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Research article

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Description of four new species of the subgenus *Tachycines* (*Gymnaeta*) Adelung, 1902 (Orthoptera: Rhaphidophoridae) from caves in China and additional notes on some previously known species

Qi-Di ZHU ¹ & Fu-Ming SHI ^{2,*}

^{1,2}College of Life Science, Institute of Life Science and Green Development, Hebei University, Baoding 071002, P.R. China.

*Corresponding author: shif_m@126.com

¹Email: qidizhu0323@163.com

¹urn:lsid:zoobank.org:author:7796C4B5-5DC2-42BB-A671-18BE36E68C48

²urn:lsid:zoobank.org:author:9E53A7F0-4FEB-4AED-8E3C-BD1AB497154D

Abstract. In this paper, four new cave-dwelling species of the subgenus *Tachycines* (*Gymnaeta*) from Guangxi, Hunan and Jiangxi are described, i.e., *Tachycines* (*Gymnaeta*) *quadratus* sp. nov., *Tachycines* (*Gymnaeta*) *shiziensis* sp. nov., *Tachycines* (*Gymnaeta*) *sparsispinus* sp. nov. and *Tachycines* (*Gymnaeta*) *papilious* sp. nov. The female of *Tachycines* (*Gymnaeta*) *liboensis* Zhu, Chen & Shi, 2020 is recorded for the first time. Moreover, images illustrating the morphology of the four new and three previously described species are provided.

Keywords. Rhaphidophoridae, *Tachycines* (*Gymnaeta*), new species, caves, China.

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Introduction

In recent years, the diversity of cave species in China has attracted widespread attention, especially in studies on spiders, pseudoscorpions, beetles and millipedes (Tian *et al.* 2017; Jiang *et al.* 2018; Liu & Wynne 2019; Feng Z.G. *et al.* 2020; Gao *et al.* 2020; Zhao *et al.* 2020; Ma *et al.* 2020). The study of cave crickets from karstic areas in Southern China began with several biospeleological expeditions in the 1990s, organized by Chinese, French, Italian and Slovenian teams. In total, 11 species (subspecies) were discovered and described from Guizhou, Guangxi, Hunan and Hubei (Gorochov *et al.* 2006; Rampini *et al.* 2008). Jiao *et al.* (2008) recorded one species, *Diestrammena* (*G.*) *caverna* Jiao, Niu, Liu, Lei & Bi, 2008, from Yinshui Cave in Hubei. After that, cave crickets did not attract scholars' attention for a decade. Since 2019, an increasing number of species has been reported (Feng X.L. *et al.* 2019, 2020a, 2020b; Zhou & Yang 2020; Zhu *et al.* 2020). Up to now, the subgenus *Tachycines* (*Gymnaeta*) contains 25 cave-dwelling species (Gorochov *et al.* 2006; Rampini *et al.* 2008; Jiao *et al.* 2008; Qin *et al.* 2019; Feng X.L. *et al.* 2019, 2020a, 2020b; Zhou & Yang 2020; Zhu *et al.* 2020; Cigliano *et al.* 2020).

This paper describes four new species from caves in Guangxi, Hunan and Jiangxi. Images showing the morphology of the four new and three previously described species are provided.

Material and methods

Specimens were preserved in 75% ethanol and measured by Vernier caliper. Morphological structures were examined using a Leica M205A stereo microscope and a Leica DFC450 digital imaging system was used to acquire morphological images. The photos were edited with Adobe Photoshop CC 2018. Type specimens are kept at the Museum of Hebei University, Baoding, China (HBU).

The following conventions were adopted for the specimen measurements: body length from apex of fastigium verticis to posterior margin of the last abdominal tergite; pronotum length from anterior margin of pronotum to posterior margin along midline; fore femur length from base of fore femur to apex of genicular lobe; hind femur length from base of hind femur to apex of genicular lobe; hind tibia length from base of hind tibia to apex; hind basitarsus length from base of hind basitarsus to apex; ovipositor length from base of subgenital plate to apex of ovipositor.

Results

Class Insecta Linnaeus, 1758
Order Orthoptera Latreille, 1810
Superfamily Rhaphidophoroidea Walker, 1869
Family Rhaphidophoridae Walker, 1869
Subfamily Aemodogryllinae Jacobson, 1905
Tribe Aemodogryllini Jacobson, 1905
Genus *Tachycines* Adelung, 1902
Subgenus *Tachycines (Gymnaeta)* Adelung, 1902

Tachycines (Gymnaeta) quadratus sp. nov.

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Figs 1, 8A–B

Diagnosis

The new species is similar to *Tachycines (Gymnaeta) sonlaensis* Gorochov, 1990 with regard to the dorsal sclerite of the male genitalia, but differs from the latter by: projection of fastigium verticis is fully reduced; hind tibia has a lower number of dorsal spines (only 11–13 inner spines and 10–14 outer spines instead of 30–40 spines in *T. (G.) sonlaensis*); interno-dorsal spine is distinctly shorter than hind basitarsus instead of nearly equal in length to hind basitarsus in *T. (G.) sonlaensis*.

Etymology

The name of the new species derives from the Latin word ‘*quadratus*’ referring to the dorsal sclerite of the male genitalia quadrate being quadrangular.

Material examined

Holotype

CHINA • ♂; Hunan Prov., Yongzhou City, Lanshan County, Dibao Cave; 2 Oct. 2011; Ming-Yi Tian leg.; HBU.

Paratypes

CHINA • 1 ♂, 1 ♀; same collection data as for holotype; HBU.

Description

BODY. Medium-sized.

HEAD. Fastigium verticis fully reduced. Eyes slightly degenerated, oval; medium ocellus oval, located between antennal sockets. Apical segment of maxillary palpus distinctly longer than subapical one, apical area inflated, globular.

THORAX. Pronotum long, anterior margin straight, posterior margin arcuate; lateral lobes longer than high, ventral margin arc-shaped. Mesonotum and metanotum short, posterior margin of mesonotum arcuate, posterior margin of metanotum straight.

