnan, Chongqing, Guizhou, Taiwan).

Stenodynerus copiosus Gusenleitner, 2012

Stenodynerus copiosus Gusenleitner, 2012: 1132–1134.

Material examined. No specimens examined.

Diagnosis. Male: clypeus yellow, with small punctures, its width almost equal to length; pronotal carina interrupted medially; metasomal tergum II without a distinct apical lamella; sternum II with a median longitudinal furrow basally; female: unknown (Gusenleitner, 2012).

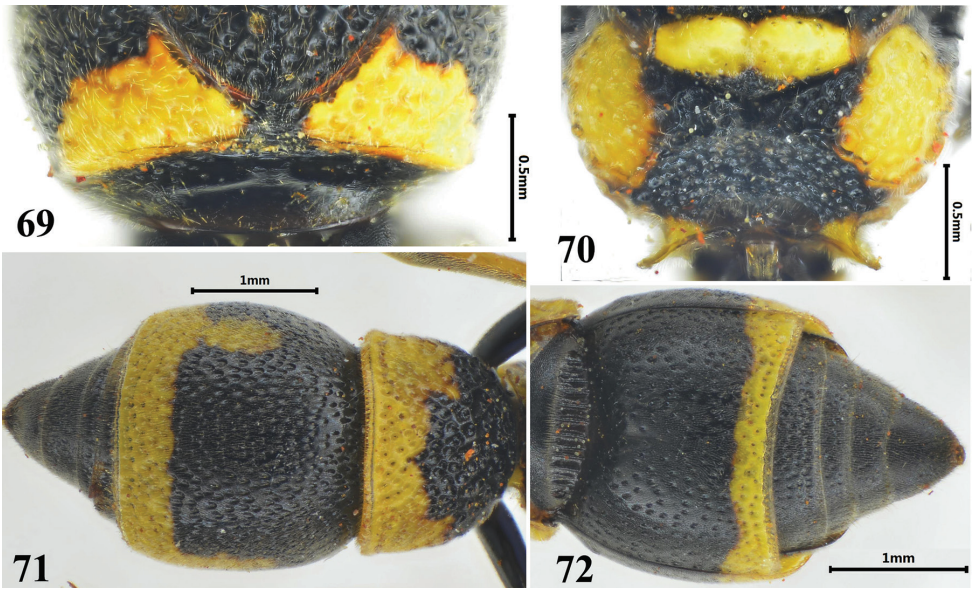
Distribution. China (Shanxi, Shaanxi).

Stenodynerus frauenfeldi (de Saussure, 1867)

Figs 69–72

Odynerus frauenfeldi de Saussure, 1867: 15; von Schulthess 1934: 91; Yasumatsu 1935: 225.
Odynerus nigriclypeatus Sonan, 1930: 356; Giordani Soika 1986: 124.
Odynerus apiciornatus: Yano 1932: 309.
Stenodynerus frauenfeldi: van der Vecht and Fischer 1972: 67; Giordani Soika 1972: 105; 1986: 124; 1994: 135, 152; Gusenleitner 1981: 220, 287; Kim 1999: 348, 350; Kim and Yamane 2004: 239, 251–252.

Material examined. 1♀2♂♂, China, Jilin Prov., Yanji City, Xiaoying Town, 4.VI.2104, Ju You & Yuan Bai; 2♀♀, China, Jilin Prov., Baishan City, Linjiang County, Naozhi Town, 7.VII.2012, Ju You & Yuan Bai; 3♀♀48♂♂, China, Shannxi Prov., Huayin City, Hua Mountain, 5.VIII.2012, Xin Zhou & Ju You; 5♀♀54♂♂, China, Shannxi Prov., Ankang City, Jianming Town, 15.VIII.2012, Xin Zhou & Cheng Yang; 2♀♀3♂♂, China, Shannxi Prov., Shangluo City, Luonan County, Mantoushan, 8.VIII.2012, Ju You & Yuan Bai; 3♂♂, China, Shannxi Prov., Hanzhong City, Liuba County, Jiangkou Town, 18.VIII.2012, Xin Zhou & Cheng Yang; 42♀♀11♂♂, China, Shanxi Prov., Baoji City, Mei County, Jinqu Town, 14.VIII.2015, Zhenxia Ma & Yan Peng; 14♀♀11♂♂, China, Shannxi Prov., Baoji City, Mei County, Qinghua Town, Jinjiazhuang Village, 15.VIII.2015, Zhenxia Ma & Yan Peng; 34♀♀3♂♂, China, Shannxi Prov., Baoji City, Mei County, Huaiya Town, 16.VIII.2015, Zhenxia Ma & Yan Peng; 4♀♀1♂♂, China, Shannxi Prov., Ankang City, Zhenping County, Zengjia Town, 10.VIII.2015, Zhenxia Ma & Yan Peng; 4♂♂, China, Chongqing Municipality, Chengkou County, Xianyi Village, Tingjing Li & Chunfa Chen; 1♀1♂,



Figures 69–72. Female of *Stenodynerus frauenfeldi*. **69** anterior surface of pronotum **70** metanotum and propodeum **71** metasomal (dorsal view) **72** metasomal (ventral view).

China, Guizhou Prov., Tongren City, Jiang kou County, Minxiao Town, 29.VI.2015, Tingjing Li & Yan Peng; 1♀1♂, China, Guizhou Prov., Tongren City, Jiang kou County, Heiwan Villiage, 28.VI.2015, Tingjing Li & Yan Peng; 1♀22♂♂, China, Sichuan Prov., Dazhou City, Chengbei Town, Hongqi Village, 7.VI.2013, Ju You; 3♀♀49♂♂, China, Sichuan Prov., Dazhou City, Chengbei Town, Qingfeng Village, 4.VI.2013, Ju You; 7♀♀19♂♂, China, Sichuan Prov., Dazhou City, Maanshan, 10.VI.2013, Ju You; 3♀♀11♂♂, China, Sichuan Prov., Dazhou City, 8.VI.2013, Ju You; 17♂♂, China, Sichuan Prov., Chengdu City, Dujiangyan, Daguan Town, 16.VIII.2011, Tingjing Li & Yuan Bai; 3♀♀, China, Sichuan Prov., Leshan City, Emeishan County, Gaoqiao Town, Zhanggou Village, 8.VIII.2012, Tingjing Li; 3♀♀2♂♂, China, Sichuan Prov., Chongzhou City, Tianshun Village, 17.VIII.2011, Tingjing Li; 4♀♀8♂♂, China, Jiangxi Prov., Fuzhou City, Lichuan County, Hufang Villiage, 21.VI.2104, Tingjing Li.

Diagnosis. Body strongly sculptured, with large and strong punctures, and extensive spots (Figs 69–72). Cephalic fovea almost obsolete; anterior surface of pronotum vertical, median foveae shallow and slightly U-shaped, a few long parallel transverse carinae above median foveae, pronotal carina complete (Fig. 69); propodeal shelf weak (Fig. 70); metasomal tergum II without a distinct apical lamella (Fig. 71); median longitudinal furrow on metasomal sternum II basally weak, even obsolete, and its anterior surface sloping (Fig. 72).

Distribution. China (Sichuan, Jilin, Shaanxi, Chongqing, Guizhou, Jiangxi), Russia, Korea, Japan.

***Stenodynerus funebris* (André, 1884)**
Figs 73–76

Odynerus funebris André, 1884: 729; Blüthgen 1955: 412.
Odynerus limbonatatus: Kostylev, 1940: 28.
Stenodynerus funebris: van der Vecht and Fischer 1972: 67; Gusenleitner 1981: 219, 243; Kim 1999: 347, 349, 350; Kim and Yamane 2004: 239, 255.

Material examined. 1♀1♂, China, Jilin Prov., Yanji City, Xiaoying Town, Minzhu Village, 3.VII.2012, Xin Zhou & Ju You.

Diagnosis. Body obviously black (Fig. 73), only with the following spots yellow: mandibular basally, scape ventrally, inter-antennal spot, a minute post-ocular spot, pronotum sometimes with a pair of small spots, apical bands on metasomal terga I–II and sternum II, a long band on fore tibiae dorsally; cephalic fovea small and shallow, width less than the distance between posterior ocelli; clypeus medically convex, apex moderately emarginated (Fig. 74); anterior surface of pronotum almost vertical, with V-shaped median foveae, pronotal carina complete (Fig. 75); propodeal shelf developed, posterior surface concave, with a very short median longitudinal carina in lower portion (Fig. 76); median longitudinal furrow on metasomal sternum II basally weak, even obsolete, and its anterior surface sloping.

Distribution. China (Shanxi, Jilin), Korea, Russia.

***Stenodynerus incurvitus* Gusenleitner, 2003**

Stenodynerus incurvitus Gusenleitner, 2003: 855.

Material examined. No specimens examined.

Diagnosis. Clypeus yellow basally, with short setae, its width equal to its length; cephalic fovea comparatively larger, width more than the distance between posterior ocelli; propodeal concavity almost smooth; metasomal tergum II without a distinct apical lamella, punctures on apex deep; sternum II with a median longitudinal furrow basally, and its anterior surface sloping (Gusenleitner 2003).

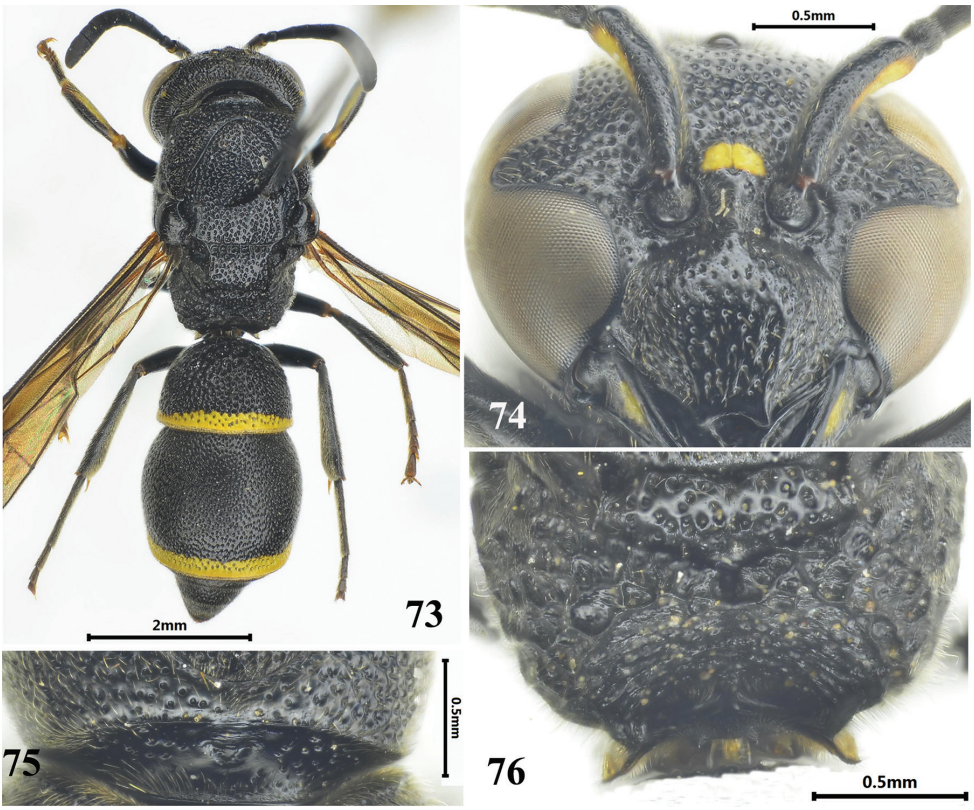
Distribution. China (Taiwan).

***Stenodynerus morawitzi* Kurzenko, 1977**

Stenodynerus morawitzi Kurzenko, 1977: 554; Gusenleitner 1981: 219, 266.

Material examined. No specimens examined.

Diagnosis. Clypeus yellow, with small punctures, its width somewhat more than length, apex deeply emarginated; prontoal carina interrupted medially; tergum II with



Figures 73–76. Female of *Stenodynerus funebris*. **73** habitus (dorsal view) **74** clypeus **75** anterior surface of pronotum **76** metanotum and propodeum.

a broad reflex lamella apically. In male, metasomal terga I–VII and sterna II–III with yellow apical bands (Gusenleitner 1981).

Distribution. China (Inner Mongolia).

Stenodynerus morbillosus Giordani Soika, 1979

Stenodynerus morbillosus Giordani Soika, 1979: 250; Gusenleitner 1981: 220, 286.

Material examined. No specimens examined.

Diagnosis. Larger species, body length generally more than 10 mm. Clypeus yellow; pronotal carina less developed; metasomal tergum II without a distinct apical lamella; sternum II with a short median longitudinal furrow basally (Giordani Soika 1979; Gusenleitner 1981).

Distribution. China (northeast).

***Stenodynerus nudus* (Morawitz, 1889)**

Lionotus nudus Morawitz, 1889: 164; Morawitz 1895: 463; von Schulthess 1934: 91.
Nannodynerus nudus: Blüthgen 1942: 320.
Stenodynerus nudus: van der Vecht and Fischer 1972: 68; Gusenleitner 1981: 219, 271.

Material examined. No specimens examined.

Diagnosis. Clypeus yellow except margin, with sparse and shallow punctures, its width much more than its length; metasomal tergum II without a distinct apical lamella; anterior surface of metasomal sternum II vertical. Metasomal terga I–V and sterna II–III with yellow apical bands (Gusenleitner 1981).

Distribution. China (Inner Mongolia), Turkmenistan, Kazakhstan, Mongolia.

***Stenodynerus pappi luteifasciatus* Kim & Yamane, 2004**

Stenodynerus pappi luteifasciatus Kim & Yamane, 2004: 235, 238, 245.

Material examined. No specimens examined.

Diagnosis. The species differs from *S. p. pappi* as follows: body with extensive orange-yellow spots; a broad band on pronotal dorsum and almost entire metanotum orange-yellow; punctures on anterior surface of pronotum sparser, apical band on tergum I broader and reflex apical lamella of metasomal tergum II narrower than the corresponding parts in *S. p. pappi* (Kim and Yamane 2004).

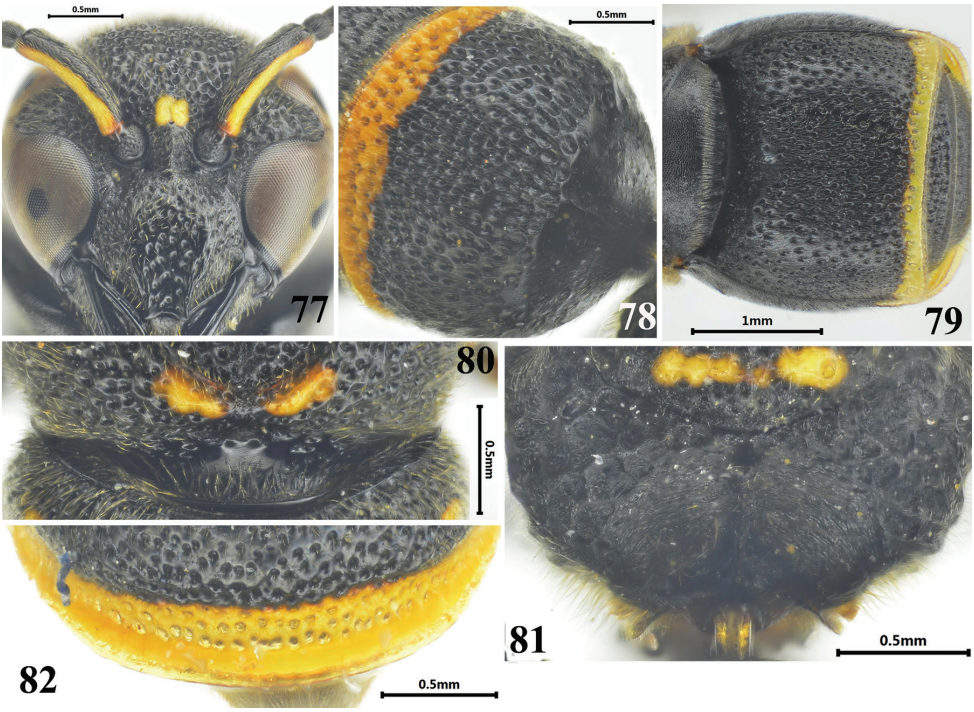
Distribution. China (Taiwan).

***Stenodynerus pappi pappi* Giordani Soika, 1976**
Figs 77–82

Stenodynerus pappi Giordani Soika, 1976: 290–291; Gusenleitner 1981: 219, 298; Kim 1999: 204; Kim and Yamane 2004: 237, 242.
Parancistrocerus ussuriensis Kurzenko, 1982 (1981): 117–122.

Material examined. 2♀♀, China, Shaanxi prov., Baoji City, Taibai County, Taochuan town, 12.VIII.2015, Zhenxia Ma & Yan Peng; 1♀, China, Shaanxi prov., Yanan City, Huanglong County, Shibao Town, 2.VIII.2012, Xin Zhou; 1♀, China, Shaanxi prov., Weinan City, Hua County, Jindui Town, 7.VIII.2012, Ju You & Yuan Bai; 1♀, China, Chongqing, Shizhu County, Huangshui Town, 12.VIII.2008, Bin Chen & Tingjing Li.

Diagnosis. Cephalic fovea small and shallow, width less than the distance between posterior ocelli; clypeus black, sparsely punctate, with sparse setae, its width more than length (Fig. 77); anterior surface of pronotum sloping, with distinct punctures and



Figures 77–82. Female of *Stenodynerus pappi pappi*. **77** clypeus **78** metasomal tergum I (dorsal view) **79** metasomal (ventral view) **80** anterior surface of pronotum **81** metanotum and propodeum **82** apex of metasomal tergum II.

a pair of round contiguous median foveae, the interspace between these two median foveae less than one diameter, pronotal carina obsolete (Fig. 80); propodeal shelf developed, posterior surface concave, with a long median longitudinal carina (Fig. 81); anterior surface of metasomal tergum I vertical, almost impunctate, and with a median longitudinal carina in upper half (Fig. 78); metasomal tergum II with a broad reflex lamella apically, dense and deep punctures forming a wide transverse groove on the base of lamella (Fig. 82); sternum II with a short median longitudinal furrow basally, and its anterior surface sloping (Fig. 79).

Distribution. China (Zhejiang, Jiangxi, Shaanxi, Chongqing, Taiwan), Korea.

Stenodynerus taiwanus Kim & Yamane, 2004

Stenodynerus taiwanus Kim & Yamane, 2004: 235, 237, 241.

Material examined. No specimens examined.

Diagnosis. Anterior surface of pronotum distinctly punctate, with a pair of round contiguous median foveae, pronotal carina weak; propodeal shelf absent, posterior surface

concave, with a median longitudinal carina lost in upper half; anterior surface of metasomal tergum I almost impunctate, dorsal surface with weak and sparse punctures, the interspaces between punctures more than one diameter. Whole body with sparse and long setae (Kim and Yamane, 2004).

Distribution. China (Taiwan).

Key to the Chinese species of the genus *Stenodynerus*

The characters are applicable to both sexes unless the sex is specified.

1 Metasomal tergum II with a lamella apically (Figs 13, 29, 36, 61, 82) **2**

– Metasomal tergum II without a lamella apically (Figs 5, 44, 45, 50, 55, 59, 67, 71) **8**

2 Anterior surface of metasomal tergum I vertical, with few punctures and a median longitudinal carina in upper half (Figs 10, 26, 33, 78) **3**

– Anterior surface of metasomal tergum I with strong punctures, not vertical and somewhat rounded, without a median longitudinal carina **7**

3 Metasomal tergum II with a broad reflex lamella apically, the transverse groove on the base of lamella wider (Figs 13, 29, 82) **4**

– Metasomal tergum II with a narrow reflex lamella apically, the transverse groove on the base of lamella narrower (Fig. 36) .... ***S. tenuilamellatus* sp. n.**

4 In female, clypeus black (Fig. 77); in profile, anterior surface of metasomal sternum II sloping (Fig. 79) ..... ***S. pappi*, 5**

– In female, clypeus with yellow or ferruginous spots (Figs 8, 24); in profile, anterior surface of metasomal sternum II vertical (Figs 12, 28) **6**

5 Body with yellow spots; pronotum with a pair of small spots dorsally (Fig. 80), metanotum with a yellow band anteriorly (Fig. 81), tergum I with a narrower apical band (Fig. 78) ..... ***S. pappi pappi* Giordani Soika**

– Body with orange yellow spots; pronotal dorsum with a broad band, metanotum almost entire orange yellow, tergum I with a broader apical band (Kim and Yamane2004) ..... ***S. pappi luteifasciatus* Kim & Yamane**

6 Anterior surface of pronotum with distinct punctures, the interspace between median foveae less than one fovea diameter (Fig. 9); propodeal shelf developed (Fig. 11); anterior vertical surface of tergum I without a transverse striation (Fig. 10); sternum II with a very short median longitudinal furrow basally (Fig. 12) ..... ***S. reflexus* sp. n.**

– Anterior surface of pronotum with few punctures, the interspace between median foveae more than one fovea diameter (Fig. 25); propodeal shelf weak (Fig. 27); anterior vertical surface of tergum I with two transverse striations (Fig. 26); sternum II without a median longitudinal furrow basally (Fig. 28) ..... ***S. strigatus* sp. n.**

7 In female, clypeus yellow; in male, metasomal terga I–VII and sterna II–III with yellow apical bands (Giordani Soika 1981) ..... ***S. morawitzi* Kurzenko**

– In female, clypeus black; in male, metasomal terga I–II and sternum II with yellow apical bands ..... ***S. tergitus* Kim (new record)**

8 Larger species, body length generally more than 10 mm (Giordani Soika 1979; Giordani Soika 1981) ..... ***S. morbillosus* Giordani Soika**

– Smaller species, body length generally less than 10 mm **9**

9 Apical bands of metasomal terga I–V yellow or orange-yellow **10**

– Apical bands of metasomal terga I–II yellow or ferruginous **11**

10 In profile, anterior surface of metasomal sternum II sloping (Fig. 53)..... ..... ***S. nepalensis* Giordani Soika (new record)**

– In profile, anterior surface of metasomal sternum II vertical (Gusenleitner 1981)..... ***S. nudus* (Morawitz)**

11 Propodeal concavity almost smooth (Gusenleitner 2003) .... ***S. incurvitus* Gusenleitner**

– Propodeal concavity with long and transverse rugae..... 12

12 Anterior surface of pronotum with a pair of round contiguous median foveae; anterior surface of metasomal tergum I almost impunctate (Kim and Yamane 2004)..... ***S. taiwanus* Kim & Yamane**

– Pronotal median foveae contiguous and forming U-shaped or V-shaped; anterior surface of metasomal tergum I with strong punctures (Figs 5, 59, 71) **13**

13 Pronotal median foveae shallow and slightly U-shaped (Fig. 69)..... ..... ***S. frauenfeldi* (de Saussure)**

– Pronotal median foveae distinct and V-shaped (Figs 3, 18, 40, 48, 57, 65, 75) **14**

14 Clypeus with yellow or ferruginous spots; metasomal sternum II with a long median longitudinal furrow basally..... **15**

– Clypeus black; metasomal sternum II with a very short median longitudinal furrow basally, sometimes obsolete **18**

15 Body with large and dense punctures, strongly sculptured (Fig. 63); anterior surface of pronotum sloping, and with distinct and strong punctures (Fig. 65)..... ***S. chinensis chinensis* (de Saussure, 1863)**

– Body with comparatively smaller punctures, moderately sculptured; anterior surface of pronotum almost vertical, with few punctures (Figs 3, 18, 40)... **16**

16 Clypeus strongly punctate (Fig. 2); apex of ocular sinus pale ferruginous; pronotal carina complete ..... ***S. ningliangensis* sp. n.**

– Clypeus moderately punctate (Figs 16, 39); apex of ocular sinus black; pronotal carina interrupted medially **17**

17 Anterior surface of pronotum with wider V-shaped median foveae (Fig. 18); apex of metasomal tergum II with somewhat shallower and sparser punctures (Fig. 45); in male, volsella slightly truncate apically (Fig. 20).... ***S. similibaronii* sp. n.**

– Anterior surface of pronotum with narrower V-shaped median foveae (Fig. 40); apex of metasomal tergum II with strongly deep and dense punctures (Fig. 44); in male, volsella with rounded apically (Figs 38, 41) .... ***S. baronii* Giordani Soika (new record)**

18 Body with pale yellow spots; metasomal sternum II black except lateral surface (Fig. 49); metasomal tergum II slightly punctate (Fig. 50); sternum II without a median longitudinal furrow basally (Fig. 49)..... .....***S. bluethgeni* van der Vecht (new record)**

– Body with yellow spots; metasomal sternum II with a narrow apical band (Fig. 58); metasomal tergum II strongly punctate (Figs 59, 73); sternum II with a very short median longitudinal furrow basally (Fig. 58) **19**

19 Anterior surface with a few short transverse carinae above median foveae (Fig. 75); propodeal shelf developed (Fig. 76) .....***S. funebris* (André)**

– Anterior surface without a transverse carina above median foveae (Fig. 57); propodeal shelf obsolete..... ***S. pullus* Gusenleitner (new record)**

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RESEARCH ARTICLE

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Notes on the genus *Episcaphium* Lewis (Coleoptera, Staphylinidae, Scaphidiinae) with description of a new species from China

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Abstract

A new *Episcaphium* species collected from Yunnan Province of China is described as *E. zhuxiaoyui* **sp. n.**, and its diagnostic characters are illustrated. A new province record of *E. haematoides* is reported. A key to the *Episcaphium* species recorded from China is provided.

Keywords

Coleoptera, Staphylinidae, *Episcaphium*, new species, China

Introduction

Episcaphium Lewis, 1893 is a small Asian genus of Scaphidiinae. Up to the present, eleven species of the genus have been known from the world, and six species have been known from China: *E. catenatum* Löbl, 1999 and *E. watanabei* Löbl, 2002 from Sichuan, *E. strenuum* Löbl, 1999 and *E. haematoides* Löbl, 1999 from Yunnan, *E. changchini* Sheng & Gu, 2009 from Shaanxi, and *E. dabashanum* Sheng & Gu, 2009 from Chongqing.

Recently, we examined some specimens of the genus, among them a new species and a new province record.

Material and methods

Specimens were mainly collected by hand from decayed wood and fungi in broad-leaved forests and killed with ethyl acetate. For examination of the male genitalia, the last two abdominal segments were detached from the body after softening the specimens in hot water. The aedeagi were mounted in Euparal (Chroma Gesellschaft Schmidt, Koengen, Germany) on plastic slides. Photos of the aedeagi were taken with a Canon G9 camera attached to an Olympus SZX 16 stereoscope; habitus photos were taken with a Canon macro photo lens MP-E 65 mm attached to a Canon EOS7D camera and stacked with Zerene Stacker (http://www.zerenesystems.com/cms/stacker).

The type specimens treated in this study are deposited in the following public and private collections:

NMPC National Museum, Praha, Prague, Czech Republic
SHNU Department of Biology, Shanghai Normal University, P. R. China

Taxonomy

***Episcaphium zhuxiaoyui* sp. n.**
http://zoobank.org/1DE9B6EA-C85E-4506-8123-BB6F3CDE9DA4
Figs 1, 2, 5–7, 11

Type material. Holotype. China: Yunnan: ♂, glued on a card with labels as follows: "China, Yunnan Prov., Gongshan County, Heiwadi, alt. 2000 m, 7–10 June 2009, Zhu Jian-Qing & Zhu Xiao-Yu leg. " "Holotype / *Episcaphium zhuxiaoyui* / Tang, Tu & Li" [red handwritten label] (SHNU) **Paratypes.** 5♂♂5♀♀, same data as the holotype (SHNU); 1♂, Deqin County, Nagu Vill., alt. 2250 m, 11.VII.2010, Wen-Xuan Bi leg. (SHNU); 7♂♂5♀♀, Lushui County, Laowo, Fenshuiling, alt. 2250 m, 7.VII.2010, Wen-Xuan Bi leg. (SHNU)

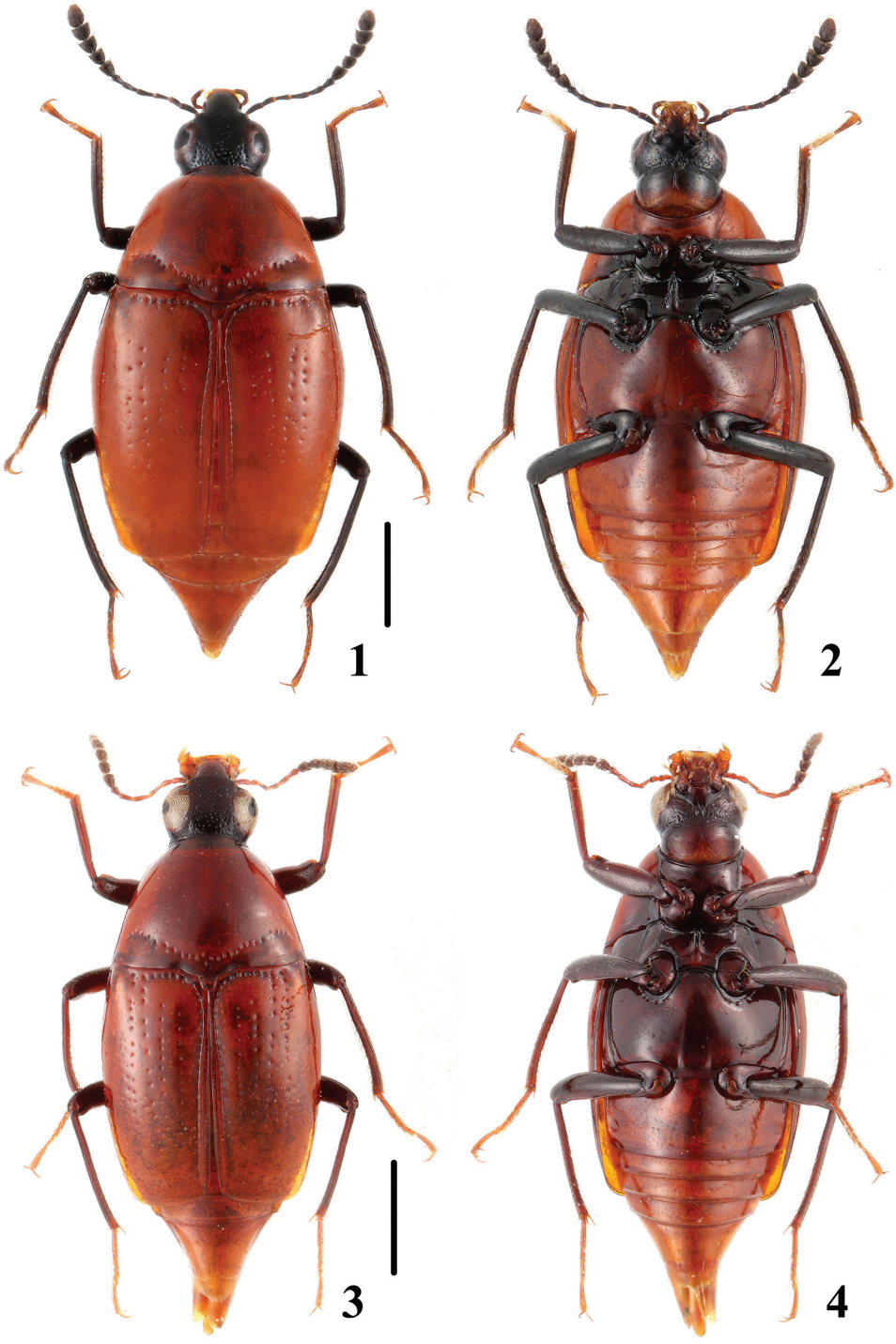
Description. Body length: 5.3–5.9 mm. Pronotum width: 2.0–2.1 mm.