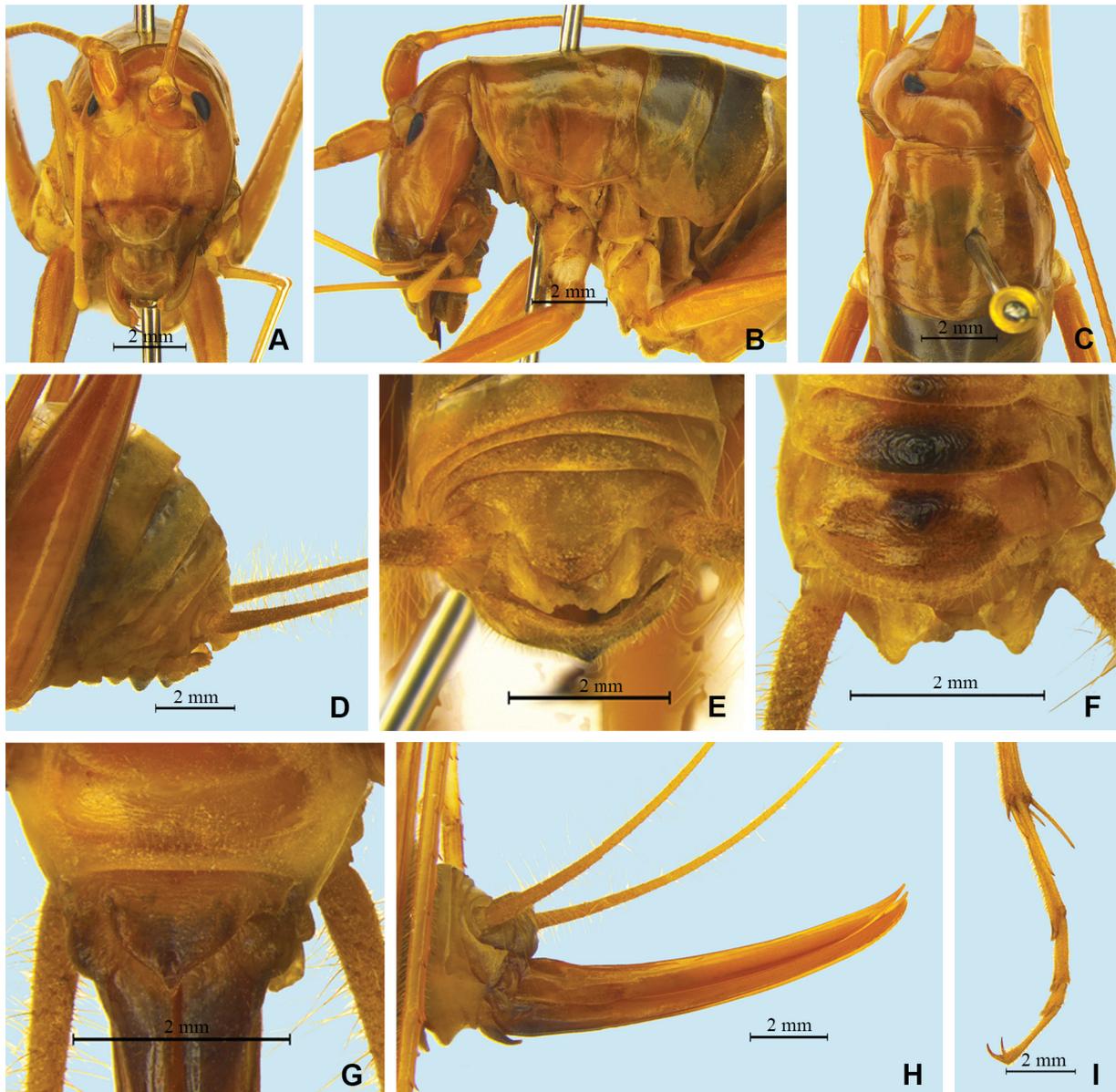


Fig. 1. *Tachycines* (*Gymnaeta*) *quadratus* sp. nov. A–F, I. Holotype, ♂ (HBU). A–C. Head and pronotum. A. Frontal view. B. Lateral view. C. Dorsal view. D–F. Apex of abdomen. D. Lateral view. E. Dorsal view. F. Ventral view. I. Hind tarsus in lateral view. — G–H. Paratype, ♀ (HBU). G. Subgenital plate. H. Ovipositor in lateral view.

LEGS. Fore coxa with one small spine; femur unarmed on ventral surface, internal genicular lobe with one small spine, external genicular lobe with one long spine; tibia with one inner spine and one to two outer spines on ventral surface, apex with one pair of ventral spines, between paired ventral spines with one small spine. Mid femur unarmed on ventral surface, internal and external genicular lobes with one long spine each; tibia with only one outer spine on ventral surface, apex with one inner spine on dorsal surface and one pair of ventral spines, between paired ventral spines with one small spine. Hind femur unarmed on ventral surface, internal and external genicular lobes unarmed; tibia with 11–13 inner spines and 10–14 outer spines on dorsal surface, arranged sparsely, with one pair of dorsal spines in subapical area, and at apex with one pair of dorsal spines and two pairs of ventral spines, interno-dorsal spine distinctly shorter than hind basitarsus. Hind basitarsus unarmed on dorsal surface, ventral surface with bristles.

MALE ABDOMEN. Posterior margins of all abdominal tergites relatively straight, abdominal sterna with conical tubercles. Epiproct tongue-shaped, paraproct simple, nearly triangular in lateral view. Cercus slender, conical, apex acute. Genitalia with six membranous lobes, apical area of dorso-median lobe with one pair of small lobes, lateral sclerite indistinct, dorso-lateral lobes nearly equal in length to dorso-median lobe, ventro-lateral lobes nearly equal in length to dorso-lateral lobes, ventro-median lobe short; dorsal sclerite quadrate. Subgenital plate quadrangular, transverse and broad, middle area with conical tubercle, posterior margin straight.

FEMALE ABDOMEN. Ovipositor longer than half the length of hind femur, slightly curved upward, dorsal margin smooth, apical area of ventral margin denticulate. Subgenital plate nearly triangular, both sides of basal area with one triangulate lobe, apex acute.

COLORATION. Body yellowish-brown. Eyes black, conical tubercles of abdominal sterna black.

Measurements (mm)

Body length: ♂: 15.30–15.70, ♀: 16.34; length of pronotum: ♂: 4.44–4.60, ♀: 4.18; length of fore femur: ♂: 11.94–12.56, ♀: 11.90; length of hind femur: ♂: 20.10–20.20, ♀: 19.04; length of hind tibia: ♂: 22.18–23.14, ♀: 22.00; length of hind basitarsus: ♂: 3.14–4.10, ♀: 3.44; length of ovipositor: 11.94.

Distribution

China (Hunan).

***Tachycines (Gymnaeta) shiziensis* sp. nov.**

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Figs 2, 8C–D

Diagnosis

The new species is similar to other congeneric species in appearance, but it can easily be distinguished by the shape of the dorsal sclerite of the male genitalia, the dorsal sclerite being trapezoidal, the basal part narrow, with one deep concavity, and the posterior margin being broad and slightly concave.

Etymology

The name of the new species refers to the type locality.

Material examined

Holotype

CHINA • ♂; Jiangxi Prov., Ji'an City, Wan'an County, Baoshan Village, Shiziyan; 16 Oct. 2013; Ming-Yi Tian, Wei-Xin Liu, Hao-Min Yin and Xin-Hui Wang leg.; HBU.

Description

Male

BODY. Slightly smaller than in other congeneric species.

HEAD. Fastigium verticis degenerated, indistinct. Eyes oval, protruding forward. Apical segment of maxillary palpus distinctly longer than subapical one, apex inflated, globular.

THORAX. Pronotum long, anterior margin straight, posterior margin arcuate; lateral lobes longer than high, ventral margin arc-shaped. Mesonotum and metanotum short, posterior margin of mesonotum arcuate, posterior margin of metanotum straight.

LEGS. Fore coxa with one small spine; femur unarmed on ventral surface, internal genicular lobe unarmed, external genicular lobe with one long spine; tibia with only two outer spines on ventral surface, apex with one pair of ventral spines, between paired ventral spines with one small spine. Mid femur unarmed on ventral surface, internal and external genicular lobes with one long spine each; tibia unarmed on ventral surface, apex with one pair of ventral spines, between paired ventral spines with one small spine. Hind femur unarmed on ventral surface, internal and external genicular lobes unarmed; tibia with 23–24 inner spines and 21–24 outer spines on dorsal surface, with one pair of dorsal spines in subapical area, and at apex with one pair of dorsal spines and two pairs of ventral spines, interno-dorsal spine slightly shorter than hind basitarsus. Hind basitarsus with one apical spine on dorsal surface, ventral surface with bristles.

MALE ABDOMEN. Posterior margins of all abdominal tergites relatively straight, abdominal sterna without obvious conical tubercles. Epiproct tongue-shaped, paraproct simple, nearly triangular in lateral view. Cercus extremely long, conical, apex acute. Genitalia with six membranous lobes, apical area of dorso-

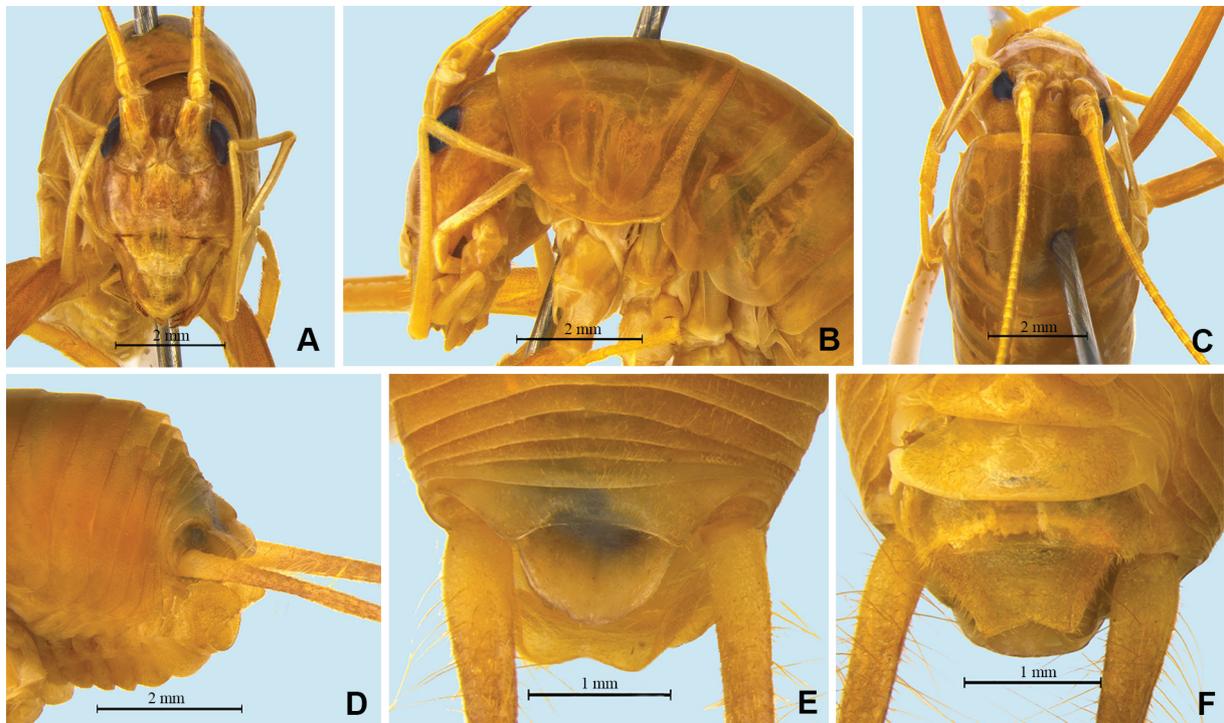


Fig. 2. *Tachycines* (*Gymnaeta*) *shiziensis* sp. nov. A–F. Holotype, ♂ (HBU). A–C. Head and pronotum. A. Frontal view. B. Lateral view. C. Dorsal view. D–F. Apex of abdomen. D. Lateral view. E. Dorsal view. F. Ventral view.

median lobe with one pair of small lobes, lateral sclerite slender, reaching subapex of dorso-median lobe, dorso-lateral lobes slightly longer than dorso-median lobe, ventro-lateral lobes much shorter than dorso-lateral lobes, ventro-median lobe short; dorsal sclerite trapezoidal, basal part narrow, with one deep concavity, posterior margin broad and slightly concave. Subgenital plate quadrangular, posterior margin slightly concave.

COLORATION. Body uniformly yellowish-brown. Eyes black.

Female

Unknown.

Measurements (mm)

Body length: ♂: 9.90; length of pronotum: ♂: 3.54; length of fore femur: ♂: 7.74; length of hind femur: ♂: 13.80; length of hind tibia: ♂: 14.20; length of hind basitarsus: ♂: 2.80.

Distribution

China (Jiangxi).

Tachycines (Gymnaeta) sparsispinus sp. nov.

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Figs 3, 8E–F

Diagnosis

The new species is similar to *Tachycines (Gymnaeta) bifolius* Zhu, Chen & Shi, 2020 and *Tachycines (Gymnaeta) fallax* (Zhang & Liu, 2009), but differs from *T. (G.) bifolius* by: eyes degenerated, taenioid; hind tibia with six to eight inner and outer spines each on dorsal surface; apical area of dorso-median lobe of male genitalia with one pair of small lobes; female subgenital plate is nearly triangular. The new species differs from *T. (G.) fallax* by: fastigium verticis completely reduced, eyes degenerated, hind tibia with six to eight inner and outer spines each on dorsal surface.

Etymology

The name of the new species is formed from the Latin words ‘*sparsus*’ (‘scattered’) and ‘*spina*’ (‘spine’), referring to the low number of dorsal spines on the hind tibia.

Material examined

Holotype

CHINA • ♂; Guangxi Zhuang Autonomous Region, Baise City, Tianlin County, Langping Village, Shizikou Cave; 13 Jun. 2014; Ming-Yi Tian, Wei-Xin Liu, Hao-Min Yin & Xiao-Zhu Luo leg.; HBU.

Paratypes

CHINA • 2 ♂♂, 1 ♀; same collection data as for holotype; HBU.

Description

BODY. Medium-sized.

HEAD. Fastigium verticis fully reduced. Eyes degenerated, taenioid. Apical segment of maxillary palpus distinctly longer than subapical one, apex inflated, globular.

THORAX. Pronotum long, anterior margin straight, posterior margin arcuate; lateral lobes longer than high, ventral margin arc-shaped. Mesonotum and metanotum short, posterior margins straight.

LEGS. Fore coxa with one small spine; femur unarmed on ventral surface, internal genicular lobe unarmed, external genicular lobe with one long spine; tibia with one inner spine and two outer spines on ventral surface, apex with one pair of ventral spines, between paired ventral spines with one small spine. Mid femur unarmed on ventral surface, internal and external genicular lobes with one long spine each; tibia with one inner spine and one to two outer spines on ventral surface, apex with one pair of dorsal spines and one pair of ventral spines, between paired ventral spines with one small spine. Hind femur unarmed on ventral surface, internal and external genicular lobes unarmed; tibia with six to eight inner and outer spines on dorsal surface each, subapical area unarmed, and at apex with one pair of dorsal spines and two pairs of ventral spines, interno-dorsal spine distinctly shorter than hind basitarsus. Hind basitarsus unarmed on dorsal surface, ventral surface with bristles.