Head black, except for the reddish mouthparts. Inner basal parts of prohypomera, legs including coxal cavity and mesosternum blackish. Other parts reddish.

Frons at narrowest point 0.42–0.44 mm wide. Head coarsely and very densely punctate, punctation coarse on vertex and fine near eyes. Intervals between punctures distinctly smaller than diameter of punctures. Between eyes with a pair of impunctate patches. Labium smooth. Gular striae impressed, groove-like basally.

Pronotum with antebasal puncture row usually interrupted at middle (rarely uninterrupted), impressed laterally. Discal punctures fine and sparse.

Elytra with shallow apical impression and indistinct humeral protuberance; disc with four discal puncture rows consisting of rather coarse punctures anteriorly gradually becoming finer posteriad. All rows start at about basal 2/11 of elytron and end blurrily where puncture rows mix with apical disc punctures. Punctation fine between



Figures 1–4. Adult habitus of *Episcaphium*. **1, 2** *E. zhuxiaoyui* sp. n. **3, 4** *E. semirufum* Lewis. Scales = 1 mm.

Figures 5–10. 5–7 *E. zhuxiaoyui* sp. n. **5** aedeagus in lateral view **6** aedeagus in dorsal view **7** details of internal sac **8–10** *E. semirufum* Lewis **8** aedeagus in lateral view **9** aedeagus in dorsal view **10** details of internal sac. Scales = 0.25 mm.

Figures 11, 12. 11 Living *E. zhuxiaoyui* sp. n. on fungus **12** Collector Mr. Zhu Xiao-Yu and log with fungus. Photo by Mr. Jian-Qing Zhu.

discal series of punctures and coarse in apical impressions. Mesoventral process with raised, ridge-like edges, and impressed in middle.

Metaventrite finely and sparsely punctate, lacking microsculpture, with medio-apical impression shallow, narrowed anteriorly, and carinate laterally.

Punctation of abdominal sternites very fine and very sparse. Micropunctures absent.

Male sexual characters. Segments 1 to 3 of protarsi slightly widened with dense setae on ventral side. Aedeagus (Figs 5, 6) with median lobe with apical portion inflexed in lateral view. Basal process small, slightly prominent. Parameres slightly sinuate in lateral view. Internal sac (Fig. 7) with a pair of comma-like sclerotized rods.

Distribution. China (Yunnan).

Remarks. This new species is similar to the variety of *E. semirufum* Lewis, 1893 with dark head described from Japan (Figs 3, 4, 8–10), but it may be distinguished from the latter by the different coloration of the ventral side, a pronotum with the antebasal puncture row usually interrupted at middle, and the formation of the discal puncture rows on the elytra: the two outer rows are distinctly separated from the basal puncture row, while in *E. semirufum*, they fuse with the basal puncture row. The new species is distinguished from all the other species by its coloration.

Etymology. This species is named in honor of Mr. Xiao-Yu Zhu who collected some specimens of the new species.

Biological notes. This species was found gathering on an unknown fungus on a huge rotten log across stream, and was observed to become active when night fell (Figs 11, 12).

Episcaphium haematoides Löbl, 1999

Material examined. China: Gansu: 1♂, Lazikou Valley, 2020–2510 m, 34°09.9–10.1'N, 103°48.2–51.9'E, 28.VI.2005, J. Hájek, D. Král & J. Růžička leg. (NMPC)

Distribution. This species was previously known from Yunnan and Sichuan. The above male represents the first record from Gansu.

Key to *Episcaphium* species of China

1	Pronotum black	**2**
–	Pronotum and elytra reddish, sometimes with black spots or fasciae	**4**
2	Elytra without puncture rows; abdomen reddish	***E. strenuum***
–	Elytra with four discal puncture rows; abdomen black	**3**
3	Pronotum with antebasal puncture row impressed laterally; elytra with distinct apical impressions	***E. dabashanum***
–	Pronotum with antebasal puncture row not impressed laterally; elytra without impressions	***E. catenatum***
4	Elytra reddish with black spots or fasciae	**5**
–	Elytra entirely reddish	***E. zhuxiaoyui***
5	Elytra each with two black transverse fasciae, without discal puncture rows	***E. watanabei***
–	Elytra each with one apical black spot, with four discal puncture rows	**6**

6 Tempora without punctures; pronotum with a pair of black basal spots situated between antebasal puncture row and basal edge..... ***E. haematoides***

– Tempora densely punctate; pronotum with a pair of black median spots anterior to antebasal puncture row .....***E. changchini***

Acknowledgements

We would like to express our sincere gratitude to Dr. Ivan Löbl (Switzerland) for his guidance, to Mr. Ryo Ogawa (Japan) and Dr. Volker Assing (Germany) for greatly improving the manuscript, to Mr. Xiao-Yu Zhu, Mr. Jian-Qing Zhu and Mr. Wen-Xuan Bi (China) for collecting specimens and sharing biological information, to Mr. Chen Chang-Chin (China) for donating specimens to us, to Dr. Masahiro Sakai, Mr. Ryo Ogawa and Mr. Yuji Katayama (Japan) for the loan of material for comparison, and to Dr. Martin Fikáček (Czech Republic) for the loan of additional material.

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Löbl I (2002) Two new species of *Episcaphium* Achard (Coleoptera, Staphynidae, Scaphidiinae). Special Bulletin of the Japanese Society of Coleopterology (5): 289–295.

Sheng C, Gu F-K (2009) Two new species of the genus *Episcaphium* Lewis (Coleoptera, Staphylinidae, Scaphidiinae) of China. Zootaxa 2325: 35–38.

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RESEARCH ARTICLE

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A revision of the *Stenus flammeus* group (Coleoptera, Staphylinidae) with descriptions of twelve new species

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Abstract

The *Stenus flammeus* group is proposed and twelve new species of the group are described: *S. corniculus* **sp. n.**, *S. daicongchaoi* **sp. n.**, *S. jiajinshanus* **sp. n.**, *S. jindingianus* **sp. n.**, *S. paraflammeus* **sp. n.**, *S. pengzhongi* **sp. n.**, *S. pseudoflammeus* **sp. n.**, *S. punctidorsus* **sp. n.**, *S. tuyueyei* **sp. n.**, *S. xilingmontis* **sp. n.**, and *S. zhoudeyaoi* sp. n. from Sichuan Province, and *S. dabashanus* **sp. n.** from Shaanxi Province. Their diagnostic characters are illustrated and a key to species of the group is provided.

Keywords

China, Coleoptera, identification key, new species, Staphylinidae, *Stenus flammeus* group

Introduction

The *Stenus flammeus* complex consisting of *S. flammeus* Tang & Puthz, 2008 and *S. bostrychus* Tang & Puthz, 2008 (both see Tang, Zhao & Puthz, 2008) was established by Tang, Zhao & Puthz in 2008 and it was assigned to the *Stenus cirrus* group at that time. With more material collected and in-depth understanding of the Chinese fauna of the genus *Stenus* increasing, it is clarified now that *S. flammeus* and its affinis represent a separate species group which may not be closely related to the *Stenus cirrus* group. The distributional range of the *Stenus flammeus* group is known only from the Sichuan Basin, while the range of the *Stenus cirrus* group is much larger, covering the most central area of East Asia from Vietnam (Puthz 1981), Hainan (Puthz 2003)

and Taiwan (Puthz 2009) to Shaanxi (Tang et al. 2005) and Japan (Naomi 2004). Although a unique character in the genus, bearing long suberect setae on the abdomen, is shared by both groups, the members of the *Stenus flammeus* group differ from those of the *Stenus cirrus* group by the following characters: paraglossa coniform, while they are oval in the *Stenus cirrus* group; male sternite IX with apicolateral projections relatively long and posterior margin usually with median projection (exceptions: *S. xilingmontis*, *S. dabashanus*, *S. jiajinshanus*, *S. zhoudeyaoi*), while in the *Stenus cirrus* group, male sternite IX with apicolateral projections relatively short and posterior margin almost without median projection; spermatheca weakly sclerotized or even difficult to be observed although basal porch and/or basal duct are usually strongly sclerotized, while in the *Stenus cirrus* group, the entire spermatheca is always sclerotized in mature females.

Material and methods

The specimens examined in this paper were collected by sifting leaf litters in forests and killed with ethyl acetate. For examination of the genitalia, the last three abdominal segments were detached from the body after softening in hot water. The aedeagi or the spermathecae, together with other dissected pieces, were mounted in Euparal (Chroma Gesellschaft Schmidt, Koengen, Germany) on plastic slides. Photos of sexual characters were taken with a Canon G9 camera attached to an Olympus SZX 16 stereoscope; habitus photos were taken with a Canon macro photo lens MP-E 65 mm attached to a Canon EOS 7D camera and stacked with Zerene Stacker (http://www.zerenesystems.com/cms/stacker).

The type specimens treated in this study are deposited in the following public and private collections:

CNC Canadian National Collection of Insects, Ottawa, Ontario, Canada
SHNU Department of Biology, Shanghai Normal University, P. R. China
cPut private collection V. Puthz, Schlitz, Germany
cSch private collection M. Schülke, Berlin, Germany
cSme private collection A. Smetana, Ottawa, Canada
cWat private collection Y. Watanabe, Tokyo, Japan
MHNG Muséum d'Histoire Naturelle, Genève, Switzerland

The measurements of proportions are abbreviated as follows:

BL body length, measured from the anterior margin of the clypeus to the posterior margin of abdominal tergite X
FL forebody length, measured from the anterior margin of the clypeus to the apex of the elytra (apicolateral angle)
HW width of head including eyes
PW width of pronotum
EW width of elytra
PL length of pronotum

EL length of elytra, measured from humeral angle
SL length of elytral suture

Taxonomy

Stenus flammeus Tang & Puthz, 2008

Stenus flammeus Tang & Puthz, 2008 in Tang, Zhao & Puthz, 2008: 10.

Material examined. CHINA: Sichuan: Holotype: ♂, Luding County, Hailuogou, alt. 2200–2300 m, 27.VII.2006, HU Jia-Yao & TANG Liang leg. (SHNU). **Paratypes:** 14♂♂21♀♀, same data as for the holotype (SHNU); 3♂♂8♀♀, same data but 28.VII.2006, HU Jia-Yao & TANG Liang leg. (SHNU)

Measurements. BL: 4.0–5.7mm, FL: 2.0–2.1 mm. HW: 0.85–0.96 mm, PL: 0.68–0.77 mm, PW: 0.68–0.74 mm, EL: 0.72–0.80 mm, EW: 0.77–0.86 mm, SL: 0.49–0.54 mm. Head 1.05–1.11 times as wide as elytra, pronotum 0.99–1.03 times as long as wide, elytra 0.87–0.92 times as long as wide.

Stenus bostrychus Tang & Puthz, 2008

Stenus bostrychus Tang & Puthz, 2008 in Tang, Zhao & Puthz, 2008: 12.

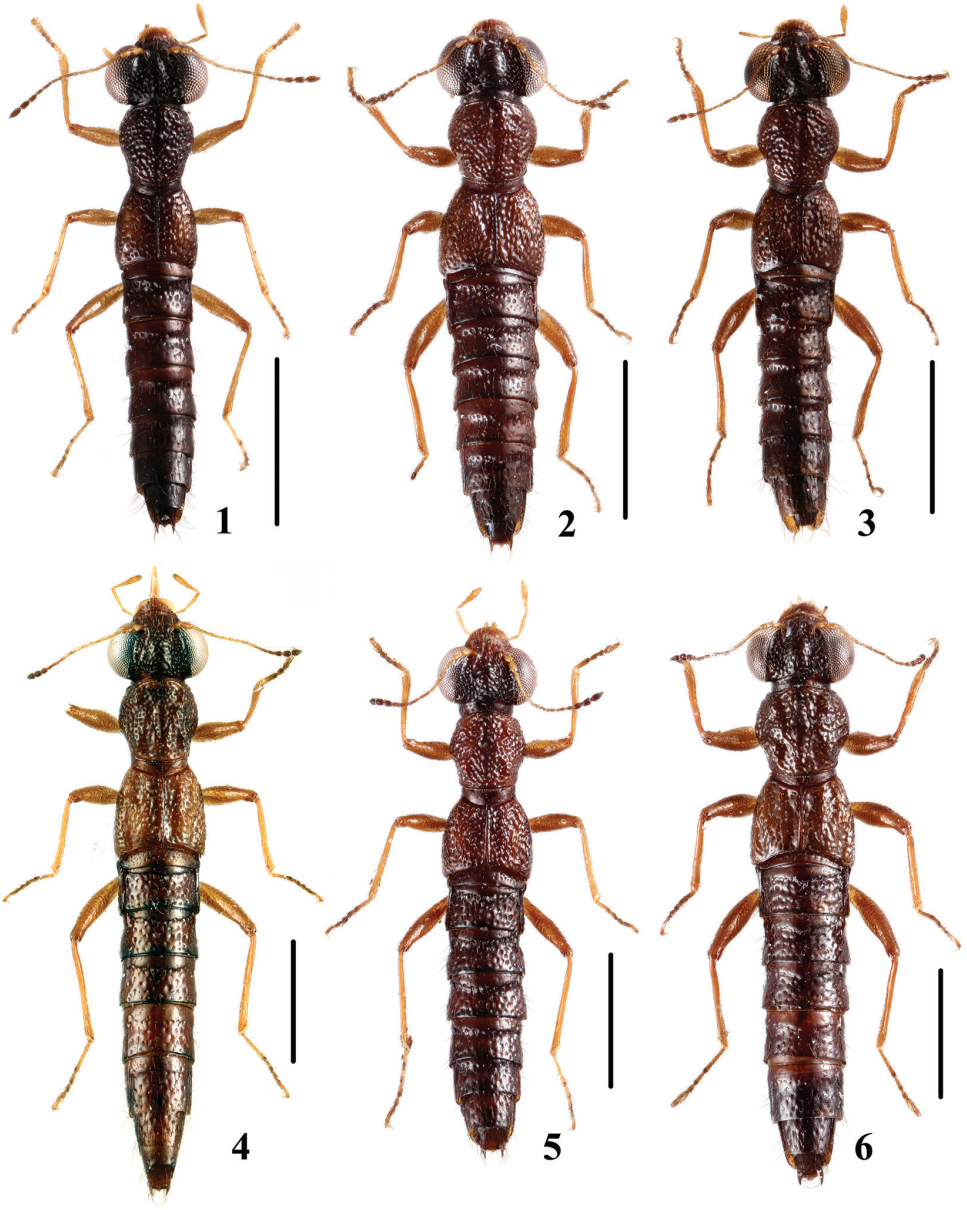
Material examined. China: Sichuan: Holotype: ♂, Tianquan County, Labahe Nature Reserve, alt. 2400–2600 m, 31.VII.2006, HU Jia-Yao & TANG Liang leg. (SHNU). **Paratypes:** 3♂♂5♀♀, same data as for the holotype (SHNU); 6♂♂ 2♀♀, Tianquan County, Labahe Nature Reserve, alt. 2000 m, 30.VII.2006, HU Jia-Yao and TANG Liang leg. (SHNU); ♂, Labahe Nature Reserve, Tianquan County, Sichuan Prov., alt. 1900 m, 29.VII.2006, HU Jia-Yao & TANG Liang leg. (SHNU)

Measurements. BL: 4.0–4.5mm, FL: 2.1–2.3 mm. HW: 0.84–0.92 mm, PL: 0.68–0.74 mm, PW: 0.65–0.71 mm, EL: 0.75–0.80 mm, EW: 0.73–0.81 mm, SL: 0.51–0.54 mm. Head 1.10–1.16 times as wide as elytra, pronotum 1.03–1.07 times as long as wide, elytra 0.98–1.03 times as long as wide.

Stenus pengzhongi sp. n.

http://zoobank.org/414DE45D-513C-415A-A901-3956206D7136
Figs 1, 13–17

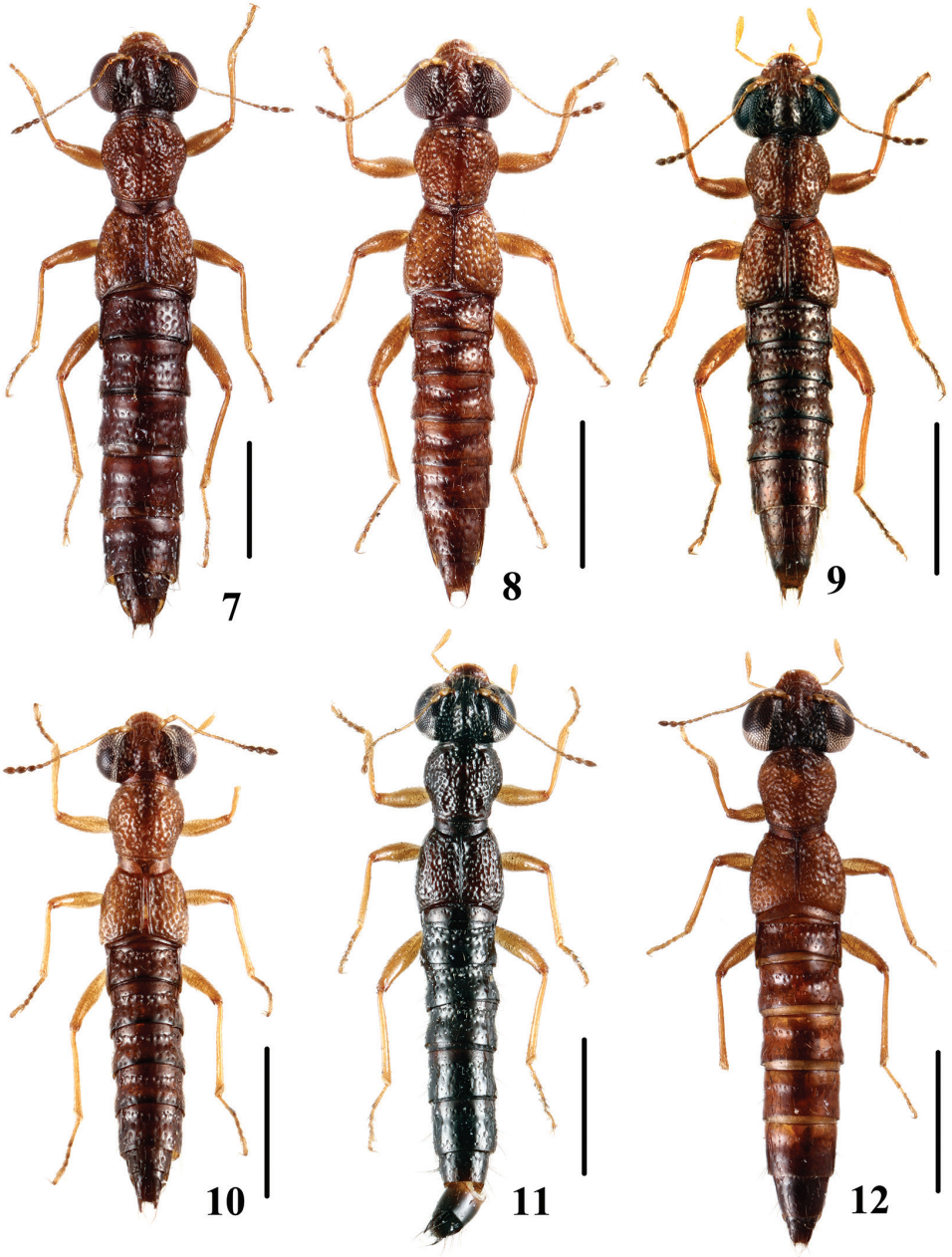
Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Emei Shan, Xixiangchi, 29°33'N, 103°20'E, alt. 2100–2300 m, 21.VII.2012, Peng, Dai & Yin leg." "Holotype / *Stenus pengzhongi* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 1♂, same data as for the holotype



Figures 1–6. Habitus. **1** *Stenus pengzhongi* sp. n. **2** *S. jindingianus* sp. n. **3** *S. corniculus* sp. n. **4** *S. daicongchaoi* sp. n. **5** *S. punctidorsus* sp. n. **6** *S. paraflammeus* sp. n. Scale bars: 1 mm.

(SHNU); 1♀, Mt. Emei, 17.VII.2003, Hu & Tang leg. (SHNU); 1♂3♀♀, Emei Shan, 29°33'39"N, 103°20'42"E, 1850m, 23.V.2011, sift04, V. Grebennikov (CNC).

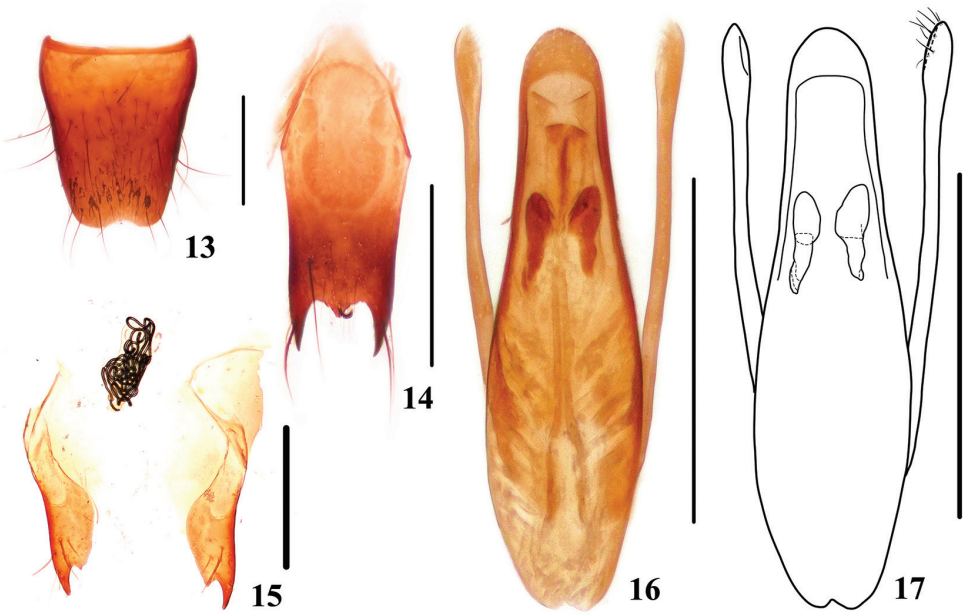
Description. Brachypterous; Head black, other body parts dark brown, each elytron with a large orange spot, which is about 3/5 as long as and 1/2 as broad as the



Figures 7–12. Habitus. **7** *Stenus pseudoflammeus* sp. n. **8** *S. xilingmontis* sp. n. **9** *S. zhoudeyaoi* sp. n. **10** *S. jiajinshanus* sp. n. **11** *S. tuyueyei* sp. n. **12** *S. dabashanus* sp. n. Scale bars: 1 mm.

respective elytron. Antennae yellowish brown, club infuscate, maxillary palpi and legs yellowish brown.

BL: 3.1–3.4mm, FL: 1.5–1.6 mm.



Figures 13–17. *Stenus pengzhongi*. **13** male sternite VIII **14** male sternite IX **15** valvifers and spermatheca **16, 17** aedeagus. Scale bars: 0.25 mm.

HW: 0.71–0.76 mm, PL: 0.54–0.58 mm, PW: 0.50–0.55 mm, EL: 0.53–0.58 mm, EW: 0.57–0.58 mm, SL: 0.40–0.42 mm.

Head 1.25–1.31 times as wide as elytra; interocular area with two deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, mostly well delimited, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices smooth, narrower than half to entire diameter of punctures except those along the midline of the convex median portion, which may be twice as wide as diameter of punctures. Paraglossa coniform.

Pronotum 1.05–1.08 times as long as wide; disk slightly uneven, with distinct median longitudinal furrow, which is about 3/5 as long as pronotum; punctures more or less confluent, slightly larger than those of head; interstices smooth, distinctly narrower than half the diameter of punctures except those at the actual middle of longitudinal furrow, which could be three times as wide as diameter of punctures.

Elytra 0.95–0.98 times as long as wide; disk relatively even; punctures more or less longitudinally confluent, slightly larger than those of pronotum; interstices smooth, distinctly narrower than half the diameter of punctures.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; line-like paratergites present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membra-

nous fringe; punctures mostly round, becoming slightly smaller posteriad; interstices smooth, mostly narrower than diameter of punctures.

Male. Sternite VIII (Fig. 13) with semi-circular emargination at middle of posterior margin; sternite IX (Fig. 14) with very long apicolateral projections, posterior margin with distinct median projection. Aedeagus (Figs 16, 17) slender; median lobe with apical sclerotized area semicircle; expulsion clasps large, strongly sclerotized; parameres extending a little beyond apex of median lobe, swollen at apical parts, each with 8–10 setae on apico-internal margins.

Female. Sternite VIII inconspicuously prominent at middle of posterior margin; sclerotized spermatheca (Fig. 15) with very complicated bends.

Distribution. China (Sichuan).

Remarks. The species can be distinguished from other related species by the following characters: body size smaller, surfaces of pronotum and elytra rather even and ratio of HW/EW larger.

Etymology. This species is named in honor of Mr. Zhong Peng who collected some specimens of the new species.

***Stenus jindingianus* sp. n.**
http://zoobank.org/871D3DAF-8684-430D-8221-7331EF903116
Figs 2, 18–23

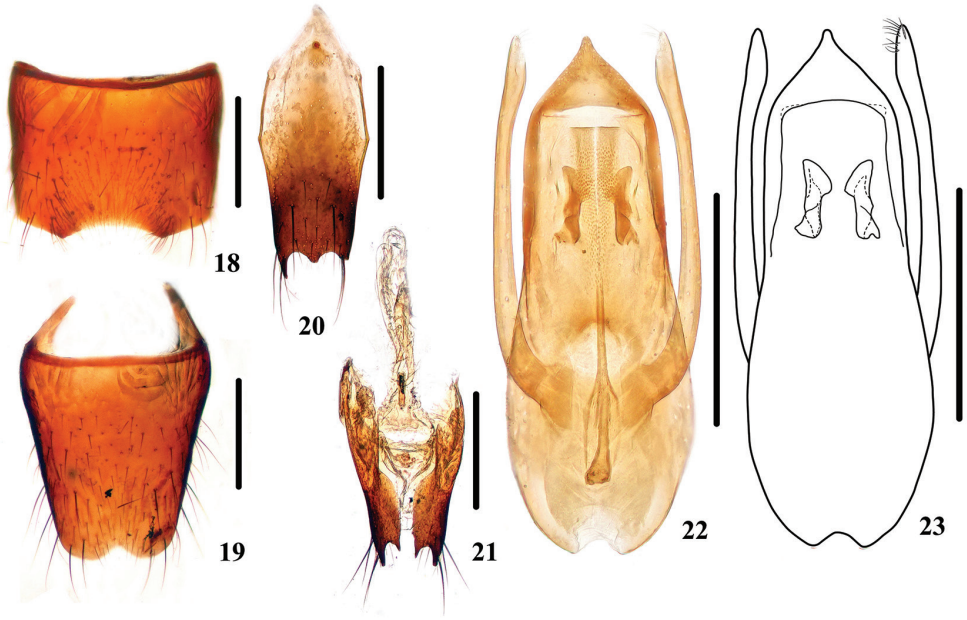
Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Emeishan Mt., Jinding, 1.35 km, 29°31'N, 103°20'E, alt. 2800–3000 m, 19.VII.2012, Peng, Dai & Yin leg." "Holotype / *Stenus jindingianus* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 1♂2♀♀, same data as for the holotype (SHNU); 1♂1♀, Emei Shan, 3000 m, 29°32'N, 103°21'E, 17.VII.1996, Smetana, Farkač & Kabátek leg. (cSme); 2♂♂, Emeishan, Jinding, 3020 m, 2.XI.1995, Uéno leg. (cWat); 2♂♂1♀, Emeishan, Taiziping, 2930 m, 2.XI.1995, Uéno leg. (cWat); 2♂♂, Emeishan, below Jinding, 3000 m, 5.X.1995, Nomura leg. (cWat).

Description. Brachypterous; head broadly black along the inner eye margins, median portion dark brown or rarely black, labrum reddish brown, rest body parts reddish brown, elytra each with trace of yellow spot at humeral impression. Antennae, maxillary palpi and legs yellowish brown except antennal club infuscate.

BL: 3.1–3.3mm, FL: 1.6–1.7 mm.

HW: 0.73–0.76 mm, PL: 0.53–0.59 mm, PW: 0.58–0.62 mm, EL: 0.56–0.64 mm, EW: 0.68–0.71 mm, SL: 0.39–0.46 mm.

Head 1.03–1.07 times as wide as elytra, interocular area with two deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, slightly confluent, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices smooth, much narrower than



Figures 18–23. *Stenus jindingianus*. **18** male sternite VII **19** male sternite VIII **20** male sternite IX **21** valvifers and spermatheca **22, 23** aedeagus. Scale bars: 0.25 mm.

half the diameter of punctures except those along the midline of the convex median portion, which may be twice as wide as diameter of punctures. Paraglossa coniform.

Pronotum 0.91–0.95 times as long as wide, disk uneven, with broad median longitudinal furrow throughout, two shallow impressions in anterior half, two shallow impressions in about middle, two shallow impressions in posterior half; punctures confluent, of similar size to those of head; interstices smooth, narrower than half the diameter of punctures except those at the bottom of longitudinal furrow, which could be much larger.

Elytra 0.82–0.90 times as long as wide; disk moderately even with indistinct longitudinal humeral impression, indistinct postero-lateral impression and indistinct long sutural impression, suture moderately convex; punctation strongly and longitudinally confluent; interstices smooth, very narrow and ridge-like.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; paratergites very narrow and punctate, present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membranous fringe; punctures gradually becoming smaller posteriad, punctures of abdominal tergites III slightly larger than those of pronotum in average; interstices smooth except sometimes traces of reticulation presented at last three tergites, narrower than the diameter of punctures on tergites III–VI.

Male. Sternite VII (Fig. 18) with emargination at middle of posterior margin and a distinct impression before it; sternite VIII (Fig. 19) with semi-circular emargination at middle of posterior margin; sternite IX (Fig. 20) with very long apicolateral projections,

posterior margin with distinct median projection. Aedeagus (Figs 21, 22) with apical sclerotized area triangular; expulsion clasps mediun in size; parameres as long as median lobe, slightly swollen at apical parts, each with 12–14 setae on apico-internal margins.

Female. Sternite VIII entire; spermatheca (Fig. 21) with basal duct strongly sclerotized, remining part of the spermathecal duct slightly sclerotized with multiple bends.

Distribution. China (Sichuan).

Remarks. The species can be distinguished from other related species except *S. corniculus* sp. n. by smaller body size and longitudinally confluent punctation of elytra. To distinguish from *S. corniculus* sp. n., see diagnoses of the latter.