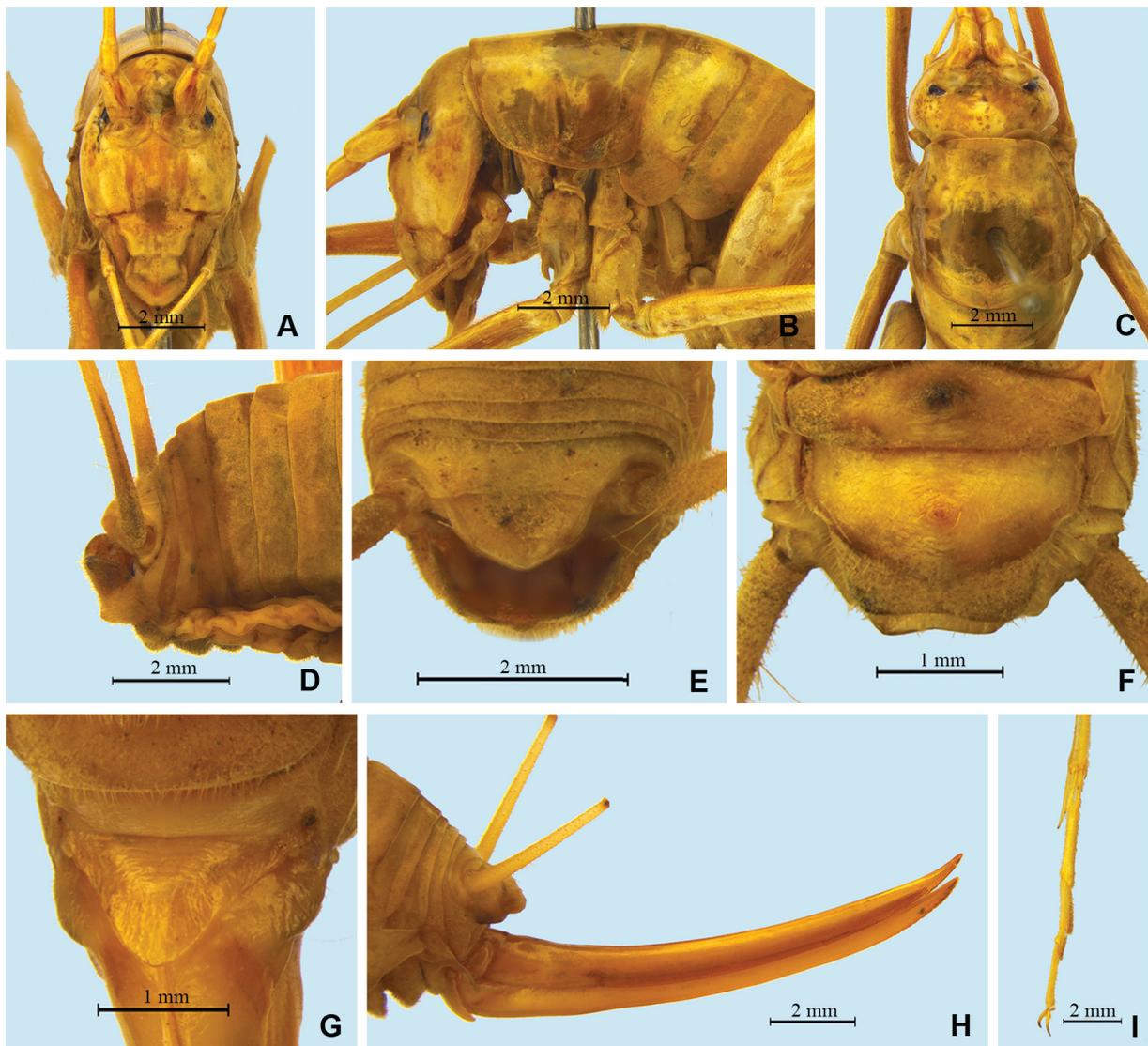


Fig. 3. *Tachycines (Gymnaeta) sparsispinus* sp. nov. A–F, I. Paratype, ♂ (HBU). A–C. Head and pronotum. A. Frontal view. B. Lateral view. C. Dorsal view. D–F. Apex of abdomen. D. Lateral view. E. Dorsal view. F. Ventral view. I. Hind tarsus in lateral view. — G–H. Paratype, ♀ (HBU). G. Subgenital plate. H. Ovipositor in lateral view.

MALE ABDOMEN. Posterior margins of all abdominal tergites relatively straight, abdominal sterna without obviously conical tubercles. Epiproct tongue-shaped, paraproct simple, nearly triangular in lateral view. Cercus slender, conical, apex acute. Genitalia with six membranous lobes, apical area of dorso-median lobe with one pair of small lobes, lateral sclerite short, basal area broad, gradually narrowing to apex, dorso-lateral lobes nearly equal in length to dorso-median lobe, ventro-lateral lobes nearly equal in length to dorso-lateral lobes, ventro-median lobe short; basal margin of dorsal sclerite narrow, truncate, posterior margin with one broad concavity. Subgenital plate quadrangular, posterior margin relatively straight.

FEMALE ABDOMEN. Ovipositor longer than half the length of hind femur, slightly curved upward, dorsal margin smooth, apical area of ventral margin denticulate. Subgenital plate nearly triangular, both sides of basal area with one triangulate lobe, apex blunt.

COLORATION. Body uniformly yellowish-brown. Eyes black.

Measurements (mm)

Body length: ♂: 14.16–14.56, ♀: 17.76; length of pronotum: ♂: 3.80–4.42, ♀: 4.0; length of fore femur: ♂: 11.08–11.80, ♀: 11.50; length of hind femur: ♂: 18.50–18.54, ♀: 17.90; length of hind tibia: ♂: 21.70–22.64, ♀: 22.00; length of hind basitarsus: ♂: 3.80, ♀: 4.60; length of ovipositor: 13.10.

Distribution

China (Guangxi).

Tachycines (Gymnaeta) papilious sp. nov.

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Figs 4, 8G–H

Diagnosis

The new species is similar to other congeneric species in appearance, but it can easily be distinguished by the dorsal sclerite of the male genitalia being shaped like a butterfly with open wings, the basal area of the dorso-median lobe forming a protuberance, and the hind tibia being provided with 104 inner spines and 114 outer spines on the dorsal surface.

Etymology

The name of the new species derives from the Latin word ‘*papilio*’ (‘butterfly’), referring to the dorsal sclerite of the male genitalia being shaped like a butterfly with open wings.

Material examined

Holotype

CHINA • ♂; Hunan Prov., Chenzhou City, Wanhuayan; 23 Aug. 2015; Xin-Hui Wang, Sun-Bin Huang, Ming-Ruo Tang and Ping-Jing Yang leg.; HBU.

Description

Male

BODY. Medium-sized.

HEAD. Fastigium verticis with two conical tubercles, apices obtusely rounded, pointing forward. Eyes oval, protruding forward; median ocellus oval, located between antennal sockets; lateral ocelli nearly

circular, situated on lateral margin of basal area of fastigium verticis. Apical segment of maxillary palpus distinctly longer than subapical one, apex inflated, globular.

THORAX. Pronotum long, anterior margin straight, posterior margin arcuate; lateral lobes longer than high, ventral margin arc-shaped. Mesonotum and metanotum short, posterior margin of mesonotum arcuate, posterior margin of metanotum straight.

LEGS. Fore coxa with one small spine; femur unarmed on ventral surface, internal genicular lobe with one small spine, external genicular lobe with one long spine; tibia with one inner spine and two outer spines on ventral surface, apex with one outer spine on dorsal surface and one pair of ventral spines, between paired ventral spines with one small spine. Mid femur unarmed on ventral surface, internal and external genicular lobes with one long spine each; tibia with one inner spine and one outer spine on ventral surface, apex with one pair of dorsal spines and one pair of ventral spines, between paired ventral spines with one small spine. Hind femur unarmed on ventral surface, internal genicular lobe with one spine, external genicular lobe unarmed; tibia with 104 inner spines and 114 outer spines on dorsal surface, with one pair of dorsal spines in subapical area, and at apex with one pair of dorsal spines and two pairs of ventral spines, interno-dorsal spine markedly shorter than hind basitarsus. Hind basitarsus with one apical spine on dorsal surface, ventral surface without bristles.

MALE ABDOMEN. Posterior margins of all abdominal tergites relatively straight, abdominal sterna with distinct conical tubercles. Epiproct semicircular, paraproct simple, nearly triangular in lateral view. Cercus extremely long, conical, apex acute. Genitalia with six membranous lobes, basal area of dorso-median lobe forming a protuberance, apical area with one pair of small lobes, lateral sclerite narrow, crescent shaped, dorso-lateral lobes slightly longer than dorso-median lobe, ventro-lateral lobes shorter

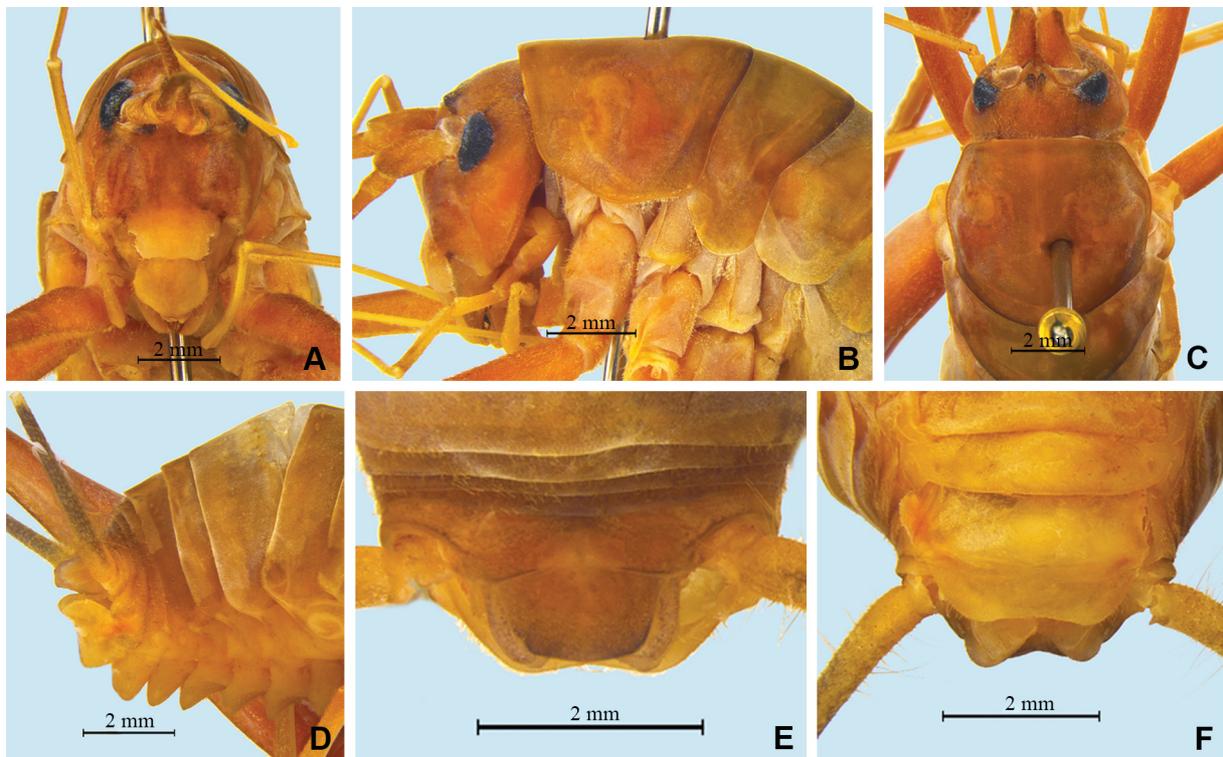


Fig. 4. *Tachycines* (*Gymnaeta*) *papilius* sp. nov. A–F. Holotype, ♂ (HBU). A–C. Head and pronotum. A. Frontal view. B. Lateral view. C. Dorsal view. D–F. Apex of abdomen. D. Lateral view. E. Dorsal view. F. Ventral view.

than dorso-lateral lobes, ventro-median lobe short; dorsal sclerite shaped like a butterfly with open wings. Subgenital plate quadrangular, posterior margin slightly concave.

COLORATION. Body uniformly yellowish-brown. Eyes black.

Female

Unknown.

Measurements (mm)

Body length: ♂: 16.54; length of pronotum: ♂: 5.10; length of fore femur: ♂: 13.58; length of hind femur: ♂: 26.28; length of hind tibia: ♂: 29.40; length of hind basitarsus: ♂: 5.04.

Distribution

China (Hunan).

Tachycines (Gymnaeta) liboensis Zhu, Chen & Shi, 2020

Fig. 5

Tachycines (Gymnaeta) liboensis Zhu, Chen & Shi, 2020: 73.

Material examined

Holotype

CHINA • ♂; Guizhou Prov., Libo County, Dongtang Village, Banzhai Hamlet, Maan Cave; 25 Oct. 2009; Hui-Ming Chen leg.; HBU.

Additional material

CHINA • 1 ♂, Guangxi Zhuang Autonomous Region, Huanjiang County, Chuanshan Village, Xiarong Hamlet, Shuiyuan Cave; 4 Oct. 2016; Ming-Yi Tian, Ju-Jian Chen, Xin-Hui Wang, Ming-Ruo Tang, Dian-Mei Wang, Zhuang-Hui Qin and Rui-Chong Wang leg.; HBU • 1 ♀; Guangxi Zhuang Autonomous Region, Huanjiang County, Chuanshan Village, Xiarong Hamlet, The Second Cave; 6 Oct. 2016; Ming-Yi Tian, Ju-Jian Chen, Xin-Hui Wang, Ming-Ruo Tang, Dian-Mei Wang, Zhuang-Hui Qin and Rui-Chong Wang leg.; HBU.

Descriptive notes of the female

Ovipositor nearly equal in length to half the length of hind femur, slightly curved upward, dorsal margin smooth, apical area of ventral margin denticulate. Subgenital plate nearly triangular, both sides of basal area with one triangular lobe, apex blunt.

Measurements (mm)

Body length: ♂: 18.0, ♀: 18.0; length of pronotum: ♂: 5.5–6.0, ♀: 5.0; length of fore femur: ♂: 14.3–15.0, ♀: 12.2; length of hind femur: ♂: 26.5–27.0, ♀: 23.0; length of hind tibia: ♂: 30.0–31.0, ♀: 27.0; length of hind basitarsus: ♂: 6.0, ♀: 5.0; length of ovipositor: 11.8.