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

***Stenus corniculus* sp. n.**

http://zoobank.org/365E42E5-8C8D-4E9A-B099-C5B813DF4040

Figs 3, 24–29

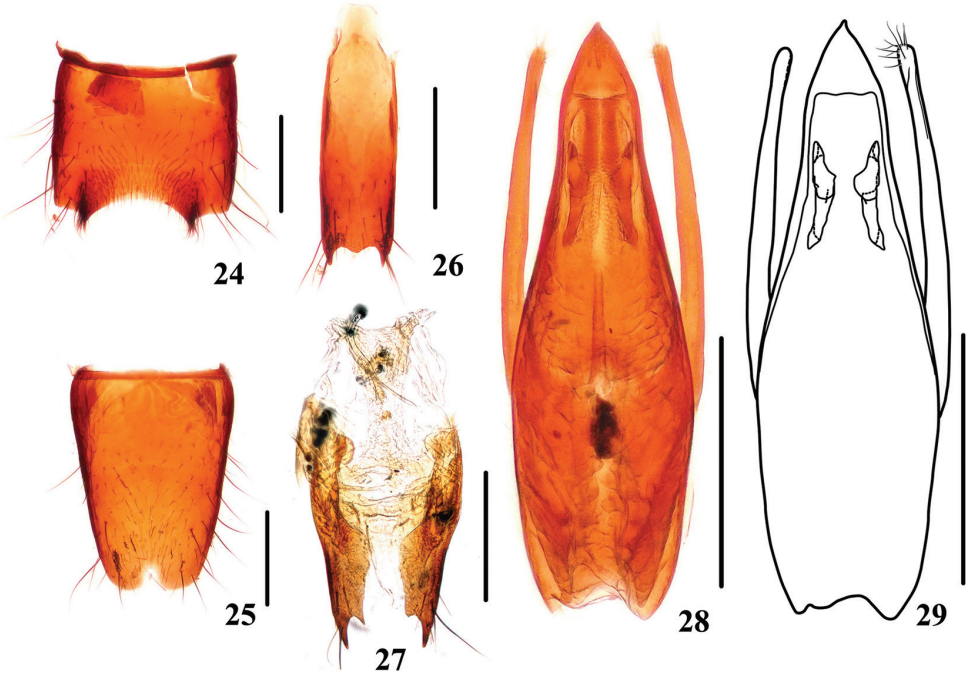
Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Emeishan Mt., Jieyin Palace, 0.7 km, 29°32'N, 103°20'E, alt. 2500–2600 m, 18.VII.2012, Peng, Dai & Yin Leg." "Holotype / *Stenus corniculus* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 11♂♂9♀♀, same data as for the holotype (1 pair in cPut, rest in SHNU); 1♂2♀♀, Emei Shan, Leidongping, 2500 m, 29°32'N, 103°21'E, 18.VII.1996, Smetana, Farkač & Kabátek leg. (cSme); 1♂1♀, Emeishan, 29°32'37.3"N, 103°19'57.5"E, 2440 m, 18.VII.2010, sifting, V. Grebennikov (CNC); 1♀, Emeishan, 29°32'57.2"N, 103°20'37.7"E, 2289 m, 16.VII.2010, sifting, V. Grebennikov leg. (CNC); 1♀, Emeishan, Xixiangchi, 29.VII.2009, He & Tang leg. (SHNU)

Description. BL: 3.4–3.7mm, FL: 1.6–1.8 mm.

HW: 0.71–0.81 mm, PL: 0.55–0.59 mm, PW: 0.55–0.61 mm, EL: 0.58–0.65 mm, EW: 0.61–0.71 mm, SL: 0.46–0.48 mm. Head 1.11–1.17 times as wide as elytra, pronotum 0.95–1.02 times as long as wide, elytra 0.91–0.96 times as long as wide.

Similar to *S. jindingianus* sp. n. in most aspects, but differs in the following characters: Head with interocular area entirely black; the traces of elytral marks more distinct and larger; abdominal tergites with punctures relatively sparser especially those of posterior area of each tergite.

Male. Sternite VII (Fig. 24) impressed at posteromedian part delimited by edged ridge on each side, posterior margin of the impression emarginated with a sharp projection on each side; sternite VIII (Fig. 25) with triangular emargination at middle of posterior margin; sternite IX (Fig. 26) with long apicolateral projections, posterior margin with broad and shallow median projection. Aedeagus (Figs 28, 29) slender; with median lobe broadest at about basal 2/5 and gradually tapering apicad, apical sclerotized area with an apical cuspidate projection; expulsion clasps large; parameres distinctly shorter than median lobe, slightly swollen at apical parts, each with 9–11 setae on apico-internal margins.



Figures 24–29. *Stenus corniculus*. **24** male sternite VII **25** male sternite VIII **26** male sternite IX **27** valvifers and spermatheca **28, 29** aedeagus. Scale bars: 0.25 mm.

Female. Sternite VIII entire; sclerotized spermatheca (Fig. 27) consisting of short basal duct and long folded duct.

Distribution. China (Sichuan).

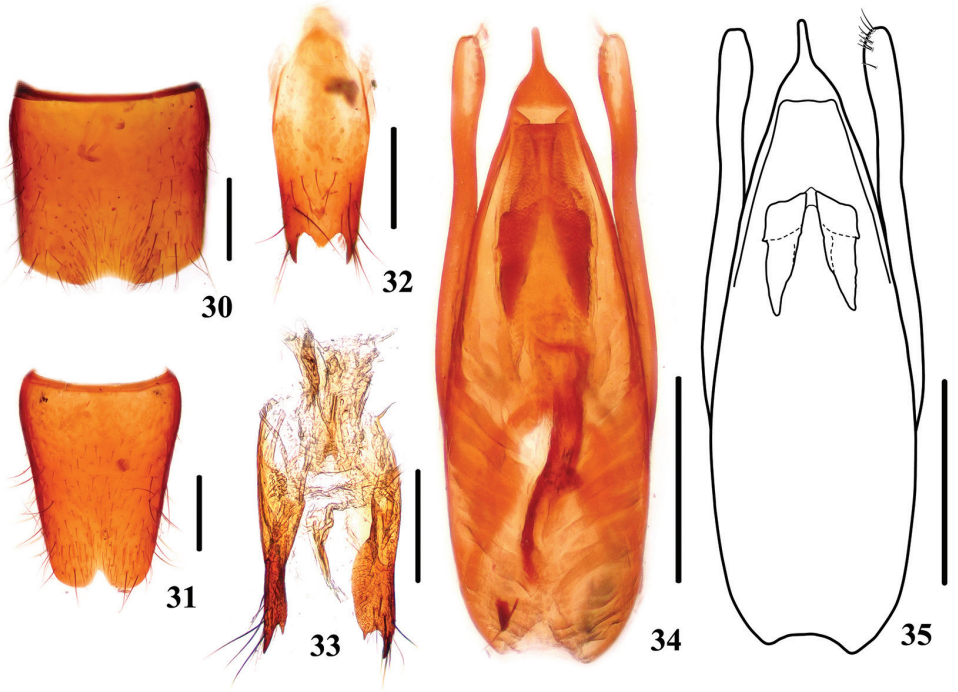
Remarks. The species resembles *Stenus jindingianus* sp. n. in most aspects, the main differences between them appear in proportions of pronotum and elytra.

Etymology. The specific name is a combination of the Latin words "cornic" and "ulus" after its sternite VII decorated by sharp projections.

Stenus daicongchaoi sp. n.

http://zoobank.org/248993F5-CC9B-44ED-8CB2-E47BB18F0897
Figs 4, 30–35

Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Emeishan Mt., Jieyin Palace, 0.7 km, 29°32'N, 103°20'E, alt. 2500–2600 m, 18.VII.2012, Peng, Dai & Yin leg."“Holotype / *Stenus daicongchaoi* / Tang Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 2♂♂2♀♀, same data as for the holotype (1 pair in cPut, rest in SHNU); 2♀♀, Emei Shan, Xixiangchi, 29°33'N, 103°20'E, alt. 2100–2300 m, 21.VII.2012, Peng, Dai & Yin leg. (SHNU);



Figures 30–35. *Stenus daicongchaoi*. **30** male sternite VII **31** male sternite VIII **32** male sternite IX **33** valvifers and spermatheca **34, 35** aedeagus. Scale bars: 0.25 mm.

1♂1♀, Emeishan Mt., Jinding, 29°31'N, 103°20'E, alt. 3000 m, 20.VII.2012, Peng, Dai & Yin leg. (SHNU); 1♀, Emeishan, 29°32'48.4"N, 103°20'06.3"E, 2342 m, 17.VII.2010, sifting, V. Grebennikov leg. (CNC);

Description. Brachypterous; body brownish except head with interocular area somewhat darker and elytra lighter, each elytron with slender spot, which is about 1/2 as long as and 1/3 as broad as the respective elytron, sometimes they are inconspicuous. Antennae, maxillary palpi and legs yellowish brown except antennal club infuscate.

BL: 4.7–5.0mm, FL: 2.2–2.4 mm.

HW: 0.87–0.89 mm, PL: 0.70–0.74 mm, PW: 0.67–0.69 mm, EL: 0.79–0.82 mm, EW: 0.81–0.83 mm, SL: 0.58–0.62 mm.

Head 1.06–1.08 times as wide as elytra; interocular area with two deep longitudinal furrows, median portion convex, reaching the level of inner eye margins; punctures round, partly confluent, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices smooth, much narrower than half the diameter of punctures except those along the midline of the convex median portion, which may be twice as wide as the diameter of punctures. Paraglossa coniform.

Pronotum 1.04–1.07 times as long as wide; disk uneven, with distinct median longitudinal furrow, two impressions in anterior half, transverse impression in the middle,

and two impressions in posterior half; punctures more or less confluent, of similar size to those of head; interstices partially and indistinctly reticulated, more or less narrower than half the diameter of punctures except those at the bottom of longitudinal furrow, which could be larger.

Elytra 0.98–0.99 times as long as wide; disk uneven with longitudinal humeral impression, postero-lateral impression and deep sutural impression, suture moderately convex; punctation longitudinally confluent; interstices smooth and ridge-like.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; paratergites very narrow and punctate, present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membranous fringe; punctures round, becoming slightly smaller posteriad; interstices smooth except those of last two tergites shallowly reticulated, narrower than half the diameter of punctures on tergite III–VI.

Male. Sternite VII (Fig. 30) impressed at posteromedian part with emargination along posterior margin of impression; sternite VIII (Fig. 31) with triangular emargination at middle of posterior margin; sternite IX (Fig. 32) with very long apicolateral projections, posterior margin with distinct median projection. Aedeagus (Figs 34, 35) broadest at about basal 2/5 and gradually tapering apicad, apical sclerotized area with a long apical cuspidate projection; expulsion clasps large; parameres a little shorter than median lobe, swollen at apical parts, each with 9–11 setae on apico-internal margins.

Female. Sternite VIII entire; spermatheca (Fig. 33) weekly sclerotized except the basal porch and basal duct well sclerotized.

Distribution. China (Sichuan).

Remarks. The species is similar to *S. bostrychus*, but can be distinguished from the latter by less confluent punctation of pronotum and relatively larger punctures of abdomen.

Etymology. This species is named in honor of Mr. Cong-Chao Dai who collected some specimens of the new species.

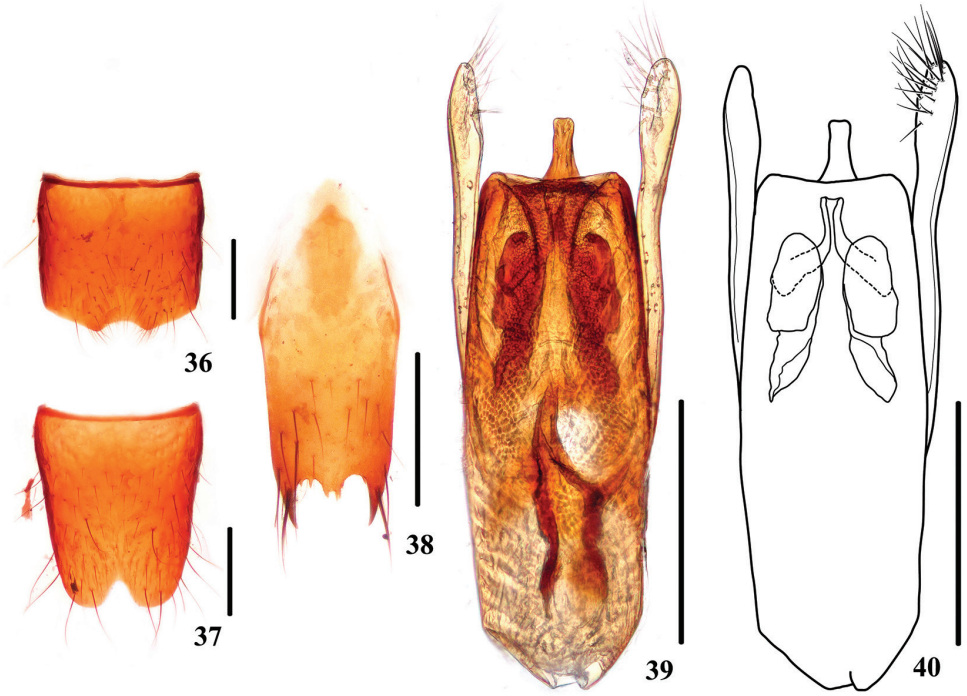
***Stenus punctidorsus* sp. n.**

http://zoobank.org/01952264-6685-4622-8F1B-003F4D343F5E

Figs 5, 36–40

Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Erlangshan Mt., 29°32'N, 102°18'E, alt. 2800–3000 m, 13.VII.2012, Peng, Dai & Yin leg." "Holotype / *Stenus punctidorsus* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 1♂, Ya'an Pref., Tianquan Co., E Erlang Shan Pass, 2900 m, 9 km SE Luding, 29°52'N, 102°18'E, Gesiebe, 22.Vi.1999, leg. M. Schülke (cSch).

Description. Brachypterous; Body reddish brown except head with interocular area blackish, each elytron with a very vague and inconspicuous small spot. Antennae, maxillary palpi and legs yellowish brown except antennal club infuscate.



Figures 36–40. *Stenus punctidorsus*. **36** male sternite VII **37** male sternite VIII **38** male sternite IX **39, 40** aedeagus. Scale bars: 0.25 mm.

BL: 3.4–3.9 mm, FL: 1.8–1.9 mm.

HW: 0.73–0.83 mm, PL: 0.58–0.63 mm, PW: 0.57–0.60 mm, EL: 0.61–0.67 mm, EW: 0.65–0.73 mm, SL: 0.45–0.50 mm.

Head 1.13–1.15 times as wide as elytra, interocular area with two deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, more or less confluent, almost the same size, diameter of punctures about as wide as apical cross section of antennal segment II; interstices smooth, much narrower than half the diameter of punctures except those along the midline of the convex median portion, which may be slightly narrower than diameter of punctures. Paraglossa coniform.

Pronotum 1.02–1.05 times as long as wide; disk uneven, with broad median longitudinal furrow throughout, two impressions in anterior half each with an small outer tubercle, two impressions in about middle each with an inner tubercle, two deep impressions in posterior half each with an larger outer tubercle; punctures confluent, slightly smaller than those of head; interstices smooth, narrower than half the diameter of punctures except those at the bottom of longitudinal furrow, which could be much larger.

Elytra 0.92–0.94 times as long as wide; disk moderately uneven with distinct longitudinal humeral impression, distinct postero-lateral impression and long sutural

impression, suture moderately convex; punctation and interstices similar to those of pronotum, except punctures slightly larger.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; paratergites very narrow and punctate, present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membranous fringe; punctures round, becoming slightly smaller posteriad; interstices smooth, narrower than half the diameter of punctures on tergite III–VI.

Male. Sternite VII (Fig. 36) impressed at posteromedian part with emargination along posterior margin of impression; sternite VIII (Fig. 37) with triangular emargination at middle of posterior margin; sternite IX (Fig. 38) with very long apicolateral projections, posterior margin with distinct median projection. Aedeagus (Figs 39, 40) with median lobe paralleled on sides, apical sclerotized area with a narrow and long apical projection; expulsion clasps large; parameres distinctly longer than median lobe, swollen at apical parts, each with 19–22 setae on apico-internal margins.

Female. Unknown.

Distribution. China (Sichuan).

Remarks. The new species is characterized by large and dense punctation of entire body especially of abdominal tergites.

Etymology. The specific name is derived from the dense punctation of abdominal tergites.

Stenus paraflammeus sp. n.

http://zoobank.org/6FE97A9D-A8B8-4B71-805F-172EEE90EF04
Figs 6, 41–46

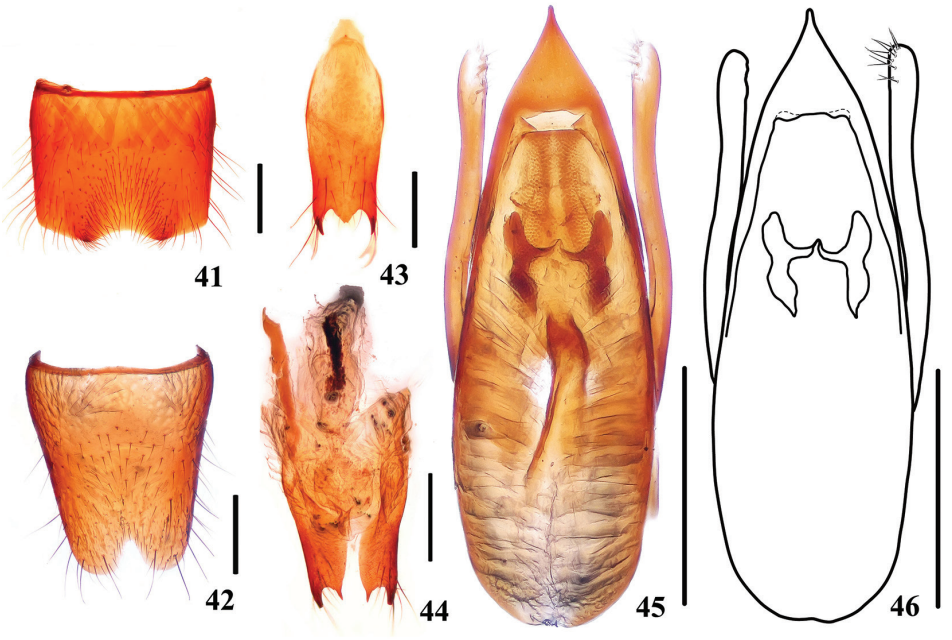
Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Tianquan County, Erlangshan Mt., Yakou 3.6km, 29°31'N, 102°17'E, alt. 2600–2800 m, 11.VII.2012, Peng, Dai & Yin leg." "Holotype / *Stenus paraflammeus* / Tang Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 5 ♂♂4♀♀, same data as for the holotype (1pair in cPut, rest in SHNU); 1♂4♀♀, same data but 29°33'N, 102°18'E, alt. 2800–3000 m, 13.VII.2012, Peng, Dai & Yin leg. (SHNU); 3♂♂1♀, same data but 29°32'N, 102°18'E, alt. 2200–2300 m, 13.VII.2012, Peng, Dai & Yin leg. (SHNU); 1♂1♀, Erlangshan, 1600–2000 m, 29.VII.2006, Hu & Tang leg. (SHNU)

Description. Brachypterous, reddish brown, head especially interocular area along the inner margins of eyes darker, abdomen moderately glossy. Antennae yellowish, club infuscate. Maxillary palpi yellowish. Legs reddish yellow, tarsomeres slightly infuscate.

BL: 4.4–4.7mm, FL: 2.0–2.3 mm.

HW: 0.90–1.00 mm, PL: 0.65–0.82 mm, PW: 0.72–0.85 mm, EL: 0.65–0.83 mm, EW: 0.83–0.96 mm, SL: 0.45–0.58 mm.

Head 1.06–1.08 times as wide as elytra; interocular area with two deep longitudinal furrows, median portion strongly convex, distinctly extending beyond the level



Figures 41–46. *Stenus paraflammeus*. **41** male sternite VII **42** male sternite VIII **43** male sternite IX **44** valvifers **45, 46** aedeagus. Scale bars: 0.25 mm.

of inner eye margins; punctures round, well delimited on the posterior areas of furrows and distinctly confluent on the rest parts especially on median portion, diameter of large punctures about as wide as medial cross section of 2nd antennal segment; interstices between punctures smooth, distinctly narrower than half the diameter of punctures. Paraglossa coniform.

Pronotum 0.90–0.96 times as long as wide; disk conspicuously uneven, with broad and deep median longitudinal furrow which begins from the anterior margin and ends at about basal 1/5, two deep impressions in anterior half each with an outer tubercle, two distinct impressions in about middle each with an inner tubercle, two deep impressions in posterior half each with an outer tubercle; punctures round and strongly confluent, mostly slightly smaller than those on frons; interstices smooth, much narrower than half the diameter of punctures except in median furrow, which is partially reticulated and broadly impunctate.

Elytra 0.85–0.89 times as long as wide; disk uneven with deep humeral impression, distinct postero-lateral impression and deep sutural impression, median portion between humeral impression and sutural impression distinctly convex; punctation irregular, punctures confluent, slightly larger than those on pronotum; interstices smooth, much narrower than half the diameter of punctures.

Legs with tarsomeres IV strongly bilobed.

Abdomen cylindrical; paratergites very narrow and punctate, present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical

membranous fringe; punctures mostly round, becoming slightly smaller posteriad; interstices smooth on the basal four tergites and more or less sculptured on the rest tergites, narrower than half the diameter of punctures on basal three tergites and narrower than diameter of punctures on the following two tergites.

Male. Seventh sternite (Fig. 41) deeply impressed at posteromedian part with emargination along posterior margin of impression; sternite VIII (Fig. 42) with triangular emargination at middle of posterior margin; sternite IX (Fig. 43) with very long apicolateral projections, posterior margin with strong median projection. Aedeagus (Figs 45, 46) with median lobe broadest at about basal 1/5 and gradually tapering apicad, apical sclerotized area with an apical cuspidate projection; expulsion clasps large; parameres distinctly shorter than median lobe, slightly swollen at apical parts, each with 10–12 setae on apico-internal margins.

Female. sternite VIII entire; valvifers (Fig. 44) each with very long inner tooth on posterior margin, spermatheca undetected.

Distribution. China (Sichuan).

Remarks. This new species is closely related to *S. flammeus* and *S. pseudoflammeus*, but can be easily distinguished from the latter two species by its broader pronotum.

Etymology. The specific name is derived from the similar appearance of *Stenus flammeus*.

***Stenus pseudoflammeus* sp. n.**

http://zoobank.org/FB84F191-34E1-4231-AED9-A65BE9FC9E31

Figs 7, 47–52

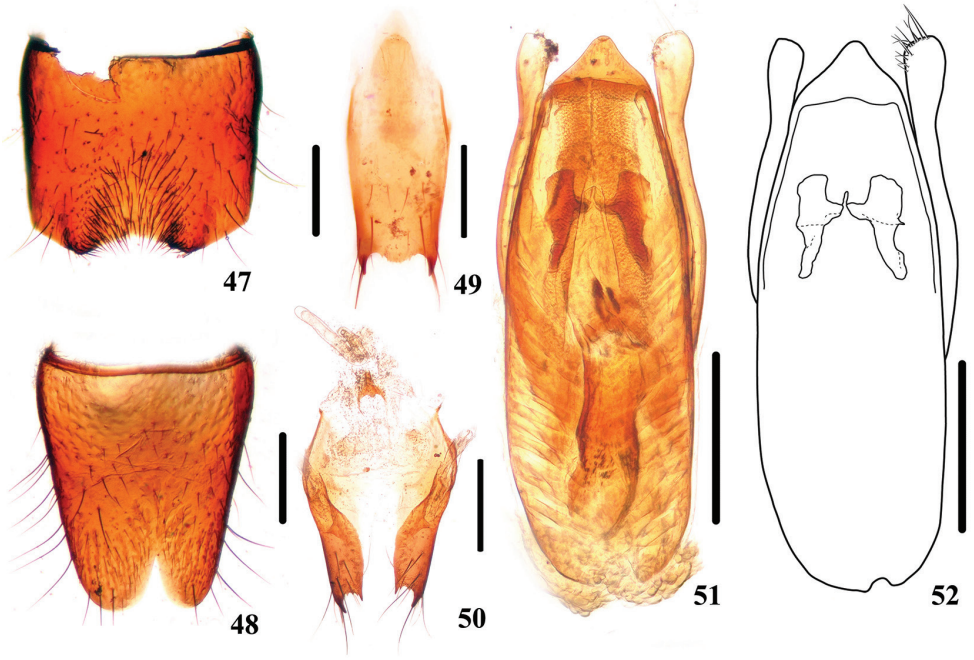
Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichaun Prov., Dayi County, Xiling Xueshan, 30°41'59"N, 103°12'10"E, mixed leaf litter, shifted, 2150 m, 29.VII.2015, Jiang, Peng, Tu & Zhou leg." "Holotype / *Stenus pseudoflammeus* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 3♂♂4♀♀, same data as for the holotype (1 pair in cPut, rest in SHNU); 1♂2♀♀, Xiling Mt., Dali, 1600-2400 m, 30.VII–4.VIII.1996, Kurbatov leg. (MHNG).

Description. BL: 4.2–5.1mm, FL: 2.2–2.3 mm.

HW: 0.95–0.98 mm, PL: 0.74–0.78 mm, PW: 0.73–0.76 mm, EL: 0.83–0.87 mm, EW: 0.91–0.95 mm, SL: 0.52–0.54 mm. Head 1.03–1.06 times as wide as elytra, pronotum 1.01–1.03 times as long as wide, elytra 0.84–0.89 times as long as wide.

Similar to *S. paraflammeus* sp. n. in most aspects, but differs in the following characters: the convex median portion of head extending to the same level of inner eye margins; punctures of forebody relatively smaller, larger punctures on head about as wide as basal cross section of 2nd antennal segment; impressions of pronotum and elytra shallower; punctation of abdominal tergites slightly finer and sparser.

Male. Sternites VII (Fig. 47) and VIII (Fig. 48) similar to those of *S. paraflammeus*; sternite IX (Fig. 49) with very long apicolateral projections, posterior margin with short broad serrate median projection. Aedeagus (Figs 51, 52) with median lobe robust, api-



Figures 47–52. *Stenus pseudoflammeus*. **47** male sternite VII **48** male sternite VIII **49** male sternite IX **50** valvifers and spermatheca **51, 52** aedeagus. Scale bars: 0.25 mm.

cal sclerotized area triangular; expulsion clasps large; parameres as long as median lobe, distinctly swollen at apex, each with 13–15 setae on apico-internal margins.

Female. Sternite VIII entire; spermatheca (Fig. 50) with basal porch strongly sclerotized, spermathecal duct slightly sclerotized and bent twice.

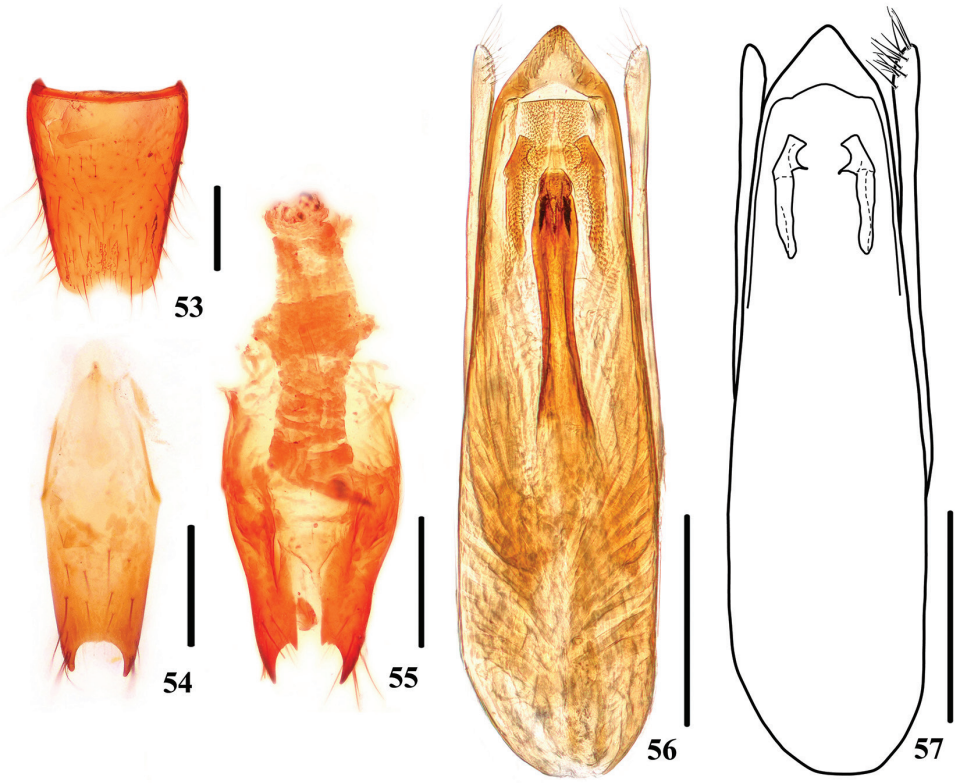
Distribution. China (Sichuan).

Remarks. The species is similar to *S. paraflammeus* but can be distinguished from the latter by slender pronotum; and it is also very similar to *S. flammeus*, dissections are necessary to distinguish them.

Etymology. The specific name is derived from the similar appearance of *Stenus flammeus*.

***Stenus xilingmontis* sp. n.**
http://zoobank.org/F06D09EA-66D2-4C6A-8580-E95581B306B4
Figs 8, 53–57

Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan, Xiling Mt., 1300 m, litter, 30.VII.1996, S. Kurbatov leg." "Holotype / *Stenus xilingmontis* / Tang, Liu & Niu" [red handwritten label] (MHNG). **Paratypes.** 2♂♂8♀♀, same data as for the holotype (1pair in SHNU, rest in MHNG).



Figures 53–57. *Stenus xilingmontis*. **53** male sternite VIII **54** male sternite IX **55** valvifers **56, 57** aedeagus. Scale bars: 0.25 mm.

Description. Brachypterous; body reddish brown except head broadly blackish along the inner eye margins. Antennae, maxillary palpi and legs yellowish brown except antennal club infuscate.

BL: 3.1–3.7mm, FL: 1.6–1.8 mm.

HW: 0.70–0. 79 mm, PL: 0.53–0.63 mm, PW: 0.55–0.63 mm, EL: 0.58–0.67 mm, EW: 0.65–0.73 mm, SL: 0.47–0.55 mm.

Head 1.06–1.09 times as wide as elytra; interocular area with two deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices smooth, much narrower than half the diameter of punctures except those along the midline of the convex median portion, which may be 1.5 times as wide as diameter of punctures. Paraglossa coniform.

Pronotum 0.95–1.00 times as long as wide; disk uneven, with distinct median longitudinal furrow, two impressions in anterior half, transverse impression in the middle, and two impressions in posterior half; punctures partially confluent, of similar size to those of head; interstices smooth except few reticulations at the bottom of median

furrow, more or less narrower than half the diameter of punctures except those at the bottom of longitudinal furrow, which may be twice as wide as diameter of punctures.

Elytra 0.89–0.93 times as long as wide; disk moderately uneven with distinct longitudinal humeral impression, distinct postero-lateral impression and long sutural impression, suture moderately convex; punctation and interstices similar to those of pronotum except punctures slightly confluent longitudinally.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; paratergites very narrow and punctate, present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membranous fringe; punctures of abdominal tergites III–VIII round, gradually becoming smaller posteriad; interstices smooth except those of last three tergites more or less shallowly reticulated, narrower than half the diameter of to the diameter of punctures.

Male. Sternite VIII (Fig. 53) with semi-circular emargination at middle of posterior margin; sternite IX (Fig. 54) with very long apicolateral projections. Aedeagus (Figs 56, 57) slender, apical sclerotized area triangular; expulsion clasps large; parameres shorter than median lobe, slightly swollen at apex, each with 12–14 setae on apico-internal margins.

Female. Sternite VIII inconspicuously prominent at middle of posterior margin; valvifers as in fig. 55, sclerotized spermatheca undetected.

Distribution. China (Sichuan).

Remarks. The new species shares the same appearance with *S. zhoudeyaoi* sp. n., and both of them distributed on the same mountain. Dissections are necessary to distinguish them, though the altitude information will be also helpful.

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

***Stenus zhoudeyaoi* sp. n.**

http://zoobank.org/4A56E419-E81B-48E0-9AB3-689C3340E5DF

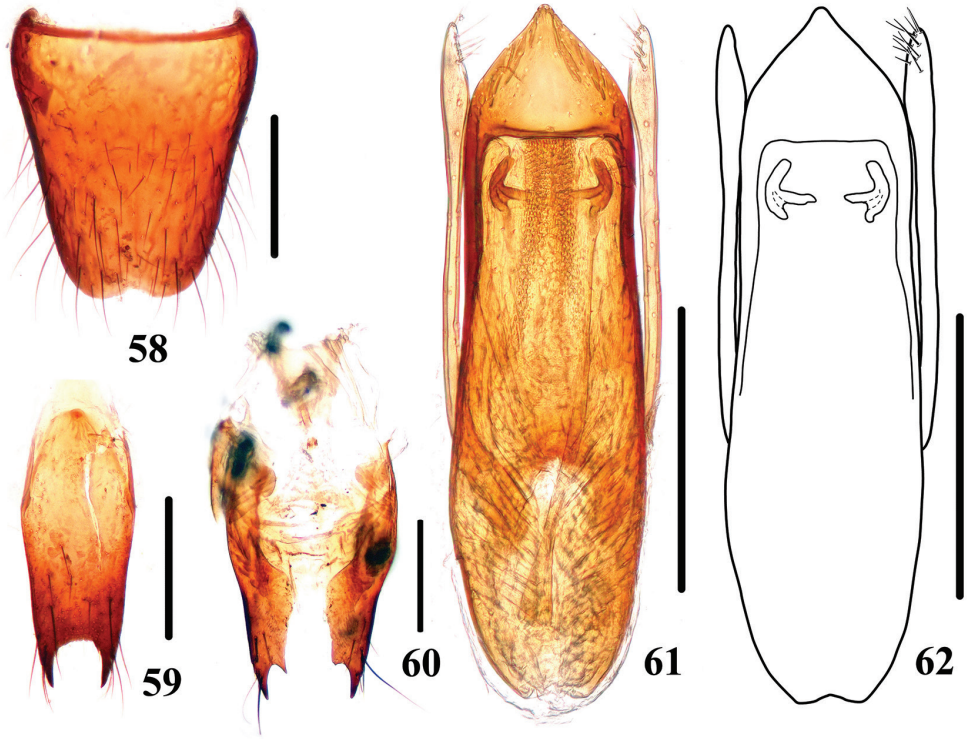
Figs 9, 58–62

Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichaun Prov., Dayi County, Xiling Xueshan, 30°41'57"N, 103°09'44"E, mixed leaf litter, shifted, 3150 m, 28.VII.2015, Jiang, Peng, Tu & Zhou leg." "Holotype / *Stenus zhoudeyaoi* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 2♂♂3♀♀, same data as for the holotype (1 pair in cPut, rest in SHNU).

Description. BL: 3.3–3.6mm, FL: 1.6–1.7 mm.

HW: 0.67–0.77 mm, PL: 0.53–0.58 mm, PW: 0.54–0.60 mm, EL: 0.56–0.62 mm, EW: 0.64–0.71 mm, SL: 0.41–0.45 mm. Head 1.04–1.08 times as wide as elytra, pronotum 0.97–1.00 times as long as wide, elytra 0.87–0.91 times as long as wide.

Similar to *S. xilingmontis* sp. n. in most aspects, but differs in the following characters: Body coloration darker; punctation of pronotum and elytra less confluent. Sexual characters are also similar to *S. xilingmontis* sp. n. except the aedeagus and spermatheca. Aedeagus (Figs 61, 62) with apical sclerotized area larger and expulsion clasps smaller;



Figures 58–62. *Stenus zhoudeyaoi*. **58** male sternite VIII **59** male sternite IX **60** valvifers **61, 62** aedeagus. Scale bars: 0.25 mm.

parameres each with 9 or 10 setae on apico-internal margins. Spermatheca (Fig. 60) with very small sclerotized basal porch and basal duct, remining part of the duct very weakly sclerotized.

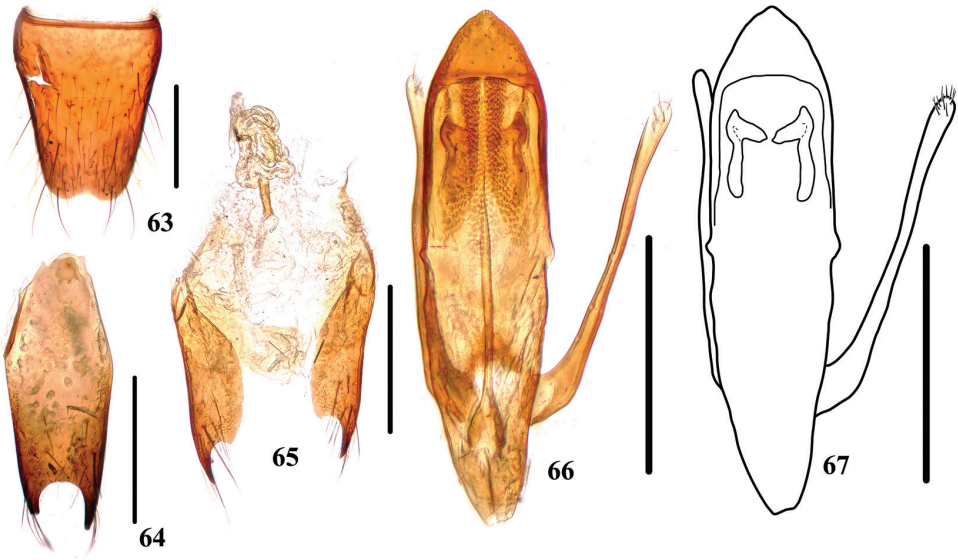
Distribution. China (Sichuan).

Remarks. See that of *S. xilingmontis* sp. n.

Etymology. This species is named in honor of Mr. De-Yao Zhou who collected some specimens of the new species.

***Stenus jiajinshanus* sp. n.**
http://zoobank.org/45EF8C89-BC0B-429C-91AB-D8D5C28DB424
Figs 10, 63–67

Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan Prov., Xiaojin County, Jiajin Shan, 30°48'49"N, 102°42'55"E, mixed leaf litter, sifted, 2490 m, 20.VII.2015, Jiang, Peng, Tu & Zhou leg." "Holotype / *Stenus jiajinshanus* / Tang, Liu & Niu" [red handwritten label] (SHNU). **Paratypes.** 1♂, same data as for the holotype (SHNU); 1 ♀, Xiaojin County, Jiajin Shan,



Figures 63–67. *Stenus jiajinshanus*. **63** male sternite VIII **64** male sternite IX **65** valvifers and spermatheca **66, 67** aedeagus. Scale bars: 0.25 mm.

Mahuanggou, 30°51'20"N, 102°45'49"E, 2630 m, 21.VII.2015, Jiang, Peng, Tu & Zhou leg. (SHNU)

Description. Brachypterous; forebody yellowish brown except areas along the inner margins of eyes slightly darker, abdomen reddish brown. Antennae, maxillary palpi and legs reddish yellow, except antennal club infuscate.

BL: 3.1–3.2mm, FL: 1.5–1.6 mm.

HW: 0.65–0.68 mm, PL: 0.48–0.49 mm, PW: 0.49–0.50 mm, EL: 0.47–0.50 mm, EW: 0.55–0.59 mm, SL: 0.35–0.40 mm.

Head 1.15–1.19 times as wide as elytra, interocular area with two deep longitudinal furrows, median portion convex, distinctly extending beyond the level of inner eye margins; punctures round, mostly well delimited, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices smooth, much narrower than half the diameter of punctures except those along the midline of the convex median portion, which may be as wide as diameter of punctures. Paraglossa coniform.

Pronotum 0.98 times as long as wide, disk uneven, with distinct median longitudinal furrow, two impressions in anterior half, transverse impression in the middle, and two impressions in posterior half; punctures slightly confluent, of similar size to those of head; interstices smooth, more or less narrower than half the diameter of punctures except those at the bottom of longitudinal furrow, which could be larger.

Elytra 0.85–0.86 times as long as wide; disk moderately uneven with shallow longitudinal humeral impression, distinct postero-lateral impression and long sutural impression, suture moderately convex; punctures more or less longitudinally confluent,

slightly larger than those of pronotum; interstices smooth, distinctly narrower than half the diameter of punctures.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; line-like paratergites present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membranous fringe; punctures of abdominal tergites III–VIII round to elliptic, gradually becoming smaller posteriad; interstices smooth except those of last two tergites shallowly reticulated, narrower than half the diameter of punctures.

Male. Sternite VIII (Fig. 63) with semi-circular emargination at middle of posterior margin; sternite IX (Fig. 64) with very long apicolateral projections. Aedeagus (Figs 66, 67) slender, apical sclerotized area subtriangular with round tip; expulsion clasps large; parameres distinctly shorter than median lobe, slightly swollen in apical part, with 9–10 setae on apico-internal margins.

Female. Sternite VIII entire; spermatheca (Fig. 65) with basal duct strongly sclerotized, remining part of the duct weakly sclerotized and very coiled.

Distribution. China (Sichuan).

Remarks. To distinguish the new species from other species with small body length, see characters listed in key.

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

***Stenus tuyueyei* sp. n.**

http://zoobank.org/18B37947-DD90-4038-A558-8E1AD685C6AC

Figs 11, 68–71

Type material. Holotype. China: Sichuan: ♂, glued on a card with labels as follows: "China: Sichuan, Mianning Co., Yele, Daba, 26°55'22"N, 102°13'32"E, mixed leaf litter, sifted, 2500 m, 25.VI.2015, Jiang, Peng, Tu & Zhou leg." "Holotype / *Stenus tuyueyei* / Tang, Liu & Niu" [red handwritten label] (SHNU).

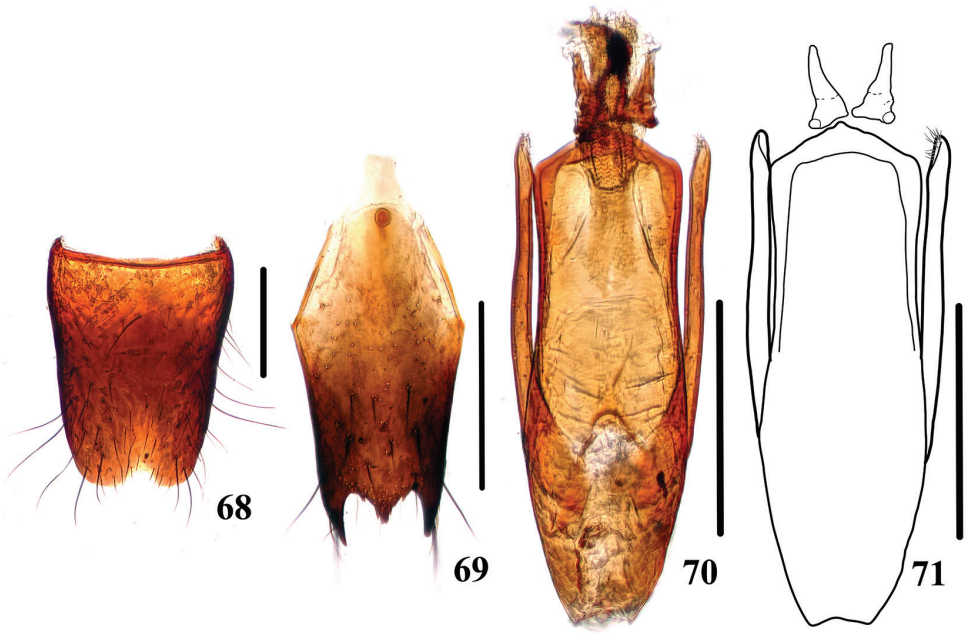
Description. Brachypterous; body blackish with pronotum and elytra somewhat lighter, antennae, maxillary palpi and legs reddish yellow, except antennal club infuscate.

BL: 3.8mm, FL: 1.8 mm.

HW: 0.73 mm, PL: 0.57 mm, PW: 0.57 mm, EL: 0.61 mm, EW: 0.64 mm, SL: 0.44 mm.

Head 1.14 times as wide as elytra; interocular area with two deep longitudinal furrows, median portion convex, reaching the level of inner eye margins; punctures round, slightly larger on posterior areas of furrows than those on rest areas, diameter of large punctures about as wide as basal cross section of antennal segment II; interstices smooth, much narrower than half the diameter of punctures except those along the midline of the convex median portion, which may be as wide as diameter of punctures. Paraglossa coniform.

Pronotum as long as wide; disk uneven, with distinct median longitudinal furrow, two impressions in anterior half, transverse impression in the middle, and two



Figures 68–71. *Stenus tuyueyei*. **68** male sternite VIII **69** male sternite IX **70, 71** aedeagus. Scale bars: 0.25 mm.

impressions in posterior half; punctures more or less confluent, of similar size to those of head; interstices faintly reticulated, more or less narrower than half the diameter of punctures except those at the bottom of longitudinal furrow, which could be three times as wide as diameter of punctures.

Elytra 0.95 times as long as wide; disk relatively uneven with shallow longitudinal humeral impression, distinct postero-lateral impression and long sutural impression, suture moderately convex; punctation and interstices similar to those of pronotum.

Legs with tarsomeres IV deeply bilobed.

Abdomen cylindrical; distinct paratergites absent, rudimentary lateral border present only on anterior half of segment III, tergites and sternites totally fused in posterior half of segment III and entire segment IV–VI; posterior margin of tergite VII without membranous fringe; punctures mostly round, becoming slightly smaller posteriad; interstices smooth except those of last three tergites shallowly reticulated, larger to much larger than diameter of punctures except those on basal impressions of basal three abdominal tergites, which could be narrower than half the diameter of punctures.

Male. Sternite VIII (Fig. 68) with triangular emargination at middle of posterior margin; sternite IX (Fig. 69) with very long apicolateral projections, posterior margin with long and sharp median projection. Aedeagus (Figs 70, 71) robust; apical sclerotized area very wide and short with small and round tip; expulsion clasps large; parameres a little shorter than median lobe, slightly swollen in apical part, with 12 setae on apico-internal margins.

Female. Unknown.

Distribution. China (Sichuan).

Remarks. The new species can be readily separated from other related species by abdominal segment III fused on posterior half.

Etymology. This species is named in honor of Mr. Yue-ye Tu who collected some specimens of the new species.

***Stenus dabashanus* sp. n.**
http://zoobank.org/66E26213-259C-4742-9E50-F0F57A822146
Figs 12, 72–76

Type material. Holotype. China: Shaanxi: ♂, glued on a card with labels as follows: "China: S-Shaanxi (Daba Shan), NW Pass 25km NW Zhenping, 32°01'N, 109°19'E, 2150 m, 11.VII.2001, M. Schülke leg. [C01-09]." "Holotype / *Stenus dabashanus* / Tang, Liu & Niu" [red handwritten label] (cSch). **Paratypes.** 1♂3♀♀, same data as for the holotype (1♀ in SHNU, rest in cSch); 1♀, Daba Shan creek vall., SE pass 20km NW Zhenping, 31°59'N, 109°22'E, 1680 m, 11.VII.2001, A. Smetana leg. (cSme); 1♀, Daba Shan creek vall., SE pass 25km NW Zhenping, 32°01'N, 109°19'E, 2150 m, 11.VII.2001, A. Smetana leg. (cSme).

Description. Brachypterous; body reddish brown except interocular area of head and abdominal segments VIII–X blackish. Antennae, maxillary palpi and legs yellowish brown except antennal club infuscate.

BL: 2.9–3.8 mm, FL: 1.5–1.7 mm.

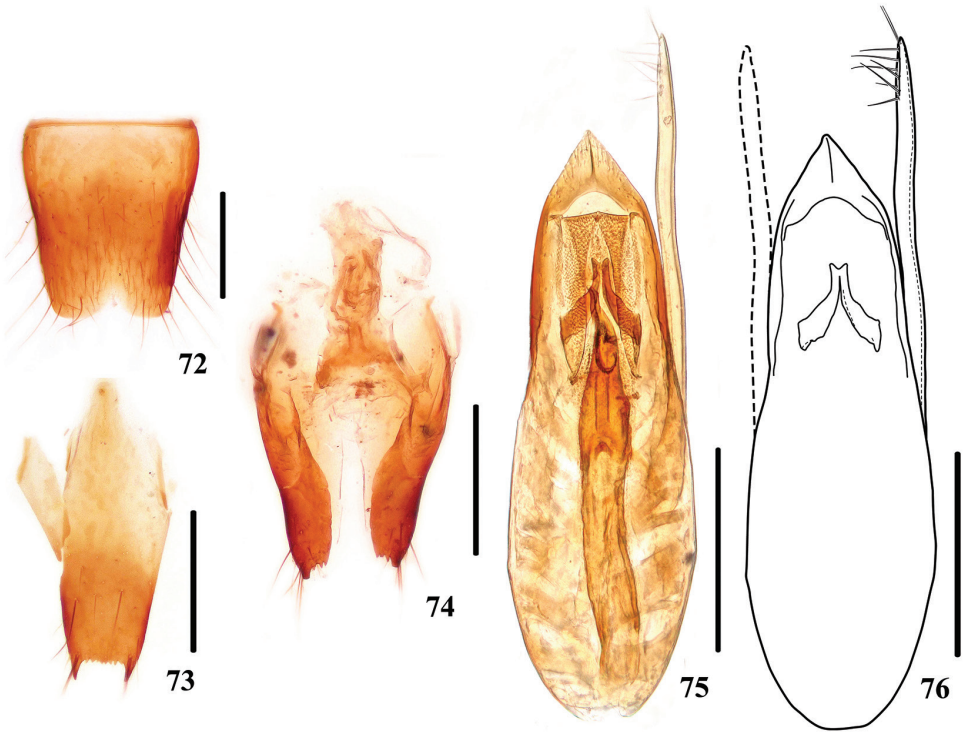
HW: 0.70–0.83 mm, PL: 0.50–0.60 mm, PW: 0.50–0.60 mm, EL: 0.50–0.63 mm, EW: 0.60–0.68 mm, SL: 0.31–0.38 mm.

Head 1.15–1.21 times as wide as elytra, interocular area with two deep longitudinal furrows, median portion convex, extending beneath the level of inner eye margins; punctures round, mostly well delimited, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as basal cross section of antennal segment II; interstices faintly reticulated, much narrower than half the diameter of punctures except those along the midline of the convex median portion, which may be twice as wide as diameter of punctures. Paraglossa coniform.

Pronotum 0.96–1.05 times as long as wide; disk uneven, with median longitudinal furrow throughout; punctures confluent, of similar size to large punctures of head; interstices reticulated, narrower than half the diameter of punctures everywhere.

Elytra 0.83–0.93 times as long as wide, disk moderately uneven with distinct longitudinal humeral impression, distinct postero-lateral impression and long sutural impression, suture moderately convex; punctures longitudinally confluent and slightly larger than those of pronotum; interstices faintly reticulated, narrower than half the diameter of punctures.

Legs with hind tarsi 0.73 times as long as hind tibiae, tarsomeres IV deeply bilobed.



Figures 72–76. *Stenus dabashanus*. **72** male sternite VIII **73** male sternite IX **74** valvifers and spermatheca **75, 76** aedeagus. Scale bars: 0.25 mm.

Abdomen cylindrical; line-like paratergites present only in segment III, tergites and sternites totally fused in segment IV–VI, tergite VII without apical membranous fringe; punctures distinctly smaller than those of elytra, gradually becoming smaller posteriad; interstices smooth, wider than the diameter of punctures except some on tergites III and IV, which could be smaller.

Male. Sternite VII with week emargination at middle of posterior margin; sternite VIII (Fig. 72) with semi-circular emargination at middle of posterior margin; sternite IX (Fig. 73) with long apicolateral projections, posterior margin serrate. Aedeagus (Figs 75, 76) slender, apical sclerotized area triangular with a keel along the middle; expulsion clasps large, strongly sclerotized; parameres much longer than median lobe, with 9–10 setae on apico-internal margins.

Female. Sternite VIII slightly prominent at middle of posterior margin; spermatheca (Fig. 74) weekly sclerotized, basal porch large and spermathecal duct with multiple bends.

Distribution. China (Shaanxi).

Remarks. The species can be easily recognized by distinctly darkened abdominal tip and reticulated forebody.

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

Key to species of the *Stenus flammeus* group

1 Abdominal segment III without distinct paratergites, rudimentary lateral border present only on the anterior half, tergite and sternite entirely fused on the posterior half. Habitus: Fig. 11; sexual characters: Figs 68–71 ..... ***S. tuyueyei***

– Abdominal segment III with line-like paratergites, tergite and sternite clearly separated..... **2**

2 Smaller with BL=2.9–3.9 mm and FL=1.5–1.9 mm..... **3**

– Larger with BL=4.0–5.7 mm and FL=2.0–2.4 mm..... **10**

3 Last three abdominal segments distinctly darker than the basal segments; head, pronotum and elytra with interstices reticulated. Habitus: Fig. 12; sexual characters: Figs 72–76..... ***S. dabashanus***

– Abdominal segments unicolor; head, pronotum and elytra with interstices smooth or rarely reticulated only at the bottom of longitudinal furrow of pronotum..... **4**

4 Head much wider than elytra with HW/EW=1.25–1.31. Habitus: Fig. 1; sexual characters: Figs 13–17 ..... ***S. pengzhongi***

– Head less wider than elytra with HW/EW=1.04–1.19..... **5**

5 Punctation of entire body very dense, head with interstices along the midline narrower than diameter of punctures. Habitus: Fig. 5; sexual characters: Figs 36–40 ..... ***S. punctidorsus***

– Punctation of entire body relatively sparse, head with some interstices along the midline distinctly wider than diameter of punctures **6**

6 Elytra especially sutural impression with punctation longitudinally confluent and interstices very narrow and ridge-like **7**

– Elytra especially sutural impression with punctation less confluent and interstices broader **8**

7 Robust, HW/EW=1.03–1.07, PL/PW=0.91–0.95 and EL/EW=0.82–0.90. Habitus: Fig. 2; sexual characters: Figs 18–23 ..... ***S. jindingianus***

– Slender, HW/EW=1.11–1.17, PL/PW=0.95–1.02 and EL/EW=0.91–0.96. Habitus: Fig. 3; sexual characters: Figs 24–29 ..... ***S. corniculus***

8 Pronotum narrower with PW=0.49–0.50 mm, head much wider than elytra with HW/EW=1.15–1.21. Habitus: Fig. 10; sexual characters: Figs 63–67 ..... ***S. jiajinshanus***

– Pronotum broader with PW=0.54–0.63 mm, head less wider than elytra with HW/EW=1.04–1.09 ..... **9**

9 Aedeagus (Figs 56, 57) with small apical sclerotized area; expulsion clasps long. Habitus: Fig. 8..... ***S. xilingmontis***

– Aedeagus (Figs 61, 62) with large apical sclerotized area; expulsion clasps short. Habitus: Fig. 9..... ***S. zhoudeyaoi***

10 Pronotum much shorter than width with PL/PW=0.90–0.96. Habitus: Fig. 6; sexual characters: Figs 41–46 ..... ***S. paraflammeus***

– Pronotum at most slightly shorter than width with PL/PW=0.99–1.07 ....**11**
11 Elytra much shorter than width with EL/EW=0.84–0.92 .....**12**
– Elytra at most slightly shorter than width with EL/EW=0.98–1.03 .....**13**
12 Posterior margin of male sternite IX with long median projection; spermatheca with very long basal porch. Habitus: Fig. 5 in Tang, Zhao & Puthz, 2008; sexual characters: Figs 25–29 in Tang, Zhao & Puthz, 2008 .... ***S. flammeus***
– Posterior margin of male sternite IX with short median projection; spermatheca with short basal porch. Habitus: Fig. 7; sexual characters: Figs 47–52 ..... ***S. pseudoflammeus***
13 Body coloration darker with head entirely black; punctation of pronotum very confluent; interstices narrowed into rugae. Habitus: Fig. 6 in Tang, Zhao & Puthz, 2008; sexual characters: Figs 30–34 in Tang, Zhao & Puthz, 2008 ..... ***S. bostrychus***
– Body coloration lighter with head brown to dark brown; punctation of pronotum less confluent; interstices mostly not narrowed into rugae. Habitus: Fig. 4; sexual characters: Figs 30–35 .....***S. daicongchaoi***

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We express our sincere gratitude to dear Dr. V. Puthz (Schlitz) for his constant guidance on our study, to Dr. A. Smetana (Ottawa), Prof. Y. Watanabe (Tokyo) and Mr. M. Schülke (Berlin) for providing material, and to all the collectors mentioned in the paper.

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RESEARCH ARTICLE

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Predaceous water beetles (Coleoptera, Hydradephaga) of the Lake St Lucia system, South Africa: biodiversity, community ecology and conservation implications

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Abstract

Water beetles are one of the dominant macroinvertebrate groups in inland waters and are excellent ecological indicators, reflecting both the diversity and composition of the wider aquatic community. The predaceous water beetles (Hydradephaga) make up around one-third of known aquatic Coleoptera and, as predators, are a key group in the functioning of many aquatic habitats. Despite being relatively well-known taxonomically, ecological studies of these insects in tropical and subtropical systems remain rare. A dedicated survey of the hydradephagan beetles of the Lake St Lucia wetlands (South Africa) was undertaken between 2013 and 2015, providing the first biodiversity census for this important aquatic group in the iSimangaliso Wetland Park, a UNESCO World Heritage Site within the Maputaland biodiversity hotspot. A total of 32 sites covering the entire spectrum of waterbody types were sampled over the course of three collecting trips. The Lake St Lucia wetlands support at least 68 species of Hydradephaga, a very high level of diversity comparing favourably with other hotspots on the African continent and elsewhere in the world and a number of taxa are reported for South Africa for the first time. This beetle assemblage is dominated by relatively widespread Afrotropical taxa, with few locally endemic species, supporting earlier observations that hotspots of species richness and centres of endemism are not always coincident. Although there was no significant difference in the number of species supported by the various waterbody types sampled, sites with the highest species richness were mostly temporary depression wetlands. This

contrasts markedly with the distribution of other taxa in the same system, such as molluscs and dragonflies, which are most diverse in permanent waters. Our study is the first to highlight the importance of temporary depression wetlands and emphasises the need to maintain a variety of wetland habitats for aquatic conservation in this biodiverse region.

Keywords
Aquatic beetles, biodiversity census, Afrotropical region, wetland conservation, iSimangaliso Wetland Park

Introduction

The aquatic Adephaga, or Hydradephaga, with over 5300 species currently described worldwide, account for around one third of the total aquatic and semi-aquatic beetles described to date (Lancaster and Downes 2013). The group is dominated by the diving beetles (Dytiscidae), with over 4300 species globally (Nilsson 2015), but also includes the familiar whirligig beetles (Gyrinidae), the crawling water beetles (Haliplidae) and the burrowing water beetles (Noteridae), as well as a number of smaller families with largely relictual distributions (Shull et al. 2001, Beutel et al. 2005, Stals and de Moor 2007, Jäch and Balke 2008, Toussaint et al. 2016).

Hydradephaga are important predators in aquatic systems, consuming a wide variety of benthic and pelagic invertebrates, mainly other insects and crustaceans (Beutel and Leschen 2005, Lancaster and Downes 2013, Culler et al. 2014). Due to their aerial respiration and winged adults, many species are able to fly long distances and move between waterbodies in response to, for example, seasonal drought – a strategy most common in the inhabitants of small, temporary lentic waters (Bilton 2014a). Like most aquatic beetles, Hydradephaga are primarily freshwater insects, but a number of species are adapted to high salinities and may dominate the macroinvertebrate fauna of hypersaline inland waters (Stals and de Moor 2007, Millan et al. 2011, Lancaster and Downes 2013); indeed as a group, the aquatic Adephaga are found across the entire spectrum of inland waters, making them an excellent focal taxon in freshwater ecology and conservation (Foster and Bilton 2014). Hydradephaga, and indeed water beetles in general, are excellent surrogates of wider freshwater macroinvertebrate biodiversity, their assemblages reflecting not only overall species richness, but also patterns of community composition very well (Bilton et al. 2006, Sánchez-Fernández et al. 2006, Guareschi et al. 2015). Water beetles are diverse both ecologically and in terms of life-history (Jäch and Balke 2008), and are functionally important in most inland waters, being involved in a range of ecosystem processes such as nutrient cycling and processing. They have been used to select priority areas for aquatic conservation in a number of countries and regions (e.g. Foster et al. 1989, Sánchez-Fernández et al. 2004, Foster and Bilton 2014), but despite excellent global or regional catalogues (e.g. Nilsson 2001, Nilsson and van Vondel 2005) this is hampered in many areas by a lack of baseline ecological data, particularly in the Afrotropics.

Lake St Lucia on the north-east coast of South Africa is a prominent coastal system, historically communicating freely with the open ocean most of the time. Recently, freshwater deprivation related to anthropogenic manipulation and a regional drought has led to large-scale desiccation and closure of its mouth since July 2002 (Whitfield and Taylor 2009, Perissinotto et al. 2013). However, climatic conditions in the area have changed, with the establishment of a new wet phase during the period 2010 - 2014. This has resulted in repeated flood events, with large amounts of fresh water flowing into the system and changing the prevailing salinity state from hypersaline to oligo- or polyhaline.

Lake St Lucia itself sits within the iSimangaliso Wetland Park, South Africa's first UNESCO World Heritage Site, and a Ramsar wetland of global significance due to its exceptional biodiversity. iSimangaliso and the coastal plains of KwaZulu-Natal form part of Maputaland, a centre of endemism and transition zone between tropical lowlands to the north and temperate regions to the south and west. Warm currents flowing south from Mozambique mean that the region's biota is now dominated by tropical species at what is a relatively high southern latitude (van Wyk and Smith 2001, Connell et al. 2013).

A detailed biodiversity census has already been completed for some prominent invertebrate groups at St Lucia/iSimangaliso, including the bivalves (Nel et al. 2013), gastropods (Perissinotto et al. 2014) and true crabs (Peer et al. 2014). Historically, there has been little dedicated work on the aquatic insects of the park, with the exception of opportunistic collections (some now deposited in museums) and a few publications in the grey literature (e.g. Vrdoljak 2004). An extensive study of the Odonata has been completed recently (Hart et al. 2014), however, revealing a rich fauna at iSimangaliso. As preliminary investigations suggested high aquatic beetle diversity in the park, the current study was undertaken to provide a better understanding of aquatic beetle biodiversity in this globally important region. Here we provide records for all hydradephagan species recorded during dedicated surveys at iSimangaliso, together with multivariate analyses of predaceous water beetle assemblage composition and a brief review of historical records. Given the general lack of such data from southern Africa, and the Afrotropical region in general, our study provides a valuable baseline for the study of this key group of freshwater macroinvertebrates in southern Africa.