Distribution

China (Guangxi, Guizhou).

Remarks

The female of this species is recorded and described here for the first time.

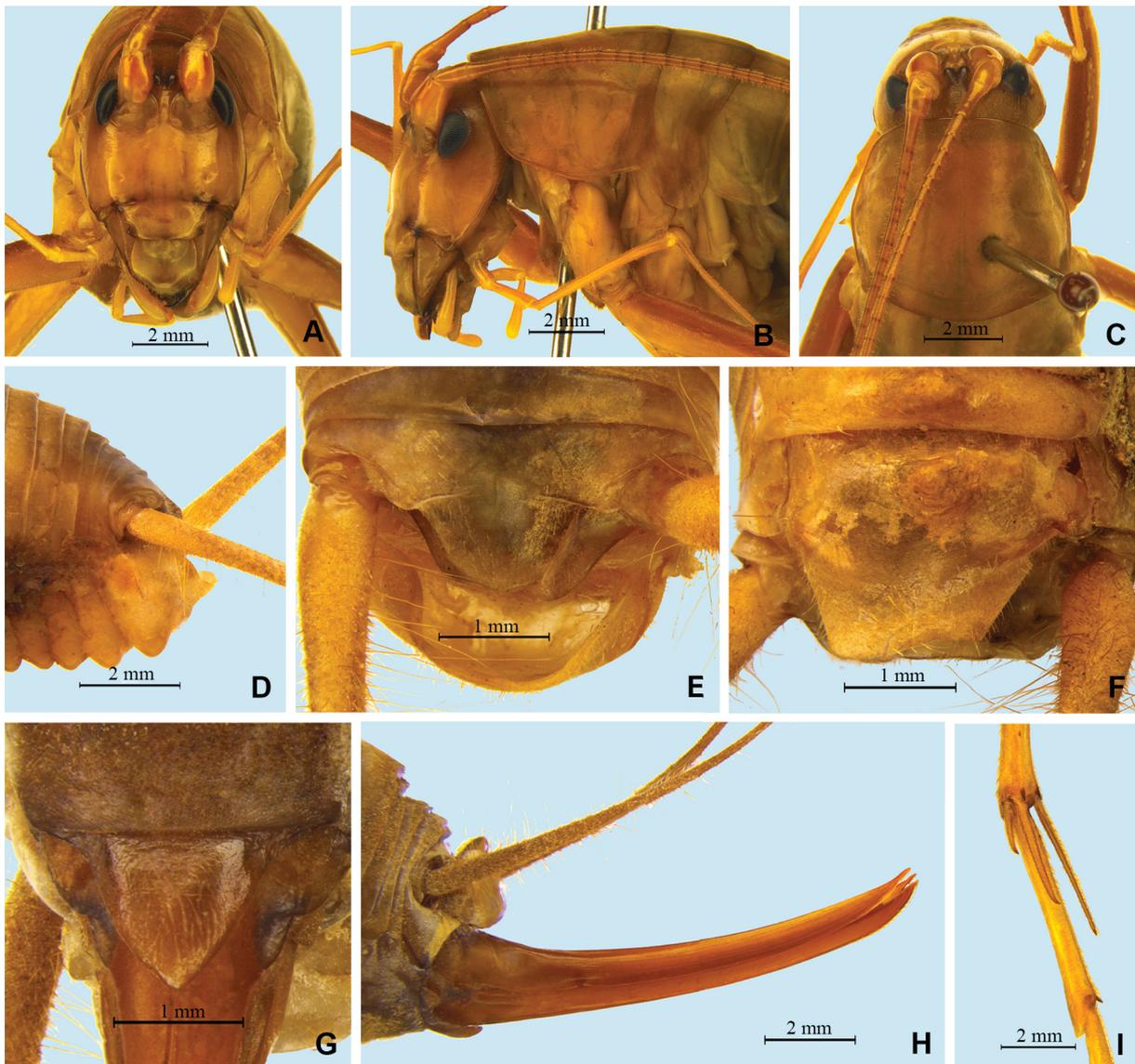


Fig. 5. *Tachycines* (*Gymnaeta*) *liboensis* Zhu, Chen & Shi, 2020. **A–F, I.** ♂. **A–C.** Head and pronotum. **A.** Frontal view. **B.** Lateral view. **C.** Dorsal view. **D–F.** Apex of abdomen. **D.** Lateral view. **E.** Dorsal view. **F.** Ventral view. **I.** Hind basitarsus in lateral view. — **G–H.** ♀. **G.** Subgenital plate. **H.** Ovipositor in lateral view.

Tachycines (*Gymnaeta*) *latellai* (Rampini & Di Russo, 2008)

Figs 6, 8I–J

Diestrarmena (*Gymnaeta*) *latellai* Rampini, Di Russo & Cobolli, 2008: 32.

Tachycines (*Gymnaeta*) *latellai* – Qin, Wang, Liu & Li 2018: 452.

Material examined

CHINA • 1 ♂, 1 ♀; Guizhou Prov., Bijie City, Zhijin County, Chengguan Village, Dongshan Hamlet, cave; 12 Jul. 2013; Ming-Yi Tian, Wei-Xin Liu, Hao-Min Yin and Sun-Bin Huang leg.; HBU • 3 ♂♂, 7 ♀♀; Guizhou Prov., Bijie City, Zhijin County, Zhijin Cave; 14 Aug. 2020; Wei Yang leg.; HBU.

Distribution

China (Guizhou).