Methods

Study area

Samples were collected in and around Lake St Lucia (27°52'0"S to 28°24'0"S and 32°21'0"E to 32°34'0"E), a large (~ 300 to 350 km^2) estuarine lake in northern KwaZulu-Natal, South Africa (Fig. 1). The St Lucia system comprises three interconnected shallow lakes (South Lake, North Lake and False Bay) that are linked to the Indian

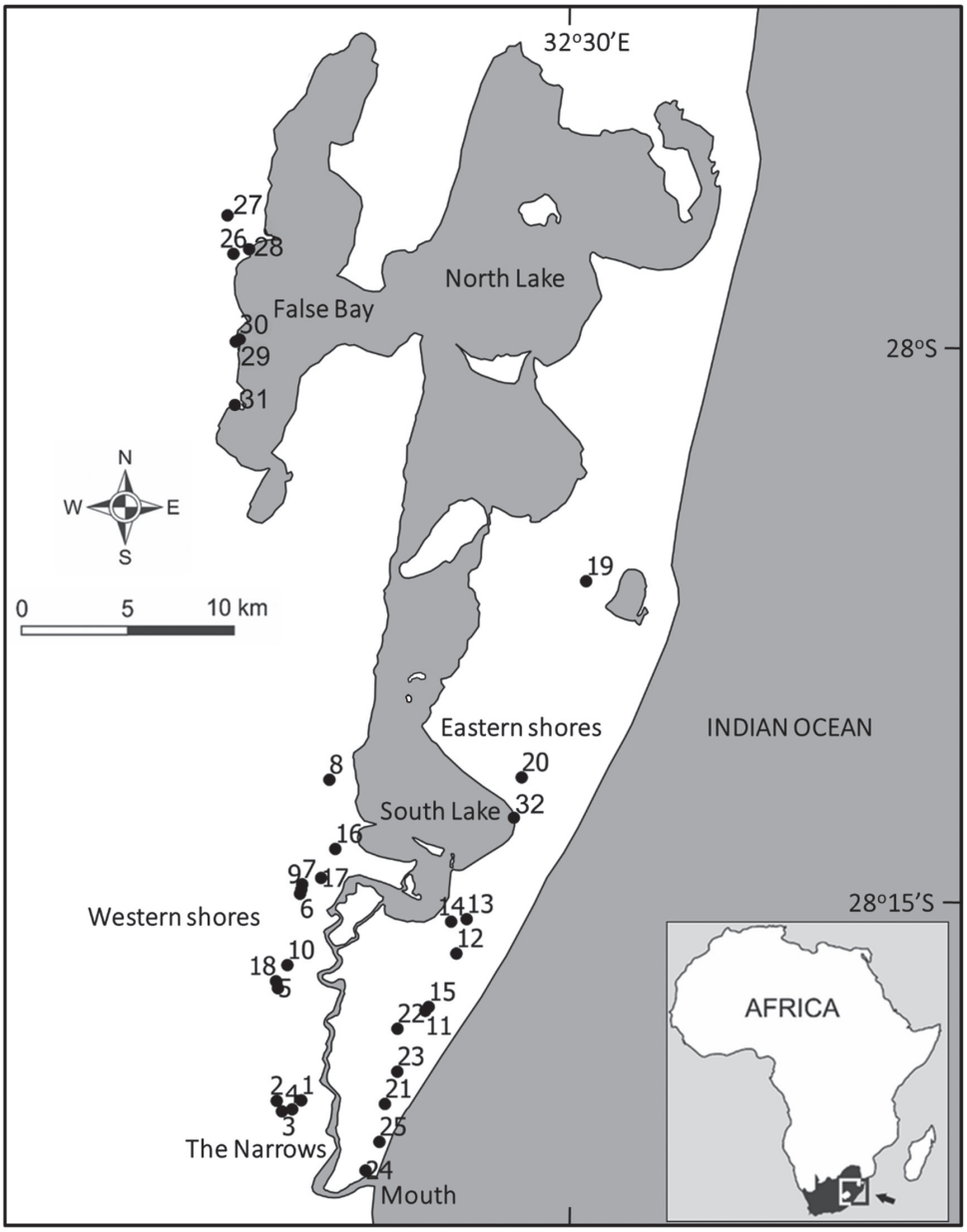

Figure 1. The Lake St Lucia system in northern KwaZulu-Natal. The locations of sites sampled between November 2013 and February 2015 are depicted. Site numbers 1–32 correspond to those in Table 1.

Ocean via a narrow channel (known as the Narrows) of 21 km in length (Fig. 1). Dedicated surveys of the aquatic beetles of Lake St Lucia and its associated wetlands were undertaken during November 2013 (19th–30th), July 2014 (23rd–24th) and January-February 2015 (31st January–6th February).

Table 1. Geographic position and classification of the waterbodies sampled during this study. Sampling took place during the three collecting trips to Lake St Lucia during November 2013, July 2014 and January/February 2015. Classification (wetland type) follows the hydrogeomorphic (HGM) approach of Ollis et al. (2015). WS – Western Shores; ES – Eastern Shores; FB – False Bay.

Site	GPS (D°M'S")		Wetland type	Region	November 2013	July 2014	January/ February 2015
1	28°20'53.33"S	32°23'38.42"E	River (pool)	WS		x	x
2	28°20'54.23"S	32°22'59.68"E	Depression	WS		x	
3	28°21'10.77"S	32°23'7.88"E	Channelled valley bottom	WS		x	
4	28°21'7.52"S	32°23'24.04"E	Channelled valley bottom	WS		x	
5	28°17'55.76"S	32°23'10.62"E	River (riparian zone)	WS		x	
6	28°15'26.06"S	32°23'36.51"E	Depression	WS	x	x	x
7	28°15'11.10"S	32°23'39.95"E	Depression	WS	x	x	x
8	28°12'25.44"S	32°24'22.97"E	Depression (artificial)	WS		x	
9	28°15'19.19"S	32°23'38.53"E	Depression	WS		x	
10	28°17'19.08"S	32°23'16.53"E	Depression	WS		x	
11	28°18'31.52"S	32°26'54.54"E	Un-channelled valley bottom	ES		x	
12	28°17'00.81"S	32°27'43.78"E	Depression	ES		x	
13	28°16'6.26"S	32°28'00.02"E	Depression	ES		x	x
14	28°16'10.26"S	32°27'35.43"E	Depression	ES		x	x
15	28°18'25.29"S	32°26'59.88"E	Un-channelled valley bottom	ES		x	
16	28°14'15.05"S	32°24'32.30"E	Depression	WS			x
17	28°15'1.00"S	32°24'9.85"E	Channelled valley bottom	WS			x
18	28°17'44.59"S	32°22'58.49"E	Flat	WS			x
19	28°07'10.99"S	32°31'8.98"E	Un-channelled valley bottom	ES			x
20	28°12'21.75"S	32°29'27.07"E	River (main channel)	ES			x
21	28°20'59.06"S	32°25'50.76"E	Depression	ES			x
22	28°18'59.92"S	32°26'10.64"E	Depression	ES			x
23	28°20'7.84"S	32°26'10.36"E	Depression	ES			x
24	28°22'44.46"S	32°25'20.13"E	River (connected to estuary)	ES			x
25	28°21'59.12"S	32°25'42.10"E	Depression	ES			x
26	27°58'32.33"S	32°21'51.14"E	Depression	FB			x
27	27°57'31.50"S	32°21'41.82"E	Depression	FB	x		x
28	27°58'25.01"S	32°22'16.02"E	Channelled valley bottom	FB			x
29	28°00'51.44"S	32°21'54.93"E	Channelled valley bottom	FB	x		x
30	28°00'47.95"S	32°22'00.92"E	Estuarine lake	FB	x		x
31	28°02'9.17"S	32°21'42.78"E	Estuarine lake shore (light trap)	FB	x	x	x
32	28°13'14.56"S	32°29'12.45"E	Seep	ES			x

Aquatic beetles were collected from a variety of freshwater habitats surrounding Lake St Lucia and from submerged vegetation habitats at the margins of the estuary itself. A total of 32 sites comprising a wide variety of waterbodies was sampled over the course of the three collection trips (Fig. 1). Sites were chosen in an attempt to cover the range of wetland habitats present in the region, and ranged from open water in the lake itself to the small forest pools and seepages. They also covered most of the geographi-

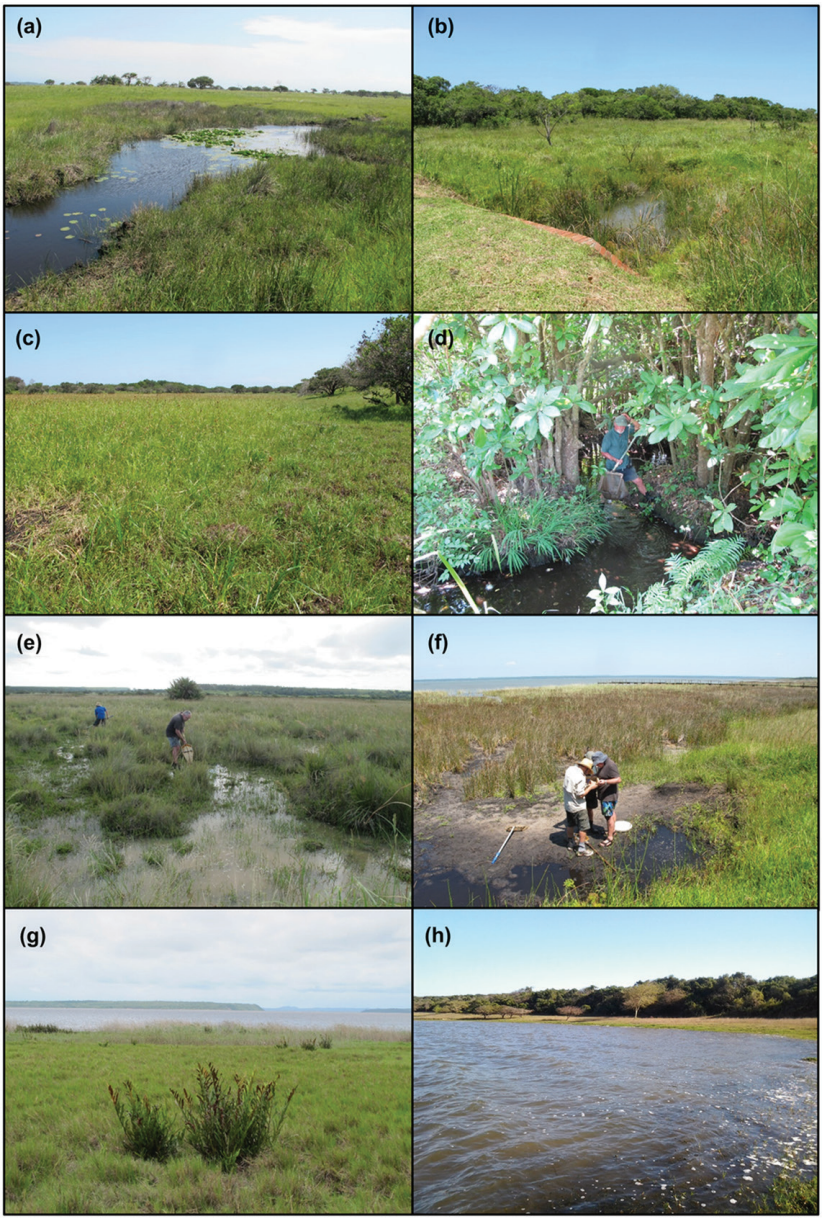

Figure 2. Examples of the wetland habitat types encountered in the St Lucia section of the iSimangaliso Wetland Park during the course of this study. **a** Depression (site 13) **b** valley bottom (channelled, site 17) **c** valley bottom (unchannelled, site 19) **d** river (site 20) **e** wetland flat (site 18) **f** seepage (site 32) **g** estuarine lake shore (site 31) **h** estuarine lake body (site 30).

cal area contained within the St Lucia section of the iSimangaliso Wetland Park. Parts of the western shore (lack of freshwater habitats) and the entire northern and north-eastern shore of the lake (inaccessibility) were not covered by this study.

In addition to sampling of the estuarine lake itself (Fig. 2g–h), the following wetland habitats were sampled (following the classification scheme of Ollis et al. 2015): depression wetlands (both isolated and non-isolated, Fig. 2a); valley bottom wetlands (both channelled and un-channelled, Fig. 2b–c); rivers (both in-channel and riparian habitats, Fig. 2d); a wetland flat (Fig. 2e); and a seepage wetland (Fig. 2f). The most frequently encountered habitat was depression wetlands (n = 16), followed by valley bottom wetlands (n = 8), rivers (n = 4), with a single wetland seep and a single wetland flat. Virtually all habitats encountered in this study were extensively vegetated by a mix of emergent and submerged macrophytes. Although the exact inundation regime is not known for each of the waterbodies, some of the smaller depression and valley bottom wetlands are expected to be temporary systems. This was confirmed during the January-February 2015 sampling expedition, when several of the sites sampled previously were dry. Table 1 provides a summary of the locations sampled, their habitat classification and dates of sampling.

Field sampling protocol

Sweep netting was employed on all three sampling trips as the primary method for collecting aquatic beetles. A long-handled square-framed sweep net with a 30 cm mouth and 1 mm mesh was swept repeatedly from the water surface to the bottom substrate and back to the surface following a protocol similar to that of Bilton et al. (2006) and Bird et al. (2013). Sweep netting effort was concentrated in submerged vegetation and around shore margins. Sampling was not quantitative, but for most waterbodies approximately 20 sweeps were performed (semi-quantitative sampling). In addition to sweep netting, the margins of each waterbody were searched visually for shore beetles and semi-aquatic taxa. A light trap, consisting of a 4x3 m white sheet hung vertically below a fluorescent mercury vapour lamp (Radiant 250 W), was deployed on all three survey trips at False Bay, adjacent to the lake shore, during the evening. Aquatic coleopteran specimens were retrieved from the light sheet by hand. All beetle specimens collected during the November 2013 and July 2014 surveys were killed using ethyl acetate vapour and preserved in 5% formalin solution. Specimens collected during January-February 2015 were preserved in 70% ethanol.

To provide an environmental context for the beetle samples and baseline information for the aquatic habitats of St Lucia, basic *in situ* physico-chemical parameters were measured at each site. Temperature, conductivity, salinity, pH, turbidity and dissolved oxygen were recorded using a YSI 6600-V2 multi-system probe. Due to technical problems, physico-chemical measurements were not taken during November 2013.

Historical records and ad hoc collections

Records of aquatic Coleoptera previously collected from Lake St Lucia and the fresh waterbodies in its immediate vicinity were obtained from the Iziko South African Mu-

seum (ISAM, Cape Town), the Ditsong National Museum of Natural History (DNMNH, Pretoria; formerly the Transvaal Museum) and the South African National Collection of Insects (SANC, Pretoria). Other data on aquatic beetle species collected historically in the St Lucia area were extracted from the works of Biström and Nilsson (2002), Biström et al. (2015), Day et al. (1954), Millard and Broekhuysen (1970) and Vrdoljak (2004). Some specimens were also obtained during opportunistic collections undertaken by the authors during 2008 and 2012. With the exception of species in Biström and Nilsson (2002) and Biström et al. (2015), specimens have not been examined by hydradephagan specialists, meaning that identifications of historical material may be inaccurate in some cases. Apart from species which do not occur in southern Africa (see below), these records are presented here for the sake of completeness, but should be viewed with caution.

Identification and illustrations

All identifications were conducted by DTB, using a wide range of literature and, in many cases, comparison with named museum material. All identifications were based, at least in part, on the study of male genitalia, unless otherwise stated. Digital photographs of both ventral and dorsal habitus of each species were taken using a Canon Powershot G11 or a Canon EOS 600D digital camera fitted with a Sigma 50mm f/2.8 EX DG macro lens for larger specimens (≥ 1.5 cm) and a Nikon SMZ25 microscope for smaller specimens (< 1.5 cm). Image stacks were produced by hand, and combined using Zerene Stacker software (www.zerenesystems.com). Photographs were then compiled into an annotated and illustrated species list of all Hydradephaga identified within the November 2013, July 2014 and January/February 2015 surveys, as well as those collected from 2008 and 2012 during ad hoc collections (Appendix 1).

Statistical analysis

Median and range values for each of the physico-chemical variables were calculated for each survey. The measured physico-chemical variables were then explored using multivariate analyses to assess how the physico-chemistry of freshwater wetlands at St Lucia varies amongst waterbody types and also spatially across the coastal plain. Principal Component Analysis (PCA) was used to depict patterns in physico-chemistry on a two-dimensional plot. Variables with non-normal distributions were log-transformed where appropriate. Conductivity was not depicted in the PCA plot as it was highly collinear with salinity ($r = 0.996$) and thus we regarded conductivity as a redundant variable.

Spatial patterns in the composition of aquatic beetle communities amongst the wetlands at St Lucia were analysed using multivariate techniques. Beetle presence-absence data were converted to a Bray-Curtis dissimilarity matrix and depicted on a two-dimensional plot using non-metric multidimensional scaling (MDS). Permutational

MANOVA (PERMANOVA, Anderson 2001) was used to test for differences in beetle assemblage composition amongst the different regions of St Lucia (eastern shores, western shores and False Bay) and amongst different waterbody types (excluding seeps and flats, for which only one site each was sampled), once again using a Bray-Curtis dissimilarity matrix. Species richness (number of species recorded per waterbody) was similarly compared amongst regions and waterbody types, but in this case, given the univariate data, the Kruskal-Wallis non-parametric ANOVA approach was used.

All tests were performed using an *a priori* significance level of $\alpha = 0.05$. PCA and MDS were performed using PRIMER v6 software (Clarke and Warwick 2001, Clarke and Gorley 2006). Permutational MANOVA was performed using the PERMANOVA routine in the PERMANOVA+ add-on package (Anderson et al. 2008) to PRIMER v6. P-values for PERMANOVA models were tested using 9999 unrestricted permutations of the raw data. Univariate techniques for species richness analyses were implemented using Statistica 12 software for Windows (Statsoft Inc. 2015).

Results

Physico-chemical characteristics of St Lucia waterbodies

Waterbodies encountered on the St Lucia coastal plain were mostly groundwater-fed depressions and valley bottom wetlands. These freshwater wetlands appeared to be abundant in the study area. True rivers (flow contained within a single main channel) were less common, but several small rivers were encountered and sampled (e.g. Nkazana Stream, site 20). Most waterbodies were small (generally < 2 ha) and shallow (<1 m maximum depth), although some of the valley bottom wetland sites formed part of larger systems (e.g. site 19 forms part of the Mfabeni mire). Due to a general predominance of lentic or slow-flowing systems, rocky biotopes were virtually absent and sites were extensively vegetated by a mix of emergent and submerged macrophytes, which formed the primary structural habitat for all sites sampled.

Surface water temperatures were warm and in summer the median recorded water temperature was as high as ~29 °C (Table 2). Sites were generally fresh with median conductivity and salinity values all below 1 $mS.cm^{-1}$ and 0.5 PSU respectively (Table 2). The exception to this was for sites with a direct connection to the estuarine lake (see Table 1), which, not surprisingly, displayed elevated salinity. Median pH values (Table 2), were close to neutral, but there was substantial variation around the medians and sites ranged from alkaline (e.g. sites 1, 25 and 30) to highly acidic (e.g. sites 4 and 7). Turbidity was extremely variable across sites, waterbodies ranging from very clear (< 10 NTU, e.g. sites 7 and 14) to highly turbid (> 1000 NTU, e.g. sites 10 and 26). Median turbidity values suggest, however, that most sites were moderately turbid (75.8 and 30.2 NTU for the winter and summer sampling expeditions respectively, Table 2). Dissolved oxygen levels were elevated in summer compared to winter (median values of 7.14 and 4.53 $mg.L^{-1}$ respectively, Table 2).

Table 2. Physico-chemical variables recorded during the July 2014 and January/February 2015 surveys. Median, minimum and maximum values are reported for each survey. Physico-chemical data were not collected in November 2013. Depth was not recorded in July 2014. Site 31 is not reported as this was a terrestrial light trapping location.

Survey date	Site	Temperature (°C)	Conductivity (mS.cm^{-1})	Salinity (PSU)	pH	Turbidity (NTU)	Dissolved O_2 (mg.L^{-1})	Depth (m)
July 2014	1	16.59	0.254	0.14	8.61	16.4	4.72	-
	2	16.08	0.471	0.29	6.81	883.6	5.15	-
	3	16.50	0.601	0.35	6.58	194.8	1.81	-
	4	17.08	0.153	0.09	4.60	570.5	1.40	-
	5	17.03	6.726	4.42	6.56	40.2	2.45	-
	6	19.07	0.437	0.24	7.07	831.3	1.61	-
	7	22.81	0.504	0.25	5.22	75.8	3.58	-
	8	21.65	0.475	0.24	7.00	529.1	8.50	-
	9	21.02	0.489	0.26	7.23	183.2	7.88	-
	10	19.17	0.943	0.53	7.33	1220.2	7.83	-
	11	16.98	0.104	0.05	5.97	15.0	3.20	-
	12	22.62	0.221	0.10	6.46	36.7	10.05	-
	13	23.02	0.344	0.16	6.52	11.2	8.08	-
	14	21.96	0.240	0.11	6.60	3.2	4.53	-
	15	19.38	0.214	0.10	5.44	47.0	2.99	-
	Median	19.17	0.437	0.24	6.58	75.8	4.53	-
	Minimum	16.08	0.104	0.05	4.60	3.2	1.40	-
	Maximum	23.02	6.726	4.42	8.61	1220.2	10.05	-
January / February 2015	1	24.02	0.378	0.18	6.62	9.6	1.00	0.34
	6	34.37	1.034	0.50	5.06	30.2	10.23	0.31
	7	32.93	0.923	0.45	3.88	6.1	7.52	0.43
	13	22.47	0.592	0.28	5.69	197.6	4.39	0.38
	14	35.61	0.342	0.16	6.89	29.4	9.92	0.27
	16	31.87	2.551	1.29	7.57	613	3.58	0.24
	17	24.57	1.866	0.95	4.22	21.8	4.23	0.31

Survey date	Site	Temperature (°C)	Conductivity (mS.cm^{-1})	Salinity (PSU)	pH	Turbidity (NTU)	Dissolved O_2 (mg.L^{-1})	Depth (m)
January / February 2015	18	34.23	0.237	0.11	7.32	191.2	7.42	0.26
	19	37.78	0.392	0.18	5.49	18.9	7.25	0.25
	20	24.33	0.411	0.20	5.96	34.8	1.27	0.37
	21	33.28	0.180	0.08	6.77	352.3	7.26	0.20
	22	34.73	0.827	0.40	4.82	25.6	8.13	0.50
	23	34.66	0.414	0.19	5.96	36.6	8.76	0.30
	24	25.84	9.752	5.48	7.65	25.8	4.32	0.70
	25	29.03	1.703	0.85	8.28	17.4	8.95	2.00
	26	26.09	0.323	0.15	7.21	1310.5	1.50	0.08
	27	22.03	0.598	0.29	7.42	151	1.82	0.70
	28	28.69	20.150	11.97	7.98	30.6	9.82	0.15
	29	26.73	1.496	0.75	6.90	306.3	5.53	0.25
	30	22.03	46.640	30.31	8.51	14.2	7.14	0.12
	32	30.03	0.710	0.35	7.55	14.6	6.98	0.05
	Median	29.03	0.710	0.35	6.89	30.2	7.14	0.30
	Minimum	22.03	0.180	0.08	3.88	6.1	1.00	0.05
	Maximum	37.78	46.640	30.31	8.51	1310.5	10.23	2.00

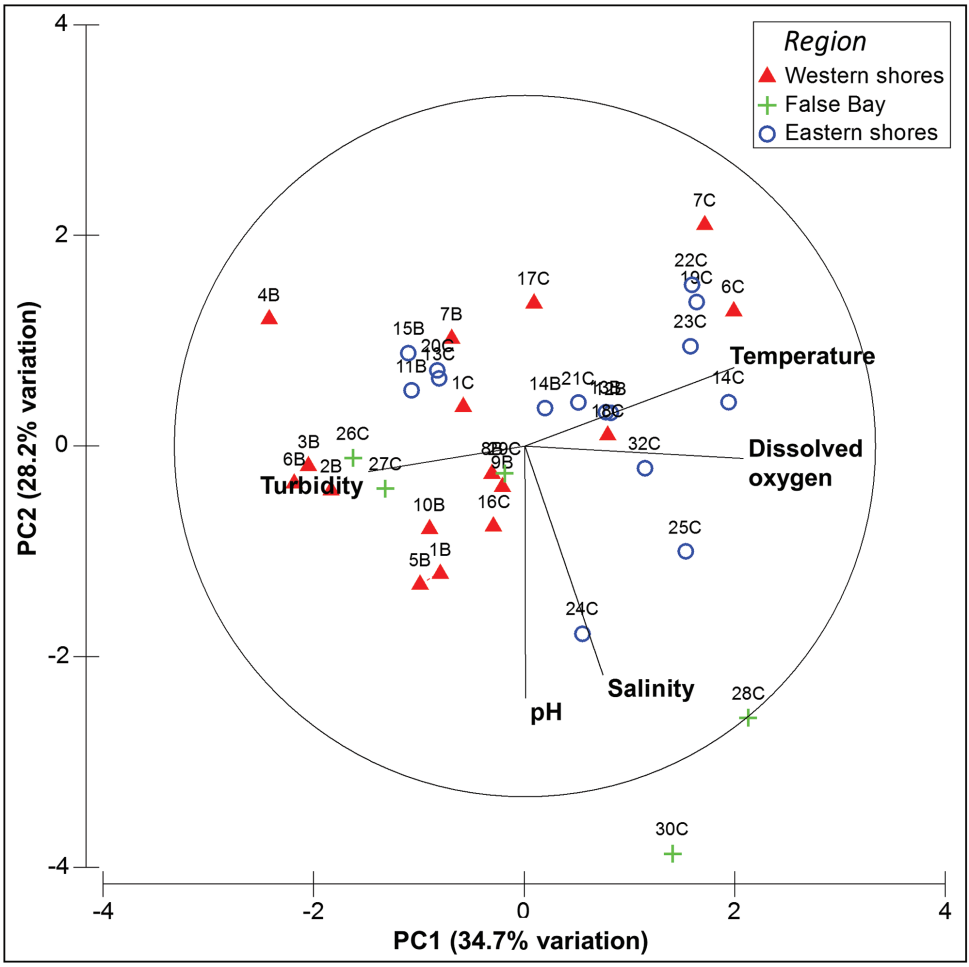

Figure 3. Principal components analysis (PCA) of physico-chemical variables. Sites are shown according to region and site numbers coded as B (July 2014) or C (January/February 2015). Physico-chemical data were not collected during the first survey (November 2013). The first two principal component axes are displayed, with PC1 and PC2 explaining 34.7 and 28.2% of the variation in the physico-chemical data, respectively. Table 2 provides the units in which each of the variables was measured.

The PCA plot (Fig. 3) offers a two-dimensional depiction of the relative positioning of sites according to their physico-chemical characteristics. The waterbodies sampled varied substantially in their overall physico-chemistry, spanning clear gradients of turbidity, temperature and dissolved oxygen, but less so for salinity, with most of the sites being fresh. There was some separation of sites according to season of sampling, with sites sampled in July 2014 (coded 'B' in Fig. 3) generally occurring to the left of the plot and sites sampled in January/February 2015 (coded 'C' in Fig. 3) generally occurring towards the right. Waterbodies across the three regions sampled (eastern shores, western shores and False Bay, see Table 1) showed some differentia-

tion (Fig. 3), with most False Bay sites falling towards the left of the plot, although the overall pattern of differentiation was weaker and there is considerable overlap in physico-chemistry between some individual sites (e.g. sites 7 and 15).

Aquatic beetles

Appendix 1 provides an illustrated checklist of the hydradephagan beetle taxa collected at St Lucia during the course of this study. Sixty-eight taxa were identified across the three sampling occasions (Table 3). Of these, 67 taxa were identified to species level, and one (*Peltodytes* sp., represented only by females) to genus. Of the beetles identified during our surveys, two belonged to the Gyrinidae, two to the Haliplidae, 12 to the Noteridae and 52 to the Dytiscidae. Thus dytiscids overwhelmingly dominated the hydradephagan species richness at St Lucia, as they do worldwide.

Hydradephagan taxa reported at Lake St Lucia and its immediate surrounds prior to our surveys are listed in Table 4. Of these, some were only identified to genus level. Fifteen of the taxa identified to species in previous studies were also recorded in our surveys. Only three unpublished museum records could be found from extensive searches across the collections of South Africa's museums. Of these, *Hydaticus bivittatus* Laporte, 1835 was recorded in the current study (Table 3). Four hydradephagan species were collected by the current authors during *ad hoc* collections made in 2008 and 2012 (Table 4), of which *Cybister natalensis* (Wehncke, 1876), *Hydaticus servillianus* Aubé, 1838 and *Rhantaticus congestus* (Klug, 1833) were all recorded during 2013–2015 (Table 3). *Laccophilus lateralis* Sharp, 1882, reported from St Lucia by Day et al. (1954) and Millard and Broekhuysen (1970) is excluded here since Biström et al. (2015) demonstrate that this species is almost certainly restricted to Madagascar, mainland African records representing other, similar species. Similarly *Aethionectes oberthueri* (Régimbart, 1895), reported by the same authors, is excluded from Table 4 as this species is apparently also a Madagascan endemic. It seems more likely that the record refers to *Aethionectes apicalis* (Boheman, 1848), widely reported in southern Africa (Guignot 1961, Omer-Cooper 1966).

Aquatic beetle assemblage composition of the sites sampled during 2013-2015 differed across both regions and waterbody types (Fig. 4); PERMANOVA tests reveal that these differences were significant (Table 5). In terms of the regions sampled, there appears to be overlap in the MDS plot between the western and eastern shores sites, whilst the False Bay sites appear to be more strongly differentiated (Fig. 4a). This is confirmed by the *post hoc* pairwise comparisons in Table 5a, which demonstrate that the overall significance was driven by differences between False Bay and the other regions. In terms of waterbody type, the different waterbodies formed quite distinct clusters in the MDS, with the exception of valley bottoms, which were scattered widely across the plot (Fig. 4b). The overall significant difference ($P < 0.05$) between waterbody types is confirmed by the PERMANOVA results in Table 5b, which show that this result is driven by differences between depression wetlands and estuarine lake shores/rivers.

Table 3. Hydradephagan beetles collected from St Lucia during the course of this study. The sites are listed from which each taxon was collected on each of the three sampling trips. Site numbers 1–32 correspond to those listed in Table 1. The regions where each taxon occurred are also indicated: WS – western shores; ES – eastern shores; FB – False Bay. Species new to South Africa are shown in bold type.

	Sampling date			Region		
	November 2013	**July 2014**	**January/February 2015**	**WS**	**ES**	**FB**
Gyrinidae:						
Gyrinus natalensis Régimbart, 1892		4		X		
Dineutus subspinosus (Klug, 1834)			21, 23, 29		X	X
Haliplidae:						
Haliplus natalensis Wehncke, 1880			27			X
Peltodytes sp.			6, 27	X		X
Noteridae:						
Canthydrus apicicornis Régimbart, 1895		7, 8, 13	6, 7, 13, 14, 17, 18, 22, 25	X	X	
Canthydrus marshalli Balfour-Browne, 1939			6	X		
Canthydrus notula (Erichson, 1843)		6, 7, 8, 9, 10, 14, 15	6, 7, 14, 16, 17, 21, 22, 23, 27, 29	X	X	X
Canthydrus quadrivittatus (Boheman, 1848)		13	1, 6, 13, 14, 16, 17, 18, 22, 23, 27	X	X	X
Canthydrus sedilloti Régimbart, 1895			1, 6, 13, 14, 16, 17, 22, 23	X	X	
***Hydrocanthus grandis* (Laporte, 1835)**			14		X	
Hydrocanthus micans Wehncke, 1883			1, 6, 14, 17, 22, 23, 29	X	X	X
Hydrocanthus ferruginicollis Régimbart, 1895	27					X
Synchortus imbricatus (Klug, 1853)			1, 7, 16, 17, 25,	X	X	
***Synchortus desaegeri* Gschwendtner, 1935**			23		X	
Neohydrocoptus aethiopicus (Balfour-Browne, 1961)		2	1, 7, 20, 23, 27	X	X	X
Neohydrocoptus angolensis (Peschet, 1925)		1, 2, 3	1, 6, 14, 25, 27	X	X	X
Dytiscidae:						
+*Copelatus* cf. *ejactus* Omer-Cooper, 1965			17, 18, 22, 26, 29	X	X	X
Copelatus erichsoni Guérin-Méneville, 1849			17, 20, 26, 27, 29	X	X	X
Copelatus pulchellus (Klug, 1834)			17, 26, 29		X	X
Cybister gschwendtneri Guignot, 1935	27, 31		14, 27		X	X
Cybister marginicollis Boheman, 1848	27, 31	11	7, 14, 18, 22, 27, 31	X	X	X

	Sampling date			Region		
	November 2013	**July 2014**	**January/February 2015**	**WS**	**ES**	**FB**
Cybister natalensis (Wehncke, 1876)			29			X
Cybister senegalensis Aubé. 1838			6, 27	X		X
Cybister tripunctatus africanus Laporte, 1835			14, 21, 27, 29, 31		X	X
Cybister bimaculatus Aubé, 1838			21		X	
***Cybister ertli* Zimmermann, 1917**		13	14		X	
Cybister vicinus Zimmermann, 1917			21, 23, 27, 29, 31		X	X
Cybister vulneratus Klug, 1834	30	4	6, 14, 16, 17, 18, 19, 23, 27, 29, 31	X	X	X
Rhantaticus congestus (Klug, 1833)	27		21, 22, 23, 27, 29, 31		X	X
Eretes sticticus (Linnaeus, 1767)			21		X	
Hydaticus bivittatus Laporte, 1835			27			X
Hydaticus exclamationis Aubé, 1838			27, 29			X
Hydaticus flavolineatus Boheman, 1848			27			X
+*Hydaticus* cf.*natalensis* Guignot, 1951			27			X
Hydaticus matruelis Clark, 1864			27			X
Hydaticus servillianus Aubé, 1838	27, 30	6, 11	14, 23, 26, 27, 29	X	X	X
Bidessus sharpi Régimbart, 1895			6, 14, 16, 21, 27, 29	X	X	X
Clypeodytes meridionalis Régimbart, 1895		3	14, 20	X	X	
Hydroglyphus farquharensis (Scott, 1912)			6, 14, 16, 17, 18, 21, 22, 27, 28, 29, 31	X	X	X
Hydroglyphus lineolatus (Boheman, 1848)			21, 31		X	X
Hydroglyphus zanz ibarensis (Régimbart, 1906)		2, 3, 10	6, 13, 14, 16, 17, 21, 22, 29, 32	X	X	X
Leiodytes hieroglyphicus (Régimbart, 1894)			7, 17	X	X	
Pseuduvarus viticollis (Boheman, 1848)			32		X	
Uvarus gschwendtneri (Guignot, 1942)			6, 17, 18, 22, 23, 27, 29	X	X	X
Hydrovatus acuminatus Motschulsky, 1859			1, 6, 13, 14, 16, 22, 23, 25, 27, 29	X	X	X
Hydrovatus cribratus Sharp, 1882			6, 7, 14, 16	X	X	
Hydrovatus dentatus Bilardo & Rocchi, 1990			14, 17, 21	X	X	
***Hydrovatus eximius* Biström, 1997**			29			X
Hydrovatus nefandus Omer-Cooper, 1957			23, 27		X	X

	Sampling date			Region		
	November 2013	**July 2014**	**January/February 2015**	**WS**	**ES**	**FB**
Hydrovatus nigricans Sharp, 1882			22, 23		X	
Hydrovatus oblongipennis Régimbart, 1895		15	23		X	
Hydrovatus obsoletus Peschet, 1922			23		X	
Hydrovatus villiersi Guignot, 1955			14		X	
***Hydrovatus visendus* Biström, 1997**			6, 18	X		
Herophydrus guineensis (Aubé, 1838)			6, 7, 14, 16, 21, 27, 29	X	X	X
Herophydrus inquinatus (Boheman, 1848)	27		27, 29			X
+*Herophydrus nigrescens* Biström & Nilsson, 2002			6, 25, 27	X	X	X
Herophydrus nodieri (Régimbart, 1895)	27	6, 11, 12	6, 7, 13, 14, 22, 23, 25, 27, 29	X	X	X
Heterhydrus senegalensis (Laporte, 1835)			6, 14, 22, 23	X	X	
Hyphydrus caffer Boheman, 1848			14, 25		X	
Hyphydrus cycloides Régimbart, 1889			14, 18, 22, 23, 29	X	X	X
Hyphydrus signatus Sharp, 1882	27		6, 27, 29	X		X
Methles cribratellus (Fairmaire, 1880)		15	1, 6, 7, 13, 16, 17, 18, 22, 23, 27, 31	X	X	X
Derovatellus cf. *natalensis* Omer-Cooper, 1965	27, 30		16, 17, 19, 22, 23, 27, 29	X	X	X
Laccophilus canthydroides Omer-Cooper, 1957			17, 22, 23, 29	X	X	X
Laccophilus cryptos Biström, Nilsson & Bergsten, 2015		2	14, 21, 22, 23, 27, 29	X	X	X
Laccophilus contiro Guignot, 1952			6, 14, 22, 23, 27, 31	X	X	X
Laccophilus simplicistriatus Gschwendtner, 1932	7, 27	7, 15	21, 23, 26, 27, 29, 31	X	X	X

+ Taxa known only from South Africa.

Table 4. Hydradephagan beetles previously recorded from the Lake St Lucia system and surrounding waterbodies. Literature sources indicated by letters as follows: (**a**) Day et al. (1954); (**b**) Millard and Broekhuysen (1970); (**c**) Vrdoljak (2004); (**d**) Biström and Nilsson (2002); (**e**) Biström et al. (2015). FWS – fresh water streams feeding into South Lake; FWW – fresh water wetlands on the eastern shores of Lake St Lucia; LT – at light, Mission Rock. Also included here are records based on museum material and ad hoc collections undertaken by the authors in 2008 and 2012 (deposited at and listed as UKZN). SANC – South African National Collection of Insects; ISAM – Iziko South African Museum; TMSA – Ditsong National Museum of Natural History; UKZN – University of KwaZulu-Natal; SL – St Lucia (lake body and immediate surrounds); KB – Kosi Bay; DF – Dukuduku forest; DP – Dukandlovu Pan (site 29 in the current study).

Family	Genus	Species	Publication	Years recorded	Location
Gyrinidae	*Dineutus*	*D. subspinosus**	(c)	2002/2003	FWW
	Gyrinus	*G. natalensis**	(c)	2002/2003	FWW
Noteridae	*Canthydrus*	*C. notula**	(c)	2002/2003	FWW
		Canthydrus spp. 1–4	(c)	2002/2003	FWW
	Hydrocanthus	*H. ferruginicollis**	(a), (b)	1964/1965	FWS
		H. funebris Fairmaire, 1869	(c)	2002/2003	FWW
		Hydrocanthus spp. 1–2	(c)	2002/2003	FWW
	Hydrocoptus	*Hydrocoptus* spp. 1–2	(c)	2002/2003	FWW
	Synchortus	*Synchortus* spp. 1–2	(c)	2002/2003	FWW
Dytiscidae	*Rhantus*	*Rhantus* sp.	(c)	2002/2003	FWW
	Copelatus	*C. sylvaticus* Guignot, 1952	(c)	2002/2003	FWW
	Cybister	*C. guignoti* Gschwendtner, 1936	(c)	2002/2003	FWW
		*C. marginicollis**	(c)	2002/2003	FWW
		*C. natalensis**	UKZN	2012	FB, DP
		*C. vulneratus**	(c)	2002/2003	FWW
		Cybister sp.	(c)	2002/2003	FWW
	Aethionectes	*Aethionectes* sp.	(c)	2002/2003	FWW
	Rhantaticus	*R. congestus**	(c)	2002/2003	FWW
			UKZN	2012	DP
	Hydaticus	*H. bivittatus**	SANC	Not specified	SL
		*H. servillanus**	UKZN	2012	FB
		Hydaticus sp.	ISAM	1988	KB
	Pseuduvarus	*P. viticollis**	(c)	2002/2003	FWW
	Hydrovatus	*H. madagascariensis Régimbart, 1903*	TMSA	1956	DF
	Herophydrus	*H. nigrescens**	(d)	1975	LT
		Herophydrus spp. 1–3	(c)	2002/2003	FWW
		Hydrovatus spp. 1–2	(c)	2002/2003	FWW
	Hyphydrus	*H. cycloides**	(c)	2002/2003	FWW
		H. grandis Laporte, 1835	(c)	2002/2003	FWW
		H. maculatus Babington, 1841	(c)	2002/2003	FWW
		*H. signatus**	(a), (b)	1964/1965	FWS
	Methles	*Methles* sp.	(c)	2002/2003	FWW
	Derovatellus	*Derovatellus* spp. 1–2	(c)	2002/2003	FWW
	Laccophilus	*L. australis* Biström, Nilsson & Bergsten, 2015	(e)	1975	LT
		*L. cryptos**	(e)	1975	LT
		L. secundus Régimbart, 1895	(e)	?	?
		Laccophilus spp. 1–5	(c)	2002/2003	FWW

* Also recorded during the dedicated surveys of 2013–2015.

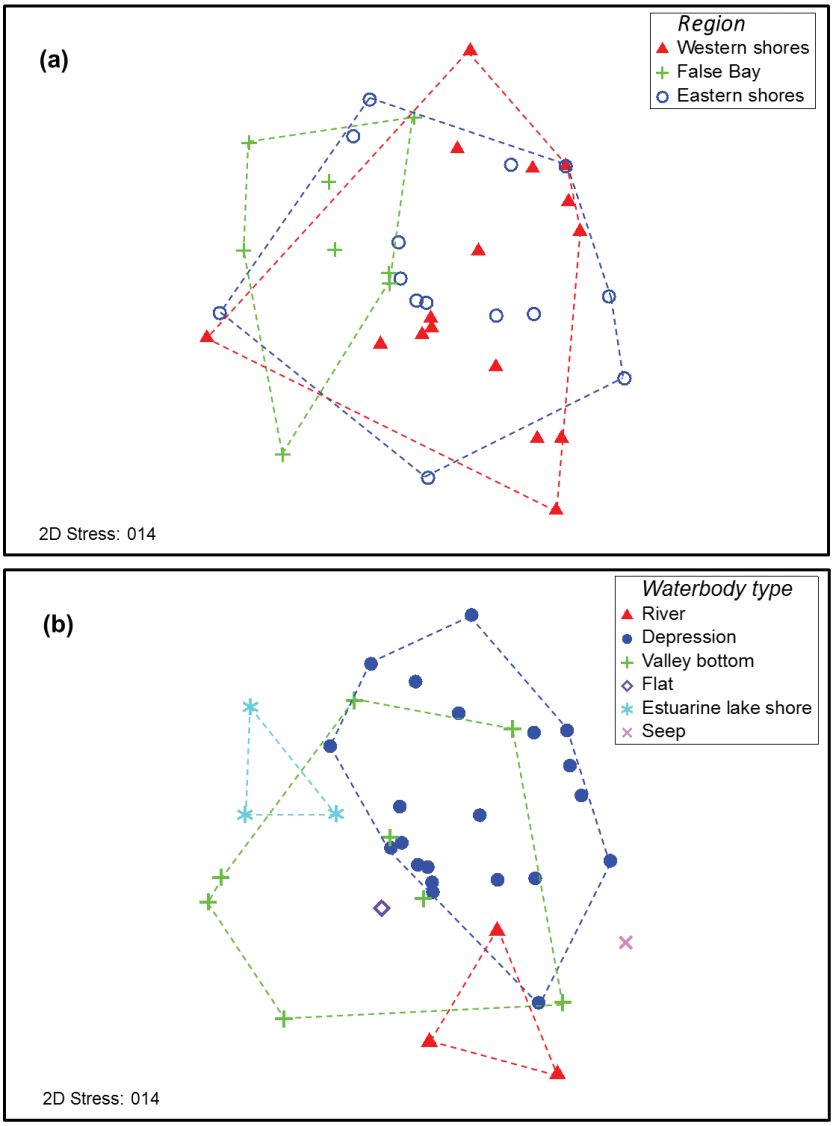

Figure 4. Multidimensional scaling (MDS) plot depicting the similarity of sites sampled in this study in terms of beetle assemblage composition. Symbols on the plot have been coded in terms of **a** region and **b** waterbody type. Convex hulls (dashed lines) have been overlaid on each plot to clarify groupings according to region/waterbody type.

Non-parametric Kruskal-Wallis tests indicate that species richness did not vary significantly between regions (KW-$H_{2, 38}$ = 1.0025, p = 0.6058) or waterbody types (KW-$H_{5, 38}$ = 2.273, p = 0.8102) at St Lucia. Mean richness across all sites and sampling trips was 8.5±9.3 (±SD) taxa per site, the very high standard deviation indicating that the number of taxa recorded per site was extremely variable. The highest recorded rich-

Table 5. Non-parametric permutational MANOVA (PERMANOVA) results for models comparing beetle assemblage composition. Assemblage composition at St Lucia was compared across (a) regions, and (b) waterbody types. The multivariate models tested for differences between group centroids in Bray-Curtis dissimilarity space. WS – western shores; FB – False Bay; ES – eastern shores; Dep. – depression wetland; ELS – estuarine lake shore; VB – valley bottom.

(a)						***Post hoc* pairwise comparisons**		
Source	**df**	**SS**	**MS**	**F**	**P**	**Groups**	**t**	**P**
Region	2	12087	6043.7	1.6119	0.0311*	WS, FB	1.6932	0.0014*
Residual	35	131230	3749.4			WS, ES	0.7968	0.8007
Total	37	143320				FB, ES	1.2882	0.0471*
(b)						***Post hoc* pairwise comparisons**		
Source	**df**	**SS**	**MS**	**F**	**P**	**Groups**	**t**	**P**
Waterbody type	3	16804	5601.4	1.5174	0.0277*	Dep., ELS	1.3635	0.0368*
Residual	32	118130	3691.6			Dep., River	1.4480	0.0205*
Total	35	134930				Dep., VB	1.1185	0.2522
						ELS, River	1.3239	0.0973
						ELS, VB	0.7162	0.9276
						River, VB	1.1209	0.1860

* Significant P values at $\alpha = 0.05$.

ness for an individual site visit was 35 taxa, collected from site 27 (Mpophomeni pan) at False Bay in January/February 2015. Sites 14 (eastern shores), 23 (eastern shores) and 29 (Dukandlovu Pan, False Bay) all yielded more than 25 taxa during January/February 2015. Yet only a single taxon was recorded from site 7 (eastern shores) in November 2013, sites 1 (western shores), 9 (western shores), 12 (eastern shores) and 14 (eastern shores) in July 2014 and site 28 (False Bay) in January/February 2015 (Fig. 5).

Discussion

This study reveals that the St Lucia lake system and its associated wetlands support at least 68 species of Hydradephaga. It is currently estimated that ca. 410 species of Hydradephaga occur in southern Africa as a whole (Stals and de Moor 2007), meaning that almost 20% of the known fauna of this biodiverse region occur in the wetlands of the St Lucia system.

The species richness observed at St Lucia is comparable with that recorded in a number of tropical locations worldwide. For example, Bilardo and Rocchi (2011) obtained 51 hydradephagan species in the Monts de Cristal National Park, Gabon, during sampling conducted between 2006 and 2010. Similarly, Apenborn (2013) reported the collection of 122 species of aquatic beetles, representing 10 different families, during an eight-week survey of the Peruvian Amazon near the Panguana Biological Field Station (Hendrich et al. 2015). Of these, around 80 belonged to the Hydradephaga. Lentic sites in northern temperate regions such as the Western Palaearctic can also sup-

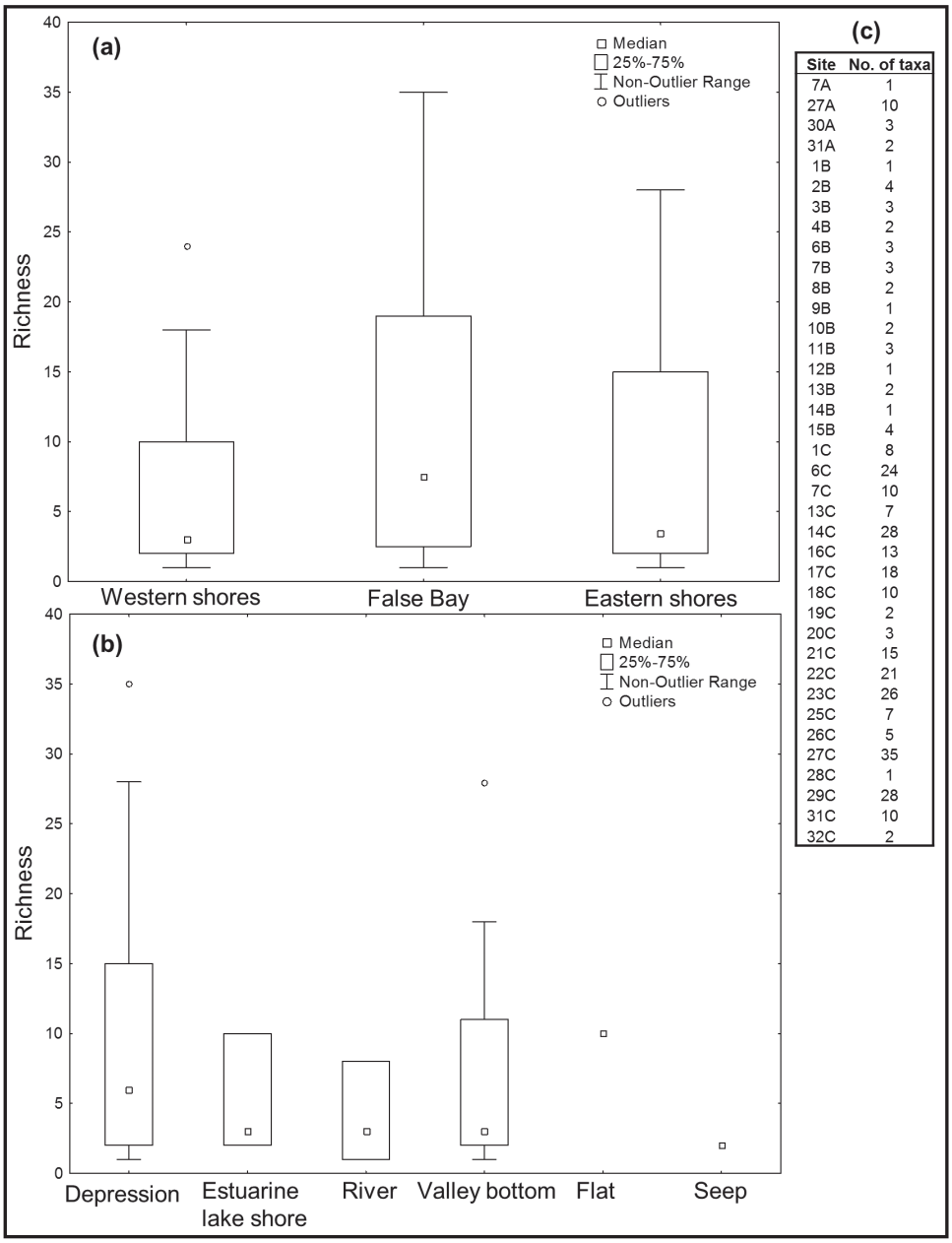

Figure 5. Box-plots comparing the median and spread of species richness (number of hydradephagan taxa per site) among **a** regions and **b** waterbody types at St Lucia during the sampling period 2013–2015. The data representing number of taxa per site are also reported (**c**). Site numbers in (**c**) are coded as A (first survey – November 2013), B (second survey – July 2014) or C (third survey – January/February 2015). Kruskal-Wallis tests indicated that species richness did not vary significantly among regions ($KW\text{-}H_{2, 38}$ = 1.0025, p = 0.6058) or waterbody types ($KW\text{-}H_{5, 38}$ = 2.273, p = 0.8102).

port relatively diverse hydradephagan assemblages. Foster (1993) summarises records from lithalsa fen complexes in Norfolk, UK, with 65 species being recorded across four sites. Bameul (1994) reported 50 species from the Marais de la Perge, a 3280 ha lithalsa complex close to Bordeaux, France, now decimated by invasive crayfish. Similarly, a total of 29 hydradephagan species were reported from the Lonjsko Polje Nature Park in Croatia (Temunović et al. 2007) and 31 in the Villafáfila shallow lakes of the NW Iberian Meseta, Spain (Régil and Garrido 1993).

Five species of Hydradephaga found during our surveys are apparently new to the fauna of South Africa (Table 3). These are all relatively widespread Afrotropical species, but include the large *Cybister ertli* Zimmermann, 1917. Whilst *C. ertli* has been recorded from Swaziland in the past, this species has not previously been reported from South Africa. It is possible that specimens have been confounded with other large black *Cybister* however, as these beetles are not easy to identify without reference to the male genitalia. It is highly likely that the *Peltodytes* found during our surveys is currently undescribed. This does not match any of the known African species in external morphology (van Vondel 2010, D. T. Bilton, *pers. obs.*), but cannot be either positively identified or described at present, in the absence of males.

The hydradephagan fauna of Lake St Lucia is dominated by relatively widespread Afrotropical taxa (see distribution records in Appendix 1), with very few species with restricted distributions, a pattern also seen in other aquatic taxa such as gastropods (Perissinotto et al. 2014) and odonates (Hart et al. 2014). Three of the species recorded in these surveys are currently thought to be endemic to South Africa (Table 3), with only two, *Herophydrus nigrescens* Biström & Nilsson, 2002 and *Hydaticus* cf. *natalensis* Guignot, 1951 apparently endemic to KwaZulu-Natal. This dominance of the diverse St Lucia fauna by widespread species fits well into the general principle that hotspots of endemism and species richness are often not coincident (e.g. Stals and de Moor 2007). In many insect taxa, the northeast of South Africa supports relatively high species richness, whilst endemism is instead generally concentrated towards the south-western part of the country, particularly in the Western Cape (Lombard 1995, Bilton 2014b, Bilton et al. 2015). In Table Mountain National Park, for example, a species-rich wetland would typically contain ca. 15–20 species of Hydradephaga (cf. up to 35 at St Lucia). In stark contrast to the fauna of St Lucia, however, around 50% of the species found in a typical Cape Peninsula wetland are endemic to the fynbos biome (D. T. Bilton, *pers. obs.*; Pryke and Samways 2009).

Only three species (*Cybister vulneratus* Klug, 1834, *Hydaticus servillianus* Aubé, 1838 and *Derovatellus* cf. *natalensis* Omer-Cooper, 1965) were found in the margins of Lake St Lucia itself, the overwhelming majority of species being associated with small wetlands in the park. False Bay sites supported relatively distinctive beetle assemblages, including species which were not recorded elsewhere, whereas the faunas of the eastern and western shores largely overlapped (Fig. 4 and Table 5). False Bay is considerably more arid than the other two areas and its landscape is dominated by dense dry woodland, in contrast to the moist grassland plains with pockets of dune forest characteristic of the eastern and western shores (Perissinotto et al. 2013). Sites at False Bay were typically heavily shaded

by shrub encroachment, whilst those on the eastern and western shores were generally more open and sunlit. Thus the contrasting riparian and terrestrial environments across these broad regions at St Lucia offers a potential explanation for the differentiation of aquatic assemblages in the wetlands of the three areas. This is reflected to some extent in the PCA of physico-chemistry (Fig. 3). Whilst sites from both eastern and western shores are scattered across the plot, the False Bay localities are largely concentrated towards the left, reflecting their relatively low water temperatures.

Although hydradephagan assemblage composition varied significantly between different areas of St Lucia, species richness did not. Similarly, richness did not differ significantly between the different types of waterbodies sampled. Although there was no significant difference in richness among the waterbody types, the sites with the very highest richness were mostly temporary depression wetlands; a pattern which contrasts markedly with other taxa such as molluscs and dragonflies which are most diverse in permanent waters. With the exception of site 29 (a channelled valley bottom wetland) all sites that yielded 20 or more taxa from a single visit were such depression wetlands (sites 6, 14, 22, 23 and 27), highlighting the importance of this habitat for aquatic conservation in the region for the first time.

Due to unprecedented drought conditions in the region and past anthropogenic activities, there have been significant changes in the St Lucia system in recent decades. The estuary mouth closed in 2002 and large-scale desiccation of the lake basins began in 2004 (Perissinotto et al. 2013). At the peak of these events, over 80% of the lake bottom sediments became exposed to the air and hypersaline conditions dominated the lake system, except in the Narrows and at the mouth. Alternation of dry and wet cycles are not new to this estuary, as can be seen for instance in historic records showing the regular occurrence of 4–10 year cycles of either droughts or anomalous wet conditions since at least the early 1900s. Projections of climate change for the next 50-100 years indicate that this situation will persist and possibly intensify, with the most likely scenario being an alternation of extreme droughts followed by floods (Mather et al. 2013). Predaceous water beetle biodiversity at St Lucia is concentrated in small waterbodies, rather than the main lake system, and the consequences of such changes remain unclear, and may depend on the degree to which changes in the lake system cascade through the wider wetland complex. Drought-induced hypersaline conditions and low water levels (including low groundwater levels) are likely to impact wetlands across the region and the main Lake St Lucia itself, and possible impacts on these wetlands should clearly be considered within wider conservation/management plans.

Conclusions

The St Lucia system, whilst being dominated by relatively widespread Afrotropical water beetles, supports what appears to be one of the most diverse assemblages of Hydradephaga reported in southern Africa. In line with the high species richness and di-

versity in other groups investigated to date (e.g. odonates, bivalves, gastropods, crabs), the results of the current study further reinforce the biodiversity importance of the iSimangaliso Wetland Park. Much remains to be investigated, particularly with regard to the environmental factors that support this exceptional biodiversity, and how these may be impacted by climatic and other anthropogenic changes in the future.

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Appendix 1

Annotated and illustrated checklist of the Hydradephaga recorded from wetlands of the Lake St Lucia system, 2013–2015.

The following list includes photographs of all species recorded during the dedicated water beetle surveys conducted by the authors during the period 2013 to 2015. With the exception of *Laccophilus australis* Biström, Nilsson & Bergsten, 2015, this includes all species reliably recorded from the region.

Family: Gyrinidae

***Gyrinus natalensis* Régimbart, 1892**

Remarks. Standing waters.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Previously recorded by Vrdoljak (2004) in 2002/2003 at fresh water wetlands. Recorded at Western Shores in July 2014, during the course of this study.

Figure 6. *Gyrinus natalensis* Régimbart, 1892
9.0mm, iSimangaliso Wetland Park, Western Shores (site 4), July 2014
MS Bird leg.

***Dineutus subspinosus* (Klug, 1834)**

Remarks. Standing waters.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Previously recorded by Vrdoljak (2004) in 2002/2003 at fresh water wetlands. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 7. *Dineutus subspinosus* (Klug, 1834)
7.85mm, iSimangaliso Wetland Park, False Bay (site 29), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Family: Haliplidae

***Haliplus natalensis* Wehncke, 1880**

Remarks. Standing water, possibly associated with charophytes

Distribution. Widespread to Western, Central and Eastern Africa

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 8. *Haliplus natalenis* Wehncke, 1880
3.72mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

***Peltodytes* sp.**

Remarks. This may be a new species, as only *P. quadratus* Régimbart, 1895 is recorded from South Africa (perhaps in error – see van Vondel, 2010) and this does not match the specimens collected. Only two females were found during this survey, making either positive identification or description impossible at present.

Distribution. Unknown.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in January/February 2015, during the course of this study.

Figure 9. *Peltodytes* sp.
4.10mm, iSimangaliso Wetland Park, Western Shores (site 6), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Family: Noteridae

***Canthydrus apicicornis* Régimbart, 1895**

Remarks. Standing waters, in dense vegetation.

Distribution. Kwa-Zulu Natal and Mozambique. Endemic to South-East Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in July 2014 and January/February 2015, during the course of this study.

Figure 10. *Canthydrus apicicornis* Régimbart, 1895
2.47mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Canthydrus marshalli Balfour-Browne, 1939

Remarks. Standing waters, in dense vegetation.

Distribution. Kwa-Zulu Natal and Central Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores in January/February 2015, during the course of this study.

Figure 11. *Canthydrus marshalli* Balfour-Borwne, 1939
2.28mm, iSimangaliso Wetland Park, Western Shores (site 6), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Canthydrus notula (Erichson, 1843)

Remarks. Standing waters, in dense vegetation.

Distribution. Widespread throughout Africa.

St Lucia records. Previously recorded by Vrdoljak (2004) in 2002/2003 in fresh water wetlands. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during the course of this study.

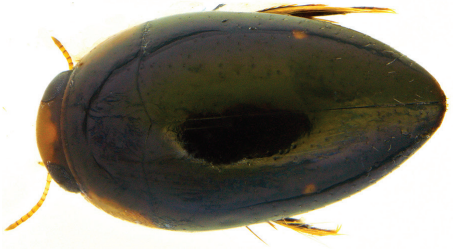

Figure 12. *Canthydrus notula* (Erichson, 1843)
3.28mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Canthydrus quadrivittatus (Boheman, 1848)

Remarks. Standing waters, in dense vegetation.

Distribution. Widespread to Central Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during the course of this study.

Figure 13. *Canthydrus quadrivittatus* (Boheman, 1848)
2.36mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Canthydrus sedilloti Régimbart, 1895

Remarks. Standing waters, in dense vegetation.

Distribution. Widespread to Western, Central and East Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in January/February 2015, during the course of this study.

Figure 14. *Canthydrus sedilloti* Régimbart, 1865
2.85mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrocanthus grandis (Laporte, 1835)

Remarks. Standing waters, in dense vegetation.

Distribution. Botswana, Zimbabwe, Mozambique and to Central and Eastern Africa. New record for South Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 15. *Hydrocanthus grandis* (Laporte, 1835)
7.40mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird, R Perissinotto leg.

Hydrocanthus micans Wehncke, 1883

Remarks. Standing waters, in dense vegetation.

Distribution. Eastern Cape, KwaZulu Natal, Botswana, Mozambique, Zimbabwe, Zambia and to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 16. *Hydrocanthus micans* Wehncke, 1883
5.59mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird, R Perissinotto leg.

Hydrocanthus ferruginicollis Régimbart, 1865

Remarks. Fresh water bodies.

Distribution. South Africa, Botswana, Zimbabwe, Mozambique to Central and Eastern Africa.

St Lucia records. Previously recorded by Day et al (1954) and Millard and Broekhuysen (1970) in 1964/1965 in fresh water streams feeding into South Lake. Recorded at False Bay in November 2013, during the course of this study.

Figure 17. *Hydrocanthus ferruginicollis* Régimbart, 1865
5.00mm, iSimangaliso Wetland Park, False Bay (site 27), November 2013
MS Bird & R Perissinotto leg.

Synchortus imbricatus (Klug, 1853)

Remarks. Standing waters, in dense vegetation.

Distribution. Kwa-Zulu Natal, Mozambique to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in January/February 2015, during the course of this study.

Figure 18. *Synchortus imbricatus* (Klug, 1853)
3.47mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Synchortus desaegeri Gschwendtner, 1935

Remarks. Standing waters, in dense vegetation.

Distribution. Botswana to Central and Eastern Africa. New record for South Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 19. *Synchrotus desaegeri* Gschwendtner, 1935
2.94mm, iSimangaliso Wetland Park, Eastern Shores (site 23), February 2015
DT Bilton, MS Bird, R Perissinotto leg.

Neohydrocoptus aethiopicus (Balfour-Browne, 1961)

Remarks. Dense vegetation.

Distribution. Western Cape to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during the course of this study.

Figure 20. *Neohydrocoptus aethiopicus* (Balfour-Browne, 1961)
2.47mm, iSimangaliso Wetland Park, Western Shores (site 1), February 2015
DT Bilton, MS Bird, R Perissinotto leg.

Neohydrocoptus angolensis (Peschet, 1925)

Remarks. Dense vegetation.

Distribution. Kwa-Zulu Natal to Western and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during the course of this study.

Figure 21. *Neohydrocoptus angolensis* (Peschet, 1925)
2.94mm, iSimangaliso Wetland Park, Western Shores (site 6), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Family: Dytiscidae

Copelatus cf. *ejactus* Omer-Cooper, 1965

Remarks. Thought to occur largely in standing waters. Possibly endemic to South Africa.

Distribution. Previously known only from the Limpopo province.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 22. *Copelatus ejactus* Omer-Cooper, 1965
6.75 mm, iSimangaliso Wetland Park, Eastern Shores (site 22), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Copelatus erichsoni Guérin-Méneville, 1849

Synonyms. *Copelatus formosus* Wollaston, 1867.