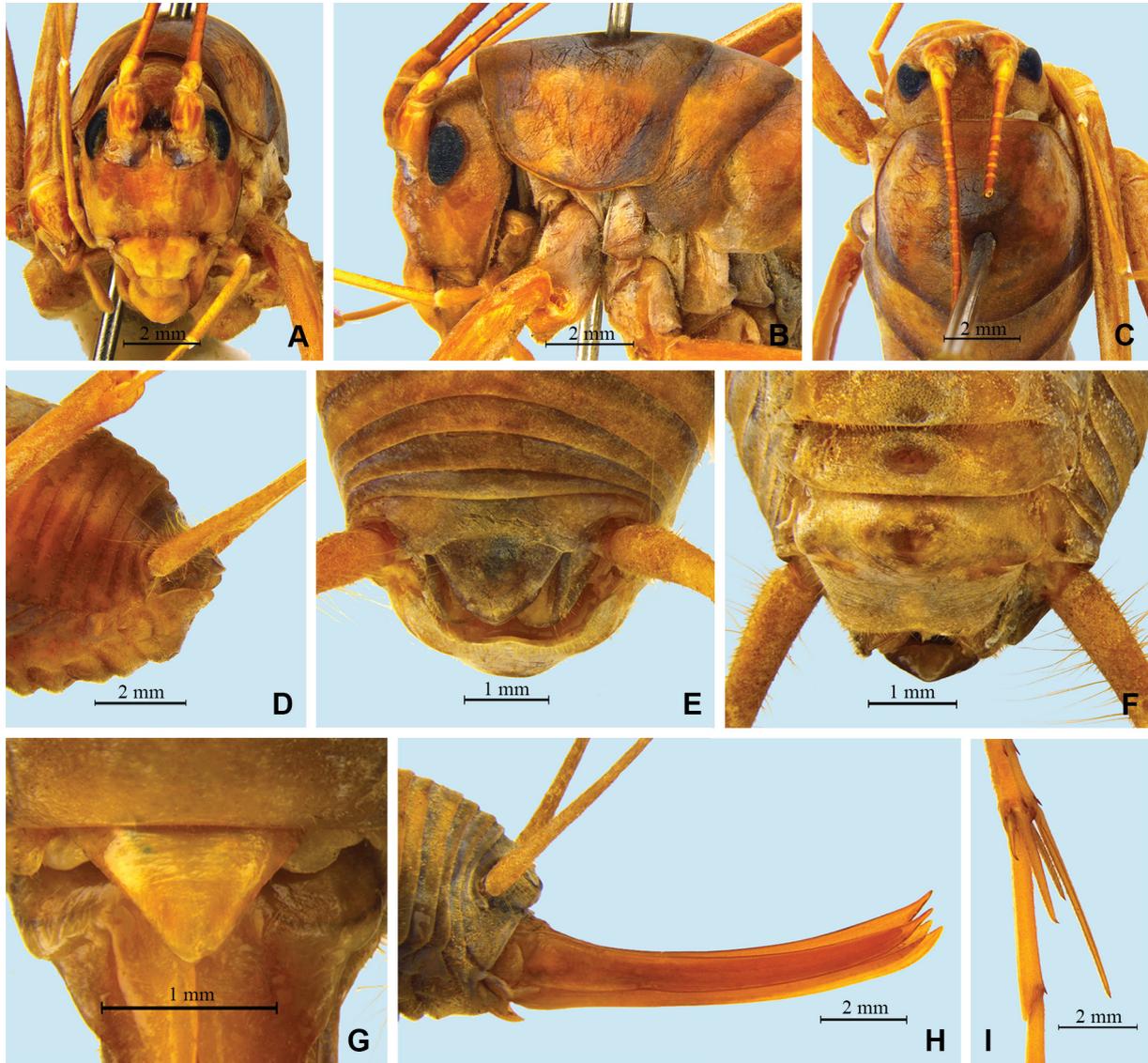


Fig. 6. *Tachycines (Gymnaeta) latellai* (Rampini & Di Russo, 2008). **A–F, I.** ♂. **A–C.** Head and pronotum. **A.** Frontal view. **B.** Lateral view. **C.** Dorsal view. — **D–F.** Apex of abdomen. **D.** Lateral view. **E.** Dorsal view. **F.** Ventral view. **I.** Hind basitarsus in lateral view. — **G–H.** ♀. **G.** Subgenital plate. **H.** Ovipositor in lateral view.

Tachycines (Gymnaeta) omninoecaecus (Gorochov, Rampini & Di Russo, 2006)

Figs 7, 8K–L

Diestrammena (Gymnaeta) omninoecaeca Gorochov, Rampini & Di Russo, 2006: 358.

Tachycines (Gymnaeta) omninoecaecus – Qin, Wang, Liu & Li 2018: 452.

Material examined

CHINA • 1 ♂, 1 ♀; Hunan Prov., Longshan County, Huoyan Village, Panlong Cave; 3 Jul. 2014; Ming-Yi Tian, Wei-Xin Liu, Hao-Min Yin, Sun-Bin Huang and Xin-Hui Wang leg.; HBU.

Distribution

China (Hunan).

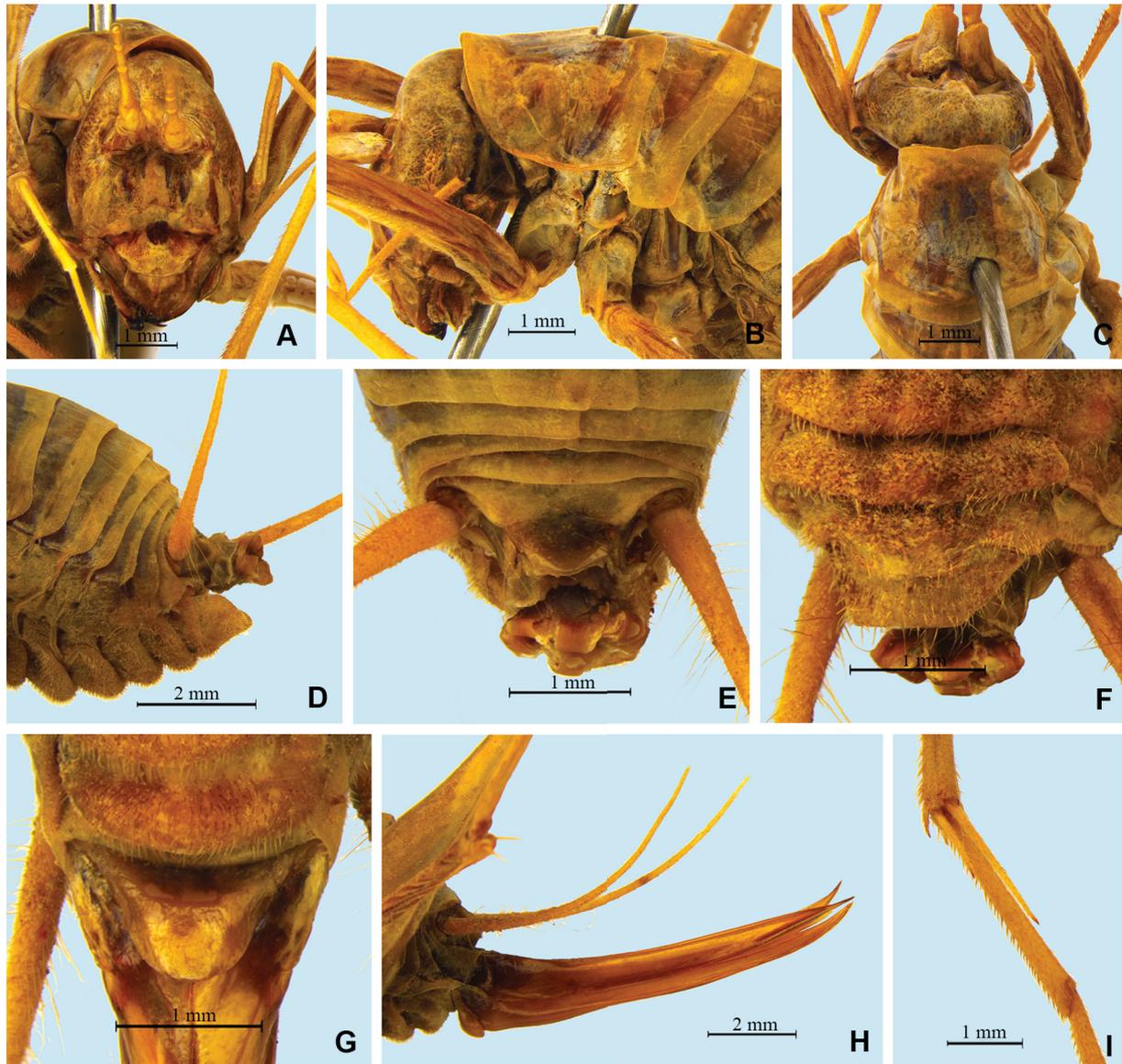


Fig. 7. *Tachycines* (*Gymnaeta*) *omninoceacus* (Gorochoy, Rampini & Di Russo, 2006). A–F, I. ♂. A–C. Head and pronotum. A. Frontal view. B. Lateral view. C. Dorsal view. D–F. Apex of abdomen. D. Lateral view. E. Dorsal view. F. Ventral view. I. Hind basitarsus in lateral view. — G–H. ♀. G. Subgenital plate. H. Ovipositor in lateral view.