Remarks. Standing waters, especially shallow pools. Likely to be a complex of closely related species.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 23. *Copelatus erichsoni* Guérin-Méneville, 1849
5.6 mm, iSimangaliso Wetland Park, Eastern Shores (site 20), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Copelatus pulchellus (Klug, 1834)

Synonyms. *Copelatus africanus* Sharp, 1882; *Copelatus basalis* Boheman, 1848; *Copelatus discoideus* Sharp, 1882; *Colymbetes marginipennis* Laporte, 1835; *Copelatus obtusus* Boheman, 1848; *Copelatus strigulosus* Sharp, 1882.

Remarks. Standing waters, especially shallow pools.

Distribution. Widespread to Western and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 24. *Copelatus pulchellus* (Klug, 1834)
6.1 mm, iSimangaliso Wetland Park, False Bay (site 26), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister gschwendtneri Guignot, 1935

Remarks. Ponds and lagoons.

Distribution. Widespread to Western and Eastern Africa, but not known to be common.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

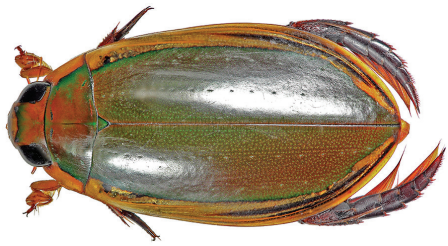

Figure 25. *Cybister gschwendtneri* Guignot, 1935
28.7 mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister marginicollis Boheman, 1848

Synonyms. *Cybister auritus* Gerstaecker, 1871; *Cybister filicornis* Sharp, 1882; *Cybister marginicollis annulicornis* Griffini, 1892.

Remarks. Ponds and lagoons.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Previously recorded by Vrdoljak (2004) in 2002/2003 in fresh water wetlands. Recorded at Western Shores, Eastern Shores and False Bay in November 2013, July 2014 and January/February 2015, during the course of this study.

Figure 26. *Cybister marginicollis* Boheman, 1848
15.9 mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister natalensis (Wehncke, 1876)

Synonyms. *Cybister circumcinctus* Gschwendtner, 1932

Remarks. Ponds and lagoons.

Distribution. Widespread to Central Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

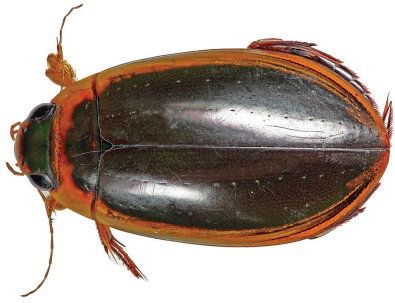

Figure 27. *Cybister natalensis* (Wehncke, 1876)
28.6 mm, iSimangaliso Wetland Park, False Bay (site 29), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister senegalensis Aubé, 1838

Synonyms. *Cybister convexiusculus* H.J. Kolbe, 1883; *Cybister marginellus* Régimbart, 1895; *Cybister rufiventris* Régimbart, 1895; *Cybister senegalensis* var. *irroratus* H.J. Kolbe, 1883; *Cybister senegalensis* var. *seidlitzii* Ragusa, 1888.

Remarks. Ponds and lagoons.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and False Bay in January/February 2015, during the course of this study.

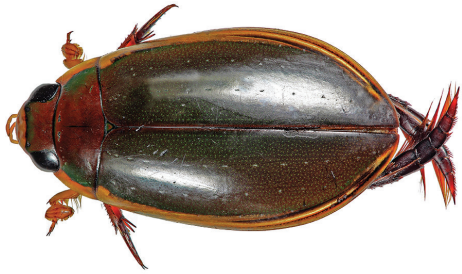

Figure 28. *Cybister senegalensis* Aubé, 1838
20.3 mm, iSimangaliso Wetland Park, Western Shores (site 6), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister tripunctatus africanus Laporte, 1835

Synonyms. *Cybister aegyptiacus* Peyron, 1856; *Trogus haagi* Wehncke, 1876; *Trochalus meridionalis* Gené, 1836; *Trogus punctipennis* Taschenberg, 1883.

Remarks. Abundant in ponds and lagoons.

Distribution. Widespread to Mediterranean basin.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

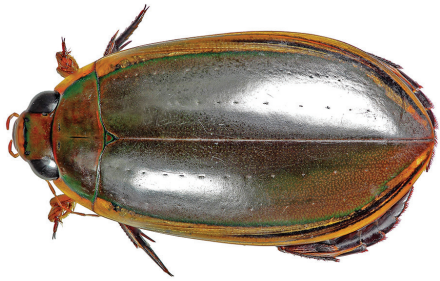

Figure 29. *Cybister tripunctatus africanus* Laporte, 1835
28.4 mm, iSimangaliso Wetland Park, Eastern Shores (site 21), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybsiter bimaculatus Aubé, 1838

Synonyms. *Cybister aequatorius* Zimmermann, 1917; *Cybister regimbarti* Wilke, 1920.

Remarks. Ponds and lagoons.

Distribution. Widespread in Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 30. *Cybister bimaculatus* Aubé, 1838
41.4 mm, iSimangaliso Wetland Park, Eastern Shores (21), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister ertli Zimmermann, 1917

Remarks. Ponds and lagoons.

Distribution. Swaziland, Zimbabwe, Mozambique, Malawi to Central and Eastern Africa. New record for South Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 31. *Cybister ertli* Zimmermann, 1917
38.7 mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister vicinus Zimmermann, 1917

Remarks. Ponds and lagoons.

Distribution. Mpumalanga and widespread to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 32. *Cybister vicinus* Zimmermann, 1917
36.7 mm, iSimangaliso Wetland Park, Eastern Shores (site 21), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Cybister vulneratus Klug, 1834

Synonyms. *Cybister binotatus* Klug, 1835; *Cybister bivuolnerus* Aubé, 1838; *Cybister madagascariensis* Aubé, 1838.

Remarks. Ponds and lagoons.

Distribution. Widespread to Mediterranean basin.

St Lucia records. Previously recorded by Vrdoljak (2004) in 2002/2003 at fresh water wetlands. Recorded at Western Shores, Eastern Shores and False Bay in November 2013, July 2014 and January/February 2015, during this study.

Figure 33. *Cybister vulneratus* Klug, 1834
23.6 mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Rhantaticus congestus (Klug, 1833)

Synonyms. *Hydaticus rochasi* Perroud & Montrousier, 1864; *Hydaticus signatipennis* Laporte, 1835

Remarks. Likely to be a species complex.

Distribution. Widespread in Old World tropics.

St Lucia records. Obtained from available museum collections and ad hoc collections by the University of KwaZulu-Natal in 2012. Recorded at Eastern Shores and False Bay in November 2013 and January/February 2015, during this study.

Figure 34. *Rhantaticus congestus* (Klug, 1833) 9.96mm, iSimangaliso Wetland Park, Eastern Shores (site 21), February 2015 DT Bilton, MS Bird & R Perissinotto leg.

Eretes sticticus (Linnaeus, 1767)

Synonyms. *Eunectes helvolus* Klug, 1834; *Eunectes punctatus* Zoubkoff, 1837; *Eunectes occidentalis* Erichson, 1847; *Eunectes conicollis* Wollaston, 1861; *Eunectes subcoriaceus* Wollaston, 1861; *Eretes subdiaphanus* Wollaston, 1861.

Remarks. Open ponds with bare substrate.

Distribution. Widespread in Afrotropics, Middle East to Americas.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 35. *Eretes sticticus* (Linnaeus, 1767) 12.71mm, iSimangaliso Wetland Park, Eastern Shores (site 21), February 2015 DT Bilton, MS Bird & R Perissinotto leg.

Hydaticus bivittatus Laporte, 1835

Synonyms. *Hydaticus bivittatus* var. *sharpi* Peschet, 1917.

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Obtained from available museum collections and ad hoc collections by the South African National Collection of Insects. The year is not specified. Specimen found at the St Lucia lake body and immediate surrounds. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 36. *Hydaticus bivittatus* Laporte, 1835
13.41mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydaticus exclamationis Aubé, 1838

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 37. *Hydaticus exclamationis* Aubé, 1838
13.71mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, M Bird & R Perissinotto leg.

Hydaticus flavolineatus Boheman, 1848

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 38. *Hydaticus flavolineatus* Boheman, 1848
16.47mm, iSimangaliso Wetland Park
False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydaticus cf. *natalensis* Guignot, 1951

Remarks. Ponds.

Distribution. The identity of this species is currently uncertain, and will require comparisons with type specimens. Apparently endemic to KwaZulu-Natal.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 39. *Hydaticus* cf. *natalensis* Guignot, 1951 11.39mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydaticus matruelis Clark, 1864

Synonyms. *Hydaticus matruelis* var. *fuscicollis* Régimbart, 1895; *Hydaticus graueri* Ahlwarth, 1921.

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 40. *Hydaticus matruelis* Clark, 1864 11.38mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydaticus servillianus Aubé, 1838

Synonyms. *Hydaticus discoidalis* Hope, 1843; *Hydaticus flavomarginatus* Zimmermann, 1920.

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in November 2013, July 2014 and January/February 2015, during the course of this study.

Figure 41. *Hydaticus servillianus* Aubé, 1838 11.23mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Bidessus sharpi Régimbart, 1895

Synonyms. *Bidessus factor* Omer-Cooper, 1959; *Bidessus granulum* Régimbart, 1859; *Bidessus sharpi nigeriensis* Omer-Cooper, 1974; *Bidessus sedilloti* Régimbart, 1859; *Bidessus sharpi sudanensis* Omer-Cooper, 1974.

Remarks. Ponds, in shallow water with dense vegetation.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 42. *Bidessus sharpi* Régimbart, 1895
1.67mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Clypeodytes meridionalis Régimbart, 1895

Synonyms. *Clypeodytes seminulum* Régimbart, 1895; *Clypeodytes cribrosus* var. *voiensis* Guignot, 1936.

Remarks. Ponds, in shallow water with dense vegetation.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in July 2014 and January/February 2015, during the course of this study.

Figure 43. *Clypeodytes meridionalis* Régimbart, 1895
1.93mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydroglyphus farquharensis
(Scott, 1912)

Synonyms. *Guignotus bivirgatus* Guignot, 1952; *Guignotus browni* Pederzani, 1982; *Guignotus harrisoni* Omer-Cooper, 1955.

Remarks. Ponds.

Distribution. Widespread to Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

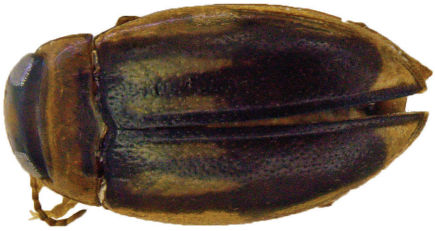

Figure 44. *Hydroglyphus farquharensis* (Scott, 1912)
2.15mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydroglyphus lineolatus
(Boheman, 1848)

Remarks. Ponds, over exposed substrates.

Distribution. Widespread in Southern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 45. *Hydroglyphus lineolatus* (Boheman, 1848)
2.82mm, iSimangaliso Wetland Park, Eastern Shores (site 21), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydroglyphus zanzibarensis
(Régimbart, 1906)

Synonyms. *Bidessus orarius* Omer-Cooper, 1931.

Remarks. Ponds.

Distribution. Widespread in Southern and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during the course of this study.

Figure 46. *Hydroglyphus zanzibarensis* (Régimbart, 1906)
1.89mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Leiodytes hieroglyphicus (Régimbart, 1894)

Synonyms. *Clypeodytes ignobilis* Omer-Cooper, 1962; *Clypeodytes inumbratus* Guignot, 1936; *Clypeodytes lautus* Régimbart, 1895; *Clypeodytes ovatus* Omer-Cooper, 1931

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in January/February 2015, during the course of this study.

Figure 47. *Leiodytes hieroglyphicus* (Régimbart, 1894)
2.04mm, iSimangaliso Wetland Park, Western Shores (site 7), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Pseuduvarus viticollis (Boheman, 1848)

Synonyms. *Amarodytes octoguttatus caligosus* Guignot, 1946; *Bidessus gentilis* Sharp, 1890; *Uvarus monticola* Guignot, 1957; *Bidessus octoguttatus* Régimbart, 1895; *Bidessus ornatipennis* Régimbart, 1899.

Remarks. Ponds.

Distribution. Widespread to Western and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 48. *Pseuduvarus viticollis* (Boheman, 1848)
2.05mm, iSimangaliso Wetland Park, Catalina Bay (site 32 - seepages over peat), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Uvarus gschwendtneri (Guignot, 1942)

Synonyms. *Bidessus opacus* Gschwendtner, 1935

Remarks. Ponds.

Distribution. Widespread to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

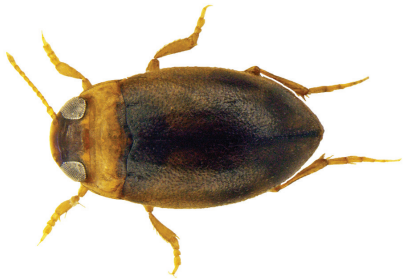

Figure 49. *Uvarus gschwendtneri* (Guignot, 1942)
1.62mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus acuminatus Motschulsky, 1859

Synonyms. *Hydrovatus acuminatus furvus* Guignot, 1950; *Hydrovatus affinis* Régimbart, 1895; *Hydroporus badius* Clark, 1863; *Hydrovatus consanguineous* Régimbart, 1880; *Hydrovatus ferrugineus* Zimmermann, 1919; *Hydrovatus humilis* Sharp, 1882; *Hydroporus malaccae* Clark, 1863; *Hydrovatus obscurus* Motschulsky, 1859; *Hydrovatus obscurus* Régimbart, 1895; *Hydrovatus sordidus* Sharp, 1882

Remarks. Ponds in dense vegetation.

Distribution. Widespread in Afrotropics, to Oriental Region.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 50. *Hydrovatus acuminatus* Motschulsky, 1859
2.53mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus cribatus Sharp, 1882

Synonyms. *Hydrovatus dyscheres* Guignot, 1955; *Hydrovatus laticornis* Régimbart, 1895.

Remarks. Ponds in dense vegetation.

Figure 51. *Hydrovatus cribatus* Sharp, 1882
2.70mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western and Eastern Shores in January/February 2015, during the course of this study.

Hydrovatus dentatus Bilardo & Rocchi, 1990

Remarks. Ponds in dense vegetation.

Distribution. KwaZulu-Natal and Zambia. Appears to be rare.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in January/February 2015, during the course of this study.

Figure 52. *Hydrovatus dentatus* Bilardo & Rocchi, 1990
2.45mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus eximius Biström, 1997

Remarks. Ponds in dense vegetation.

Distribution. Zimbabwe and Mozambique. New record for South Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in January/February 2015, during the course of this study.

Figure 53. *Hydrovatus eximius* Biström, 1997
2.24mm, iSimangaliso Wetland Park, False Bay (site 29), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus nefandus Omer-Cooper, 1957

Remarks. Ponds in dense vegetation.

Distribution. Widespread in Southern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 54. *Hydrovatus nefandus* Omer-Cooper, 1957
2.53mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus nigricans Sharp, 1882

Synonyms. *Hydrovatus abotti* Guignot, 1959.

Remarks. Ponds in dense vegetation.

Distribution. Widespread to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 55. *Hydrovatus nigricans* Sharp, 1882
4.10mm, iSimangaliso Wetland Park, Eastern Shores (site 23), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus oblongipennis Régimbart, 1895

Synonyms. *Hydrovatus crassus* Guignot, 1958.

Remarks. Ponds in dense vegetation.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in July 2014 and January/February 2015, during the course of this study.

Figure 56. *Hydrovatus oblongipennis* Régimbart, 1895
5.10mm, iSimangaliso Wetland Park, Eastern Shores (site 23), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus obsoletus Peschet, 1922

Synonyms. *Hydrovatus adelphus* Guignot, 1956; *Hydrovatus straeleni* Guignot, 1947.

Remarks. Ponds in dense vegetation.

Distribution. Widespread to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 57. *Hydrovatus obsoletus* Peschet, 1922
3.89mm, iSimangaliso Wetland Park, Eastern Shores (site 23), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus villiersi Guignot, 1955

Synonyms. *Hydrovatus albertianus* Guignot, 1959.

Remarks. Ponds in dense vegetation.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 58. *Hydrovatus villiersi* Guignot, 1955
4.23mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hydrovatus visendus Biström, 1997

Remarks. Ponds in dense vegetation.

Distribution. Zimbabwe to Eastern Africa. New record for South Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores in January/ February 2015, during the course of this study.

Figure 59. *Hydrovatus visendus* Biström, 1997
3.10mm, iSimangaliso Wetland Park, Western Shores (site 6), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Herophydrus guineensis (Aubé, 1838)

Synonyms. *Hydroporus barbarous* Schaum, 1847; *Hydroporus ferrugineus* Lucas, 1846; *Hydroporus hyphydroides* Perris, 1864; *Hydroporus inflatus* Reiche, 1869; *Hydroporus turgidus* Erichson, 1843; *Herophydrus umbrosus* Zimmermann, 1926.

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 60. *Herophydrus guineensis* (Aubé, 1838)
4.45mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Herophydrus inquinatus
(Boheman, 1848)

Synonyms. *Herophydrus cooperi* Gschwendtner, 1938; *Herophydrus ignoratus* Gschwendtner, 1933; *Herophydrus kalaharii* Gschwendtner, 1935.

Remarks. Ponds and stream pools. Eurytopic.

Distribution. Widespread to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at False Bay in November 2013 and January/February 2015, during the course of this study.

Figure 61. *Herphydrus inquinatus* (Boheman, 1848)
5.27mm, iSimangaliso Wetland Park,
False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Herophydrus nigrescens
Biström & Nilsson, 2002

Remarks. Ponds.

Distribution. Endemic to KwaZulu-Natal.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 62. *Herophydrus nigrescens* Biström & Nilsson, 2002
5.31mm, iSimangaliso Wetland Park,
False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Herophydrus nodieri
(Régimbart, 1895)

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in November 2013, July 2014 and January/February 2015, during the course of this study.

Figure 63. *Herophydrus nodieri* (Régimbart, 1895)
5.66mm, iSimangaliso Wetland Park,
False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Heterhydrus senegalensis (Laporte, 1835)

Remarks. Ponds.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores and Eastern Shores in January/February 2015, during the course of this study.

Figure 64. *Heterhydrus senegalensis* (Laporte, 1835)
5.56mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hyphydrus caffer Boheman, 1848

Remarks. Ponds.

Distribution. Widespread to Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Eastern Shores in January/February 2015, during the course of this study.

Figure 65. *Hyphydrus caffer* Boheman, 1848
6.06mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hyphydrus cycloides Régimbart, 1889

Synonyms. *Hyphydrus circularis* Régimbart, 1895; *Hyphydrus lamottei* Legros, 1958; *Hyphydrus malawiensis* Omer-Cooper, 1971; *Hyphydrus nigeriensis* Omer-Cooper, 1971; *Hyphydrus pelates* Guignot, 1953.

Remarks. Ponds.

Distribution. Widespread to Central and Eastern Africa.

St Lucia records. Previously recorded by Vrdoljak (2004) in 2002/2003 at freshwater wetlands. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during this study.

Figure 66. *Hyphydrus cycloides* Régimbart, 1889
3.35mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Hyphydrus signatus Sharp, 1882

Synonyms. *Hyphydrus aethiopicus* J. Balfour-Browne, 1944; *Hyphydrus grossus* Sharp, 1882.

Remarks. Ponds.

Distribution. Widespread to central and Eastern Africa.

St Lucia records. Previously recorded by Day et al (1954) and Millard and Broekhuysen (1970) in 1964/1965 at fresh water streams feeding into South Lake. Recorded at Western Shores and False Bay in November 2013 and January/February 2015, during this study.

Figure 67. *Hyphydrus signatus* Sharp, 1882
4.52mm, iSimangaliso Wetland Park,
False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Methles cribratellus (Fairmaire, 1880)

Synonyms. *Methles punctipennis* Sharp, 1882; *Methles umbrosus* Gschwendtner, 1930.

Remarks. Ponds in dense vegetation.

Distribution. Widespread to Mediterranean basin and Middle East.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during this study.

Figure 68. *Methles cribratellus* (Fairmaire, 1880)
3.87mm, iSimangaliso Wetland Park,
False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Derovatellus cf. *natalensis* Omer-Cooper, 1965

Remarks. Ponds and small wetlands with dense vegetation. This beetle is either *D. natalensis* or an undescribed species. Omer-Cooper (1965) states that the type is in the Natural History Museum, London, but no specimens of this species are present in the collection (D.T. Bilton, *pers. obs.*). The male genitalia are close to Omer-Cooper's figures of *natalensis*, but do differ. It is hoped that the identity of these specimens can be resolved by future studies of material named by Omer-Cooper.

Distribution. Endemic to South-East Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in November 2013 and January/February 2015, during this study.

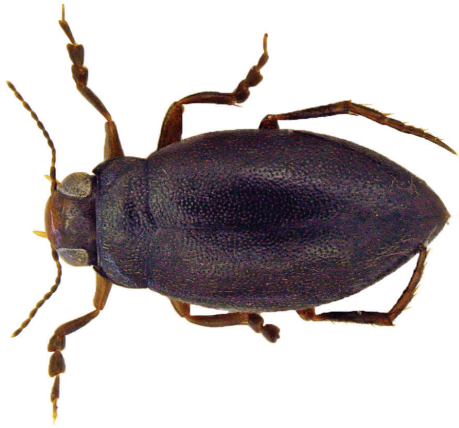

Figure 69. *Derovatellus* cf. *natalensis* Omer-Cooper, 1965
3.91mm, iSimangaliso Wetland Park, False Bay (site 27), January 2015
DT Bilton, MS Bird & R Perissinotto leg.

Laccophilus canthydroides Omer-Cooper, 1957

Remarks. Uncertain. Appears to prefer dense vegetation.

Distribution. Described from South Africa. Now known to be widespread, from Cameroon and Ethiopia through east Africa to the Cape (Biström et al., 2015).

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 70. *Laccophilus canthydroides* Omer-Cooper, 1957
3.24mm, iSimangaliso Wetland Park, Eastern Shores (site 23), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Laccophilus cryptos Biström, Nilsson & Bergsten, 2015

Remarks. Ponds.

Distribution. Widespread in Southern Central and Eastern Africa.

St Lucia records. Holotype and some paratypes taken at light at St Lucia in 1975. Recorded at Western Shores, Eastern Shores and False Bay in July 2014 and January/February 2015, during the course of this study.

Figure 71. *Laccophilus cryptos* Biström, Nilsson & Bergsten, 2015
2.5mm, iSimangaliso Wetland Park, Western Shores (site 2), July 2014
MS Bird leg.

Laccophilus contiro Guignot, 1952

Remarks. Ponds and other small waterbodies.

Distribution. Widespread to Western, Central and Eastern Africa.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in January/February 2015, during the course of this study.

Figure 72. *Laccophilus contiro* Guignot, 1952
3.30mm, iSimangaliso Wetland Park, Eastern Shores (site 14), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

Laccophilus simplicistriatus Gschwedntner, 1932

Synonyms. *Laccophilus monas* Guignot, 1953.

Remarks. Known from a range of habitats including a reservoir, river pools, river swamps, waterholes and dams (Biström et al., 2015).

Distribution. Widespread from Sudan to South Africa and Namibia.

St Lucia records. Not previously recorded from St Lucia. Recorded at Western Shores, Eastern Shores and False Bay in November 2013, July 2014 and January/February 2015, during the course of this study.

Figure 73. *Laccophilus simplicistriatus* Gschwendtner, 1932
3.8 mm, iSimangaliso Wetland Park, Eastern Shores (site 21), February 2015
DT Bilton, MS Bird & R Perissinotto leg.

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RESEARCH ARTICLE

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Two new species of *Brachytrycherus* Arrow, 1920 from China (Coleoptera, Endomychidae)

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Abstract

Two new species of *Brachytrycherus* from China, *B. conaensis* **sp. n.** and *B. curviantennae* **sp. n.** are described and illustrated. *Brachytrycherus conaensis* **sp. n.** is the first species of the Handsome Fungus Beetles recorded feeding on Ascomycetes. A key to the species of *Brachytrycherus* known in China is provided.

Keywords

Coleoptera, Endomychidae, new species, taxonomy, China

Introduction

The genus *Brachytrycherus* was established by Arrow (1920) with *B. perotteti* as the type species. It is a member of the largest endomychid subfamily Lycoperdininae, the monophyly of which was confirmed by the phylogenetic studies of Tomaszewska (2000, 2005).

In 2015, a large-scale phylogenetic study was presented for Cucujoidea by Robertson et al., using molecular evidence to rebuild the relationship tree of this superfamily, and established one new superfamily, Coccinelloidea Robertson et al., 2015. The Endomychidae was included in it. Through this significant study, the monophyly of subfamily Lycoperdininae is more clear, and with subfamily Epipocinae forms the sister group to Endomychinae+Stenotarsinae (Robertson et al. 2015).

Tomaszewska (2005) placed *Brachytrycherus* with another seven genera in the Amphisternus-group: *Amphisternus* Germar, 1843, *Amphistethus* Strohecker, 1964, *Cacodaemon* Thomson, 1857, *Gerstaeckerus* Tomaszewska, 2005, *Ohtaius* Chûjô, 1938, *Spathomeles* Gerstaecker, 1857 and *Stictomela* Gorham, 1886. The monophyly of this group is well supported based on the following synapomorphies: mesoventrite with intercoxal process widened laterally towards apex, overlapping parts of coxae; elytra with basal margins thickened and raised, mandible with apical tooth widely chisel-shaped, male genital segment with additional internal V- or U-shaped sclerite (Tomaszewska 2005). Since then, two new genera of the Amphisternus-group were described, *Stroheckeria* Tomaszewska, 2006 from Vietnam, and *Humerus* Chang & Ren, 2013a from China.

Strohecker (1964) in his synopsis of the tribe Amphisternini (=Amphisternus-group of Tomaszewska (2005)) listed four species of *Brachytrycherus*, (*B. convexus* Strohecker, 1964, *B. gemmatus* (Arrow, 1928), *B. madurensis* Arrow, 1920 and *B. perotetti* Arrow, 1920) of which *B. convexus* as a new species and *B. gemmatus* as a new combination moved from *Engonius*. He also provided a key to the species of *Brachytrycherus* known at that time. Prior to the present study, *Brachytrycherus* included six species (Shockley et al. 2009a): *B. concolor* Arrow, 1937 (Borneo), *B. convexus* Strohecker, 1964 (India), *B. femoralis* (Arrow), 1928 (Laos, Vietnam), *B. gemmatus* (Arrow), 1928 (Laos, Myanmar and Thailand), *B. madurensis* Arrow, 1920 (India, Taiwan) and *B. perotteti* Arrow, 1920 (India). Only one of which was previously known from China: *B. madurensis*.

During the examination of the Endomychidae collected in China, two new species were recognized and are described here.

Material and methods

Type specimens of the new species described here are deposited in the following institutions or private collections:

MHBU Museum of Heibei University, Baoding, China;
CBWX Collection of Wenxuan Bi, Shanghai, China;
SHEM Shanghai Entomology Museum, Chinese Academy of Sciences, Shanghai, China.
MIZ Museum and Institute of Zoology, Polish Academy of Sciences, Warszawa, Poland.

The specimens were examined and described using a Nikon® SMZ800 dissecting microscope. The following measurements were made using a Leica® M205 A dissecting microscope: body length from apical margin of clypeus to apex of elytra; width across both elytra (at widest part); elytral length along suture, including scutellum. The aedeagus was boiled in 10% NaOH solution, cleaned, and finally dissected in distilled water. Habitus photos were taken using a Canon® Eos 5D III SLR camera and Canon® MP-E 65mm macro lens. All photographs were modified in Adobe Photoshop® CC 2015.

Taxonomy

Brachytrycherus Arrow, 1920

Brachytrycherus Arrow, 1920: 12.

Type species. *Brachytrycherus perotteti* Arrow, 1920.

Diagnosis. The species of *Brachytrycherus* resemble those of *Ohtaius* and *Gerstaeckerus* in having the body black or blackish-brown, elytral maculae transverse, most often orange or yellow. These genera share the feature of having the mandibles chisel-shaped apically. However, *Brachytrycherus* can be distinguished from these other genera by the following combination of characters: 1) body less elongate; 2) head with well-developed gular sutures; 3) mesoventral process with sides parallel; 4) maxillary laciniae with tuft of S-like setae apically (Tomaszewska 2005).

Brachytrycherus conaensis sp. n.

http://zoobank.org/278F3113-648B-4DFF-BBFB-D2AB2B47177A
Figs 1–2, 5

Type material. Holotype, male, Xizang, Cona, Lexiang, 2500-2600 m, 20-30.VI.2013, Wen-Xuan Bi leg. (MHBU); Paratypes, 1 female, same data as holotype. 2 females, Xizang, Medog, Beibeng, Gelincun, 1700 m, 3.VIII.2014, Wen-Xuan Bi leg. (CBWX); 3 males, 7 females, Xizang, Cuona, Lexiang, 2500 m, 6.VIII.2010, Wen-Xuan Bi leg. (CBWX); 5 males, 6 females, ditto except 15.VII.2011 (CBWX); 26 males, 11 females, ditto except 29–30.VI.2013 (CBWX); 1 male, 1 female, ditto except (MZPW); 18 males, 1 female, ditto except 2500-2600 m, 20-30.VI.2013 (CBWX); 1 female, ditto except 2700 m, 18.VI.2013 (CBWX).

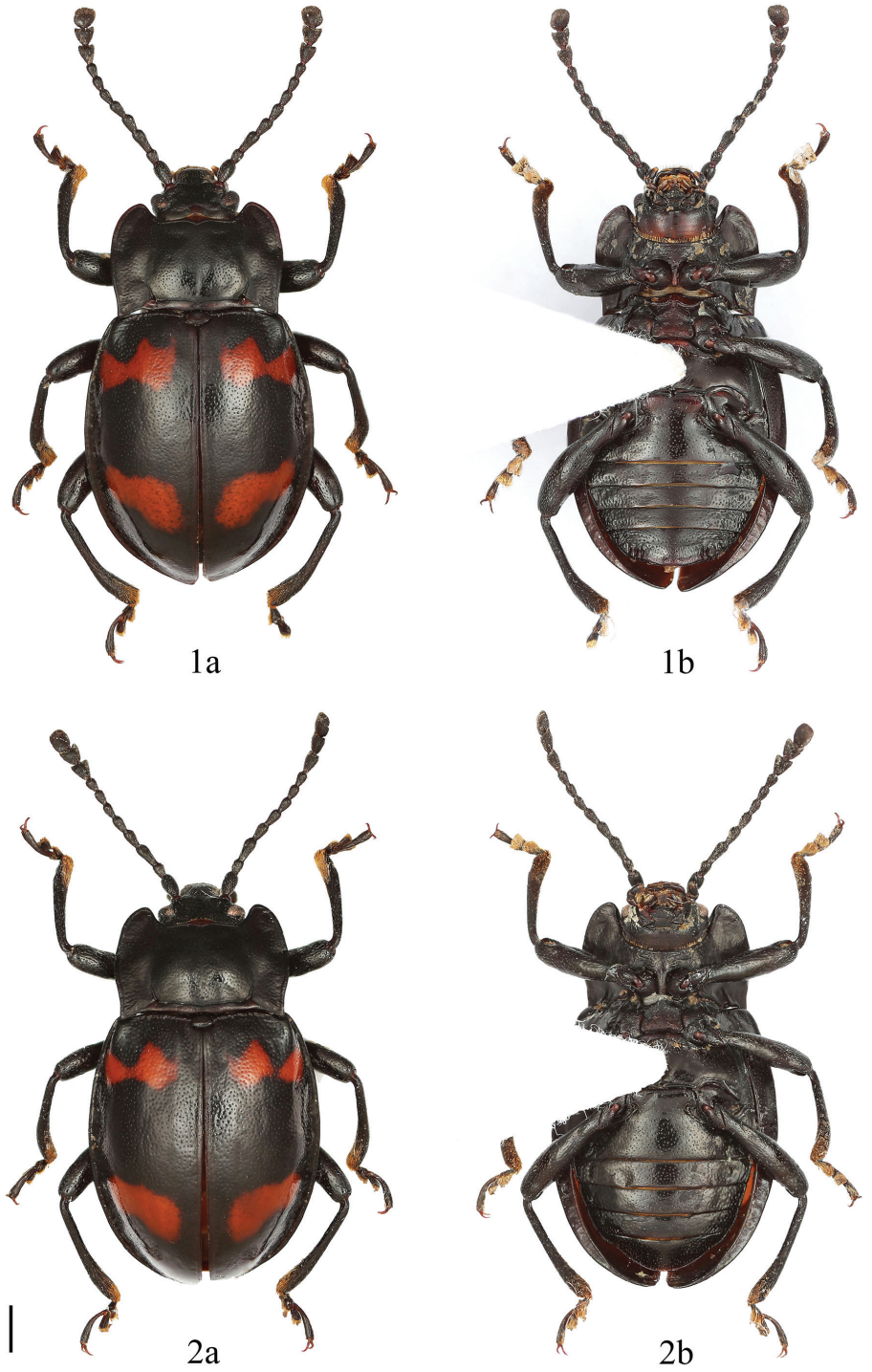
Etymology. The specific name is derived from the type locality.