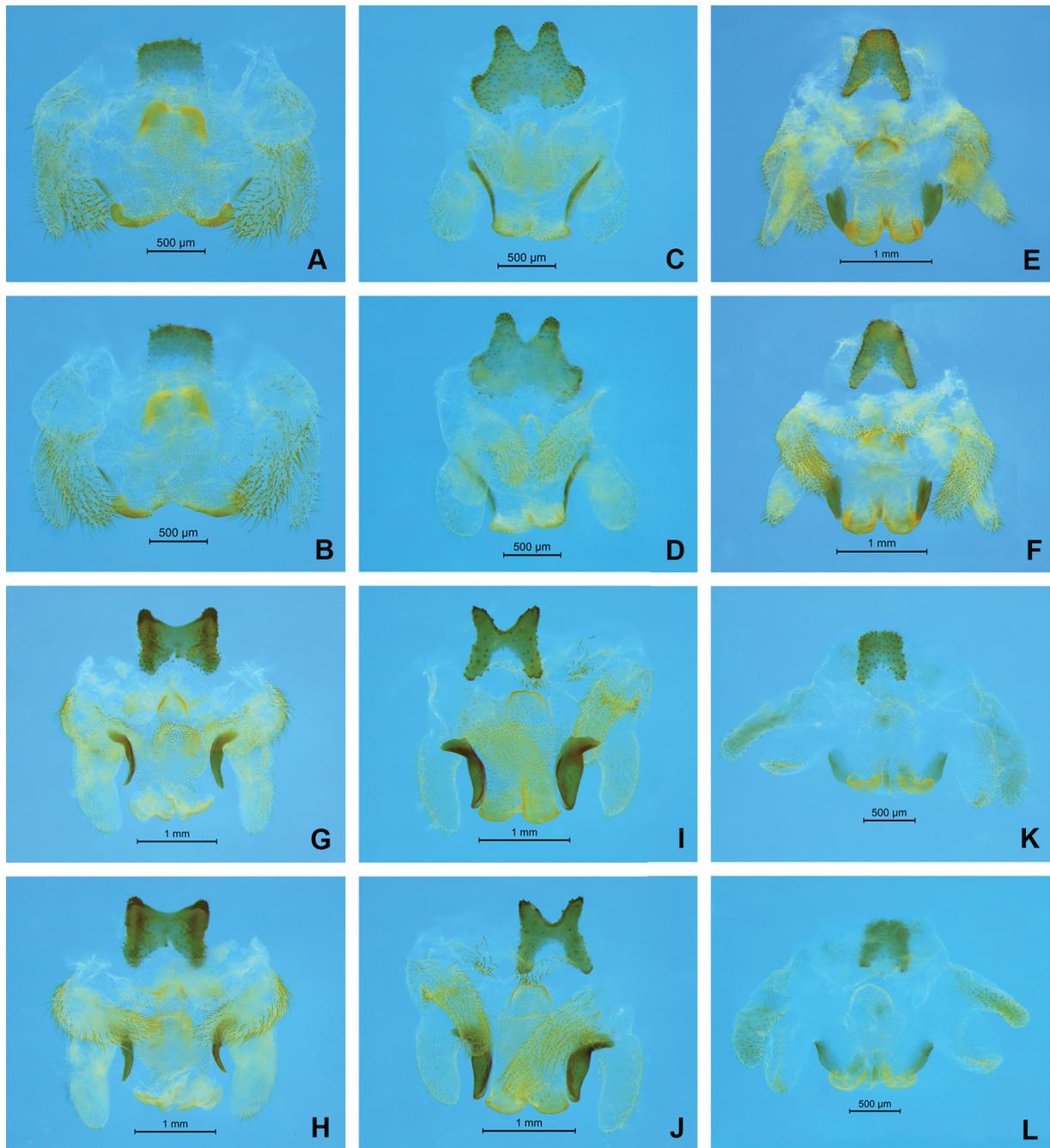


Fig. 8. Male genitalia. **A, C, E, G, I, K.** Dorsal view. **B, D, F, H, J, L.** Ventral view. **A–B.** *Tachycines (Gymnaeta) quadratus* sp. nov., holotype, ♂ (HBU). **C–D.** *Tachycines (Gymnaeta) shiziensis* sp. nov., holotype, ♂ (HBU). **E–F.** *Tachycines (Gymnaeta) sparsispinus* sp. nov., holotype, ♂ (HBU). **G–H.** *Tachycines (Gymnaeta) papiliosus* sp. nov., holotype, ♂ (HBU). **I–J.** *Tachycines (Gymnaeta) latellai* (Rampini & Di Russo, 2008), ♂. **K–L.** *Tachycines (Gymnaeta) omninocecus* (Gorochov, Rampini & Di Russo, 2006), ♂.

Discussion

Gymnaeta was erected as a genus by Adelung (1902). Karny (1934) considered it as a subgenus of *Tachycines*. Gorochov & Storozhenko (1992) compared the genus *Diestrammena* with the genus *Tachycines* and thought that the structure of their male genitalia was very similar. The most remarkable difference between them was the number of spines on the hind tibia, which was unstable in this subfamily. Therefore, Gorochov & Storozhenko (1992) insisted that the number of spines on the hind tibia is completely inappropriate to be used to differentiate genera and transferred the subgenus *Gymnaeta* to the genus *Diestrammena*. Moreover, according to the minor differences in the structures of male genitalia, the subgenus *Tachycines* may also have to be placed in the genus *Diestrammena*. However, Qin *et al.* (2018) followed Karny's classification system and supposed that the arrangement of spines on the hind tibia could be used to identify not only the two genera but also other genera in Aemodogryllini. Therefore, they reinstated the status of the genus *Tachycines* and retransferred the subgenera *Gymnaeta* and *Tachycines* from the genus *Diestrammena* to the genus *Tachycines* (Qin *et al.* 2018). At present, species belonging to the subgenus *Gymnaeta* can easily be identified according to the male genitalia and the absence of spines on the hind femora. The most controversial question is whether the spines on the hind tibia could be used as a generic character to classify *Diestrammena* and *Tachycines*. In the absence of sufficient evidence to clarify this issue, no changes have been made to the current classification system and the species are temporarily placed in the genus *Tachycines*. More evidence is needed for further study.

The South China Karst is one of the world's biodiversity hotspots with an abundant diversity of species (Shu *et al.* 2013; Monro *et al.* 2018). Up to now, approximately 145 species of Rhaphidophoridae are recorded from China, among which only 25 species are described from caves.

Cave crickets have developed some characteristics to adapt to cave life, such as a light body color, different degrees of degenerated eyes and fastigium verticis, longer appendages, etc. This fauna represents a good model to study biogeographical issues (Weckstein *et al.* 2016), and especially to discuss the current distribution pattern of cave species in relation to the geology and the geomorphology, as well as to analyze the relationships between epigeal and subterranean species.

However, habitats of cave systems are easily destroyed and cannot be recovered and many undescribed species are in danger of extinction (Jaffé *et al.* 2016; Borges *et al.* 2019).

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