Diagnosis. *Brachytrycherus conaensis* is similar to *B. madurensis* in appearance, but can be differentiated by each elytron with three maculae, anterior two maculae nearly rhomboid in shape, sometimes connected to each other, and the anterior and posterior elytral maculae without dentition.

Description. Length 8.2–8.3 mm. Body oval, about 1.8–1.9 times as long as wide; rather convex; shiny. Colour black with three red maculae on elytra.

Head. Antenna 11-segmented, long and rather slender, nearly 1/2 body length, with antennomeres 1–8 distinctly longer than wide; scape approximately 4.5 times as long as pedicel; antennomere 3 slightly shorter than 4 and 5 combined; antennomeres 4 nearly as long as 5, antennomeres 5–8 gradually shorter; club composed of 3 antennomeres, moderately broad, flat, loose. Maxilla with terminal palpomere elongated, almost 2.0 times as long as palpomere 3, tapering anteriorly, truncate apically.

Thorax. Pronotum 2.0–2.3 mm long, 3.2–3.3 mm wide; widest near 1/2 of pronotal length; coarsely and densely punctate; lateral margins rather narrowly bordered,



Figures 1–2. Dorsal and ventral habitus of *B. conaensis* sp. n. **1** male **2** female. a = dorsal view, b = ventral view. Scale bar 1 mm.

sides nearly parallel; front angles produced anteriorly, rather acute; disc weakly convex, two small round raised area laterally; transverse wrinkle laterally; median furrow absent; lateral sulci linear, deep, extending to basal 1/3 length of pronotum; basal sulcus nearly straight, deep. Prosternal process rather narrowly separates procoxae; not extending beyond coxae; sides in male weakly curved outwardly, rounded apically; in female sides nearly straight, weakly truncate apically. Mesoventral process transverse, lateral margins widening apically and overlapping part of mesocoxae; posterior margin nearly straight. Elytra 5.9–6.1 mm long, 4.5–4.7 mm wide; 2.7–3.0 times as long as pronotum and 1.4 times as wide as pronotum, sides curved, widest near 1/2 length of elytron; densely and coarsely punctate; humeri rather prominent. Each elytron with three irregular red maculae. Anterior 2 elytral elytral maculae nearly rhombus, located near apical 1/4, medial macula larger than lateral one, sometimes narrowly connected. Posterior macula transverse, anterior margin shallowly emarginate or nearly straight, posterior margin U-shaped, widely emarginate.. All tibiae with sexual characters; protibiae in male with concavity on inner edge of apical 1/4, in female without concavity; mesotibiae abruptly curved from near apical 1/3 to apex, in female gently curved; metatibiae in male abruptly widened from near 1/3 length to apex, in female gently widened.

Abdomen with five ventrites in both sexes. Ventrite 5 with lateral margins gently converging posteriorly, three pairs of longitudinal short wrinkles laterally; posterior margin weakly curved medially in male; in female ventrite 5 lateral margins abruptly converging posteriorly, without longitudinal wrinkles; posterior margin truncate, nearly straight medially. Aedeagus (Fig. 5) rather long, heavily sclerotized, straight. Median lobe branched apically; branch long and rather straight, abruptly raised near basal 1/3 length, gently converging apically, flat, acute and weakly reflexed apically. Tegmen basal, comparatively large, ring-shaped.

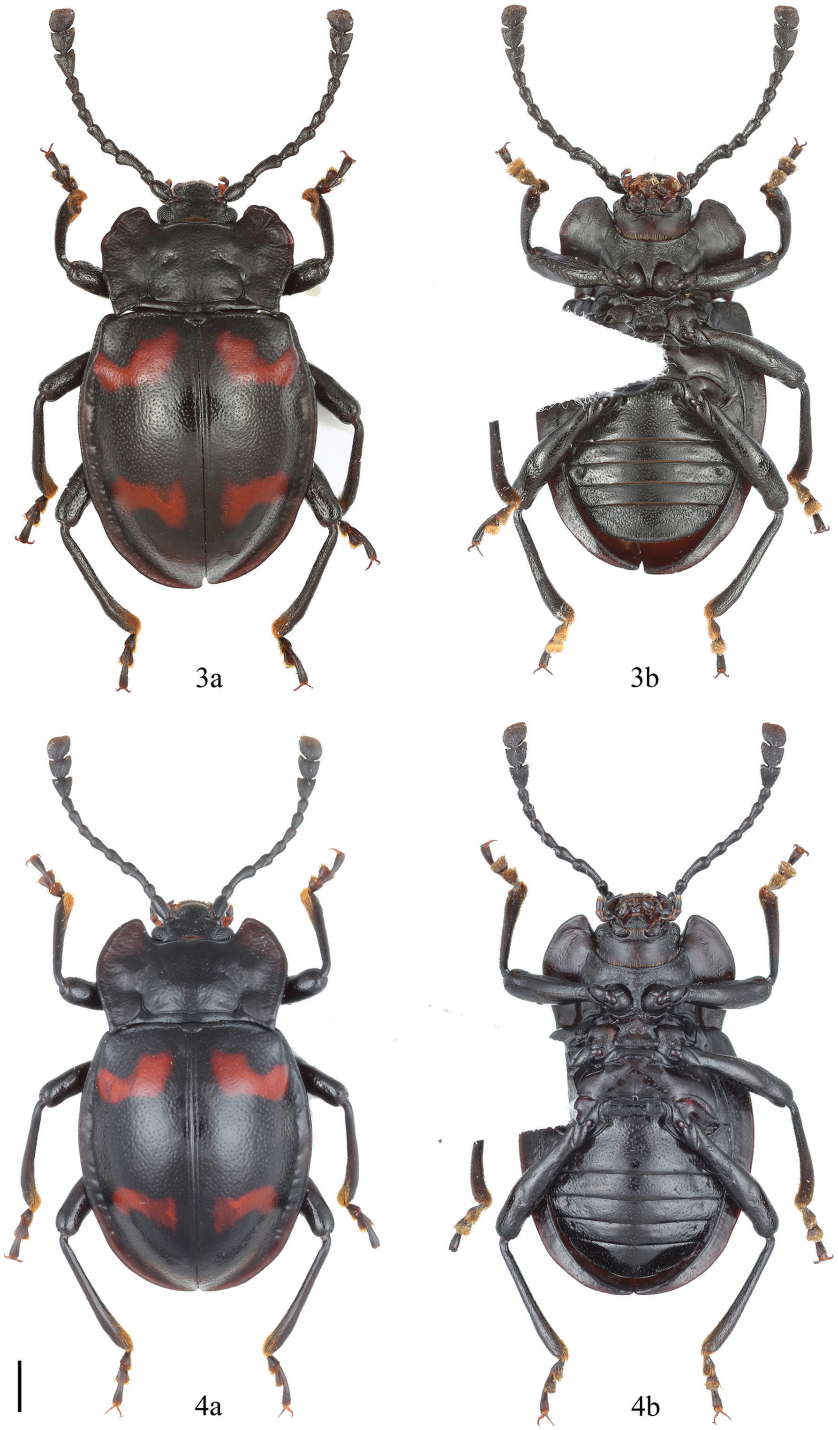
Biology and ecology. Almost all individuals were found active on fence, woodpile or timber piles within the village and its surrounding area at night (Figs 9–11). Some larvae and adults were found (sometimes at the same time) feeding on the surface of the perithecia or spores of *Daldinia concentrica* (Xylariaceae) (Fig. 10), seeming to prefer the asexual phase; however, individuals were also found on mature ascocarps.

Based on the study of the natural history of the handsome fungus beetles (Shockley et al. 2009b), this report is possibly the first record of the handsome fungus beetles feeding on ascomycetes. In addition, some individuals were found active on the wood without fungus, and may be feeding on lichen growing on the wood (Fig. 11). This species association may not be host-specific.

***Brachytrycherus curviantennae* sp. n.**

http://zoobank.org/CA118D1D-C4CD-4DB6-BEFB-22D840A76F1A
Figs 3–4, 6

Type material. Holotype, male, Xizang, Medog, 1500 m, 20.VIII.2013, Wen-Xuan Bi leg. (SHEM); Paratypes, 1 female, Xizang, Medgo, Beibeng, Gelincun, 3.VIII.2014,



Figures 3–4. Dorsal and ventral habitus of *B. curviantennae* sp. n. **3** male **4** female. **a** = dorsal view, **b** = ventral view. Scale bar 1 mm.

Figures 5–6. Aedeagus **5** *B. conaensis* sp. n.; **6** *B. curviantennae* sp. n. **a** = lateral view, **b** = apical view. Scale bars 1 mm.

Wen-Xuan Bi leg. (MHBU); 1 female, Xizang, Medgo, Beibeng, Gelincun, 3.VIII.2014, Wen-Xuan Bi leg. (CBWX).

Etymology. The name refers to the antennomere 3 distinctly outwardly curved.

Diagnosis. *Brachytrycherus curviantennae* is similar to *B. madurensis* in appearance, but can be differentiate by antennomere 3 distinctly curved outwards, pronotum sides strongly curved, elytral maculae with front and hind margins emarginate.

Description. Length 8.5–9.4 mm. Body broadly oval, approximately 1.6–1.8 times as long as wide; convex; shiny. Colour black with four red maculae on elytra.

Head. Antenna 11-segmented, long and rather slender, nearly 1/2 body length, with antennomeres 1–8 distinctly longer than wide; scape approximately 4.5 times as long as pedicel; antennomere 3 distinctly curved, and nearly as long as 4 and 5 combined; antennomere 4 as long as 5, antennomeres 5–8 gradually shorter; club composed of 3 antennomeres, broad and flat. Maxilla with terminal palpomere elongate, almost 2.0 times as long as palpomere 3, tapering anteriorly, truncate apically.

Thorax. Pronotum 2.0–2.4 mm long, 4.1–4.2 mm wide; widest near 1/2 of pronotal length; coarsely and densely punctate; lateral margins narrowly bordered, sides in male wavy and strongly curved; in female sides smooth and strongly curved,; front angles produced anteriorly, blunt; disc weakly convex, with two large round raised areas laterally; transverse wrinkle laterally; median furrow absent; lateral sulci linear, deep, extending to basal 1/3 of pronotal length; basal sulcus nearly straight, deep. Prosternal process moderately separates the procoxae; sides weakly curved outwardly , weakly truncate apically. Mesoventral process transverse, lateral margins widening apically and overlapping part of mesocoxae; posterior margin nearly straight. Elytra 6.0–7.1 mm long, 5.1–5.2 mm wide; 3.0 times as long as

Figures 7–11. Habitats of *Brachytrycherus* species. **7** large clump of Fagaceae plants of collecting site in Xizang, China **8** male of *B. curviantennae* sp. n. (arranged) **9** village of collecting site in Xizang, China **10** male of *B. conaensis* sp. n. and larva on the wood pile **11** female of *B. conaensis* sp. n. feeding on the lichen growing on wood.

pronotum and 1.2–1.3 times as wide as pronotum, sides curved, widest near 1/2 length of elytron; densely and coarsely punctate; humeri rather prominent. Each elytron with two transverse, irregular in shape red maculae. Anterior elytral macula

nearly cymbiform, anterior margin widely U-shaped and deeply emarginate, posterior margin weakly wavy. Posterior macula transverse, inversely cymbiform, anterior margin weakly wavy, posterior margin widely U-shaped and deeply emarginate. Protibiae in male with concavity on inner edge of apical 1/3, in female without concavity; mesotibiae abruptly curved from near apical 1/3 to apex, in female gently curved; metatibiae in male abruptly widened from near 1/3 length to apical 1/4, in female gently widened.

Abdomen with 5 ventrites in both sexes. Ventrite 5 with lateral margins gently converging posteriorly, posterior margin widely rounded medially in male; in female ventrite 5 lateral margins abruptly converging posteriorly, posterior margin truncate, nearly straight medially. Aedeagus (Figs 6) rather long, heavily sclerotized, straight. Median lobe branched apically; branch long and rather straight, gently rising from about basal 1/3 to apical 1/3, flat, acute and weakly reflexed apically. Tegmen placed basally, comparatively large, ring-shaped.

Biology and ecology. The male was hand collected by simple searching, as it is active on branches at night (Fig. 7). Two females were collected by shaking the tree from a large clump of dead wood of Fagaceae plants (Fig. 8).

Key to the species of *Brachytrycherus* known in China

1 Antennomere 3 distinctly outwardly curved; pronotum sides strongly curved..... ***B. curviantennae* sp. n.**
– Antennomere 3 straight; sides of pronotum nearly parallel..... **2**
2 Each elytron bearing 2 transverse, strongly dentate maculae.... ***B. madurensis***
– Each elytron bearing 3 maculae, anterior 2 maculae nearly rhomboid, sometimes connected to each other; elytral maculae not dentate ..... ***B. conaensis* sp. n.**

Conclusions

Prior to this study, only *B. madurensis* was recorded from China (Taiwan) (Shockley et al. 2009a). Two new species comprise the first record of *Brachytrycherus* from mainland China.

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DATA PAPER

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Assessment of the current state of biodiversity data for butterflies and skippers in the state of Mato Grosso, Brazil (Lepidoptera, Papilionoidea and Hesperioidea)

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Abstract

Lepidoptera is one of the four megadiverse insect orders, comprising butterflies and moths. In Brazil, the bulk of knowledge about the butterfly fauna is restricted to some areas in the southeast of the country, with large gaps of knowledge in other areas. The state of Mato Grosso is one of the largest states in Brazil, and holds three of the main Brazilian biomes: Amazon rain forest, Cerrado and Pantanal. However, knowledge about Mato Grosso butterflies is fragmented and restricted to a few localities, and information is scattered in various sources. The aim of this study is to assemble the biodiversity information of the butterfly fauna of the state of Mato Grosso based on historical and recent literature data and collections carried out in the southwest of the state from 2007–2009. Records without precise locality data or taxonomic information were not included. Species identification was based on literature and comparison with specimens in collections; higher and species-level taxonomy were updated based on the Neotropical Checklist of Hesperioidea and Papilionoidea and recent phylogenetic and revisionary taxonomic works. In total, 901 species were recorded in 2,820 occurrence records. This represents 148 species of Hesperiidae, 29 Papilionidae, 28 Pieridae, 77 Lycaenidae, 238 Riodinidae, and 381 Nymphalidae. Of these, 207 species records are from the type specimens of species described in the state. Based on the results and literature records for other Brazilian states and biomes, probably the figures for Mato Grosso are underestimated,

particularly in the families Hesperiidae, Lycaenidae and Riodinidae, in that order. Future collecting efforts should be directed towards certain areas of the state, especially in less sampled areas and biomes, as the north of the state and Pantanal.

Keywords
Biodiversity, Database, Amazon, Cerrado, Pantanal, Occurrence

Introduction

The butterflies are a highly suitable taxonomic group for assessing environmental disturbance and its impact on species conservation. They are effective biodiversity indicators; similarly, their charismatic appeal and biological peculiarities make them an effective "umbrella group" for biodiversity and habitat conservation (Brown Jr 1992, Brown Jr and Freitas 1999, Santos et al. 2008).

Gathering species distribution data is essential for any practical decision about species conservation (Lewinsohn and Prado 2002). However, even though interest in the conservation of biodiversity has recently increased, species inventories and lists are still lacking (Mielke et al. 2008), and the bulk of the knowledge about the butterfly fauna of Brazil is restricted to a few areas in the southeast of the country, with large gaps of knowledge in other areas (Santos et al. 2008). Along with many other organisms, butterflies are threatened by the destruction and fragmentation of their natural habitats (Emery et al. 2006) and therefore efforts to gather local and regional species lists should be intensified before natural habitats have been altered by anthropic landscapes (Lewinson and Prado 2005).

The state of Mato Grosso is potentially highly biodiverse because three of the main Brazilian biomes are present within its borders: Amazon tropical rainforest, Cerrado and Pantanal. However, knowledge about Mato Grosso butterflies is fragmentary and information is scattered throughout various sources (Santos et al. 2008). Given the absence of comprehensive regional lists for most of the Brazilian states, the aim of this study is to accrue and present the biodiversity data for the butterfly fauna in the state of Mato Grosso, based on literature data from the years 1895 to 2015, and collections carried out in the southwest region of the state from 2007 to 2009. Additionally, records assigned to the state of Mato Grosso in error are corrected.

General description

Additional information: The authors would like to thank Marcelo Duarte (MZUSP) and Geraldo Lamas (UNMSM) for providing access to essential literature, Marcelo Medaglia for help with maps and georeferencing, and Fábio Santos for suggestions about the manuscript and Keith M. Bayless for reviewing the English version of the manuscript. We also would like to thank the following researchers for help in the identification of specimens: Alfred Moser (Lycaenidae), Eduardo Carneiro (Hesperiidae),

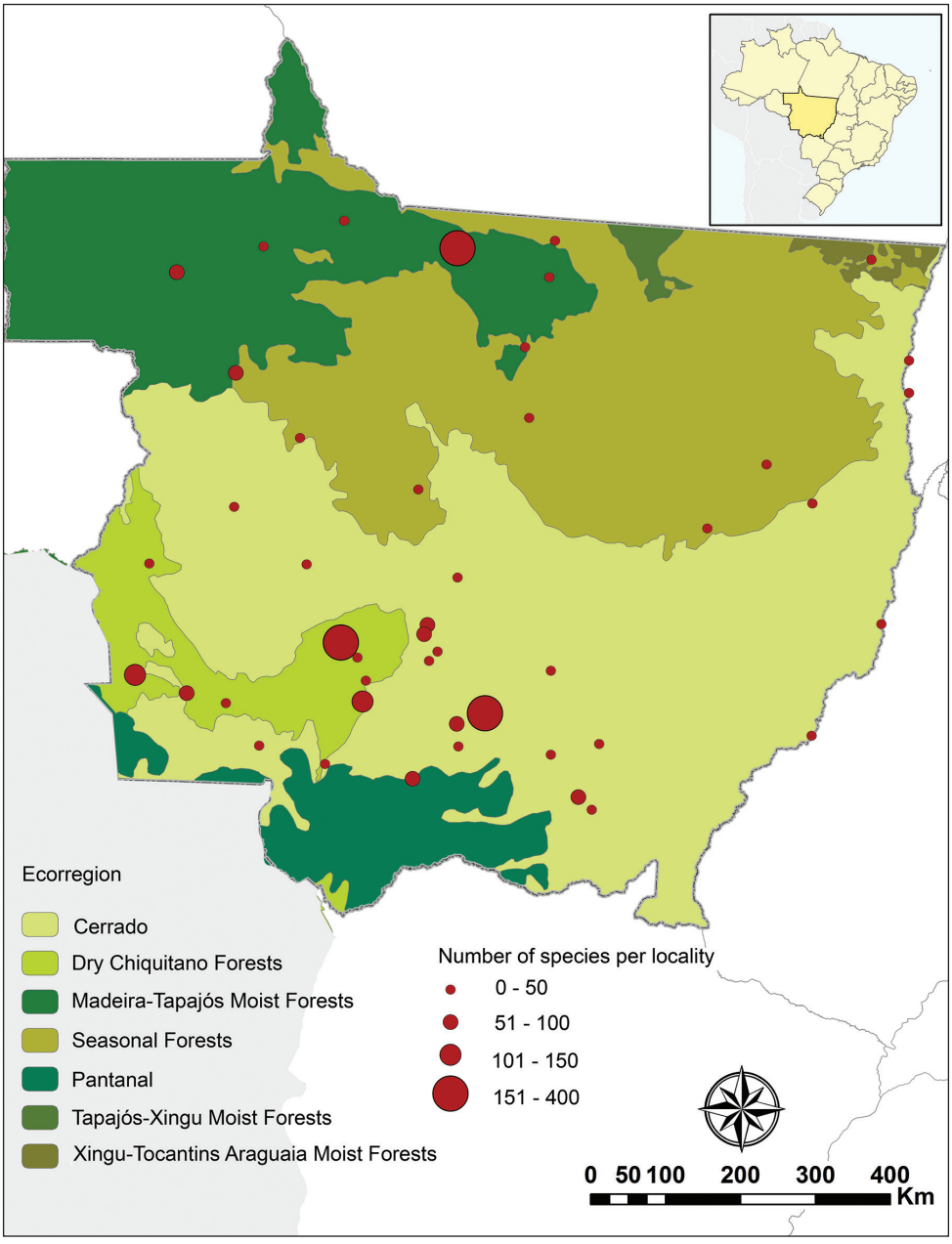

Figure 1. Occurrence localities of butterflies and number of species per locality in the state of Mato Grosso, Brazil.

Diego Dolibaina (Riodinidae), Thamara Zacca (Satyrinae), Eduardo Barbosa for species of Hermeuptychia, and Lucy Mila Salik (Biblidinae). The authors would like to thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)

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Project details

Project title: Assessment of the current state of biodiversity data for butterflies and skippers (Lepidoptera: Papilionoidea and Hesperioidea) in the state of Mato Grosso, Brazil

Personnel: Luziany Queiroz-Santos, Fernando Maia Silva Dias, Rafael Dell'Erba, Mirna Martins Casagrande, Olaf Hermann Hendrik Mielke

Funding: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)

Study area descriptions/descriptor: Mato Grosso is located in the central-western part of Brazil, with an area of 903,378,292 km², making it the third largest state in Brazil. The state has three different climate zones: in lower elevations, there is a tropical monsoon climate, with rainy summers and dry winters and an average temperature of over 24°C; and also a tropical rainforest climate, with no distinct seasons, heavy rainfall, and average temperature of 23°C; and in higher elevations, there is a subtropical climate, with an average temperature of 17°C. Most regions are at low to medium elevations, with areas from about 100 meters in the southwest and northern areas, reaching up to 1,118 meters above sea level; nevertheless, about two thirds of the state is below 600 meters in elevation. Mato Grosso is drained by streams that flow north to the Amazonas drainage basin (e.g. Juruena, Teles Pires, and Xingu rivers), east to the Tocantins-Araguaia river basin (e.g. Araguaia River), and south to the Paraná river basin (e.g. Cuiabá River).

Design description: The list of diurnal butterflies occurring in the state of Mato Grosso, Brazil, was compiled based on faunistic studies, species descriptions and other taxonomic literature, and specimens collected by the first author in field expeditions carried out between November 2007 and January 2009 in the municipality of Pontes e Lacerda, southwestern Mato Grosso.

The first records of butterflies from the state of Mato Grosso are the type localities of species described by Fruhstorfer (1895) and Godman and Salvin (1896); in the following years, several authors added records to the state. The Talbot and Collenette expedition was the first significant contribution to the knowledge of the butterfly fauna of Mato Grosso; two papers, both published in 1928, provide several records and descriptions of new taxa. The results of the Rondon expedition led by Miranda-Ribeiro (1931), records provided by Brown Jr. (1979, 1987), and data available in the illustrated guide by Garwood et al. (2009), stand out as important sources of occurrence records. A total of 2,820 individual occurrence records were included in the database; of the 901 species recorded, 207 are from type localities of descriptions of taxa and 102 from the three years of field work in the municipality of Pontes e Lacerda. Of these, 31

species were not recorded before in the literature to Mato Grosso. The highest number of records are from Nymphalidae (381 species in 1,669 records), followed by Riodinidae (238 species in 605 records) and Hesperiidae (148 species in 177 records). The families with the least number of both species and records are Lycaenidae (77 species in 105 records), Pieridae (28 species in 151 records) and Papilionidae (29 species in 94 records).

Data published through

GBIF: http://ipt.sibbr.gov.br/sibbr/resource?r=ufpr_borboletasmt

Taxonomic coverage

General taxonomic coverage description: The taxonomic coverage of this dataset spans the diurnal butterflies, which includes superfamilies Hesperioidea (with one family, Hesperiidae) and Papilionoidea (with five families, Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Riodinidae). The highest number of records in the study area are from Nymphalidae (381 species in 1,669 records), followed by Riodinidae (238 species in 605 records) and Hesperiidae (148 species in 177 records). The families with the least number of both species and records are Lycaenidae (77 species in 105 records), Pieridae (28 species in 151 records) and Papilionidae (29 species in 94 records).

Taxonomic ranks

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Lepidoptera
Family: Papilionidae, Pieridae, Riodinidae, Nymphalidae, Lycaenidae, Hesperiidae
Common names: Animals, Arthropods, Insects, Butterflies and Moths, Swallowtails, Sulphurs and Whites, Metalmarks, Brush-footed Butterflies, Blues, Coppers and Hairstreaks, Skippers

Spatial coverage

General spatial coverage: This dataset collates species occurrences from the Brazilian state of Mato Grosso. Most regions are at low to medium elevations, with areas from 100 meters in the southwest and northern limits, reaching up to 1,118 meters above sea level, however, about two thirds of the state is below 600 meters in elevation.

Coordinates: 18°7'12"S and 7°22'48"S Latitude; 61°36'0"W and 50°23'60"W Longitude
Temporal coverage: 1895 - 2015
Natural collections description
Collection name: Coleção Zoobotânica "James A. Ratter", Universidade do Estado de Mato Grosso, Nova Xavantina, Mato Grosso, Brazil
Collection identifier: CZNX
Natural collections description
Collection name: Coleção Entomológica Padre Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Paraná, Brazil
Collection identifier: DZUP
Specimen preservation method: Mounted

Methods

Method step description: Compilation of occurrence data from the literature, and data of the specimens collected between November 2007 and January 2009 in the municipality of Pontes e Lacerda, southwestern Mato Grosso.

Study extent description: Literature and specimens between November 2007 and January 2009 in the municipality of Pontes e Lacerda, southwestern Mato Grosso.

Sampling description: The list of diurnal butterflies occurring in the state of Mato Grosso, Brazil, was compiled based on faunistic studies, species descriptions and other taxonomic literature (Fruhstorfer 1895; Godman and Salvin 1896, Godman and Salvin 1898, Godman 1900, Godman 1903, Druce 1904, Godman 1905, Druce 1907, Stichel 1909, Fruhstorfer 1910a, Fruhstorfer 1910b, Niepelt 1910, Stichel 1910, Weymer 1911, Fruhstorfer 1912, Röber 1913, Fruhstorfer 1915, Stichel 1915, Fruhstorfer 1916a, Fruhstorfer 1916b, Oberthür 1916, Stichel 1916a, Stichel 1916b, Seitz 1917, Reverdin 1919, Stichel 1919, Lathy 1921, Riley 1921, Röber 1921, Skinner 1921, Martin 1923, Stichel 1923, Joicey and Talbot 1924, Riley 1924, Stichel 1924, Joicey and Talbot 1925, Neustetter 1925, Röber 1925, Lathy 1926a, Lathy 1926b, Stichel 1926, Williams 1926, Williams 1927, Collenete and Talbot 1928a, Collenette and Talbot 1928b, D'Almeida 1928, Talbot 1928, Hall 1929, Riley 1929, Stichel 1929, Miranda-Ribeiro 1931, Lathy 1932, Le Moult 1932, Seitz 1932, Talbot 1932, D'Almeida 1935, Bell 1938, Williams and Bell 1939, D'Almeida 1941, Hayward 1942a, Hayward 1942b, Evans 1944, Goodson 1945, Dillon 1948, Evans 1951, D'Almeida 1952, Bryk 1953, Evans 1953, Evans 1955, D'Almeida 1958, Le Moult and Réal 1962–1963, Weber 1963, Mielke 1967, Mielke 1968, Brown Jr et al. 1970, Brown Jr 1973, Mielke 1978, Casagrande and Mielke 1979, Bristow 1981, 1982, 1991, De Jong 1983, Jenkins 1983, Brown Jr 1987, Steinhauser 1991, Blandin 1993, Johnson 1993, Burns 1994, Tyler et al. 1994, D'Abrera 1995, Mielke 1995, Hall and Willmott 1996, Johnson and Kruse 1997, Austin and Mielke 1997, Hall 1998, Callaghan 1999, Hall and Furtado 1999, Harvey and Hall 2002, Blandin 2007b, Garwood and Lehman 2009, Casagrande 2009, Dolibaina et al. 2013, Dorval et al.

2013, Kaminski et al. 2015). Only occurrences explicitly recorded in a locality within the limits of the state of Mato Grosso were acknowledged, therefore, approximately 470 species of Hesperiidae listed by Brown Jr (1987) were not recorded, as his list also contains data from neighboring states. Similarly, occurrences without precise taxonomic information (e.g. unidentified species, species noted with "cf.", "aff.", "?", and uncertain identifications, when explicitly stated, etc.) were not included. Due to factual errors and successive changes in the political boundaries of the states of Brazil, some records of type specimens supposedly from "Mato Grosso" (Lamas 2004, Mielke 2005a,b,c,d,e,f) actually belong to the Brazilian states of Rondônia, Mato Grosso do Sul or Pará. The type localities of these species were corrected, based on the information provided in the original descriptions and assigned to the correct state. Additionally, data from specimens collected by LQS in field expedition carried out between November 2007 and January 2009 in the municipality of Pontes e Lacerda, Mato Grosso were included. Specimens were actively collected with standard entomological nets, mounted, labeled, identified, and deposited at the Coleção Zoobotânica "James A. Ratter", Universidade do Estado de Mato Grosso, Nova Xavantina (CZNX).

Higher and species-level taxonomy of all records were checked and updated, based on Blandin (1988), McAlpine (1971), Jenkins (1985), Jenkins (1990), Bristow (1981, 1982, 1991), Holzinger and Holzinger (1994), Tyler et al. 1994, Hall (1998), Hall (2000), Willmott (2003), Lamas (2004), Bálint (2005), Hall (2005), Blandin (2007a), Hall (2007), Austin (2008), Penz (2008), Faynel et al. (2012), Dolibaina et al. (2013), Ortiz-Acevedo and Willmott (2013), Seraphim et al. (2013), Zacca et al. (2013), Dias et al. (2014) and Díaz et al. (2014). Collected specimens were identified through direct comparison with specimens deposited at the Coleção Entomológica Pe. Jesus Santiago Moure, Departamento de Zoologia, Universidade Federal do Paraná (DZUP) and with the aid of specialists (see additional information).

Datasets

Dataset description
Object name: Darwin Core Archive Assessment of the current state of biodiversity data for butterflies and skippers (Lepidoptera: Papilionoidea and Hesperioidea) in the state of Mato Grosso, Brazil
Character encoding: UTF-8
Format name: Darwin Core Archive format
Format version: 1.0
Distribution: http://ipt.sibbr.gov.br/sibbr/archive.do?r=ufpr_borboletasmt
Publication date of data: 2016-03-30
Language: English

Metadata language: English
Date of metadata creation: 2016-01-21
Hierarchy level: Dataset

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