

## Research article

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**Six new species of *Rhaphidophora* from China (Orthoptera: Rhaphidophoridae: Rhaphidophorinae)**Mi DI (狄米)<sup>1</sup>, Yan-Yan QIN (秦艳艳)<sup>2</sup>, Zi-Hao SHEN (沈子豪)<sup>3</sup>,  
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Kai LI (李恺)<sup>6,\*</sup> & Zhu-Qing HE (何祝清)<sup>7,\*</sup><sup>1,4,6,7</sup>School of Life Sciences, East China Normal University, Shanghai, China.<sup>2</sup>School of Life Sciences, Henan University, China.<sup>3</sup>Hubei Broad Nature Technology Service Co., Ltd, Wuhan, China.<sup>5</sup>Shanghai Entomological Museum, Chinese Academy of Sciences, Shanghai, China.\*Corresponding authors: [zqhe@bio.ecnu.edu.cn](mailto:zqhe@bio.ecnu.edu.cn) – [whq@cemps.ac.cn](mailto:whq@cemps.ac.cn) – [kaili@admin.ecnu.edu.cn](mailto:kaili@admin.ecnu.edu.cn)<sup>1</sup> Email: [superbiuua@outlook.com](mailto:superbiuua@outlook.com)<sup>2</sup> Email: [644147002@qq.com](mailto:644147002@qq.com)<sup>3</sup> Email: [shenzihao@broadnature.cn](mailto:shenzihao@broadnature.cn)<sup>4</sup> Email: [261889691@qq.com](mailto:261889691@qq.com)<sup>1</sup> urn:lsid:zoobank.org:author:38A64BB2-8235-4085-BC10-7D402B8ED022<sup>2</sup> urn:lsid:zoobank.org:author:408351DB-C2B7-4E7C-8C31-AC2362C90DCF<sup>3</sup> urn:lsid:zoobank.org:author:B97AE4A4-D730-4DF4-804E-907096C6942E<sup>4</sup> urn:lsid:zoobank.org:author:806809E7-28C1-4EDD-B6F1-6057D150E7A3<sup>5</sup> urn:lsid:zoobank.org:author:8471D9AE-AAF8-4590-AF6C-31166CBF0E9A<sup>6</sup> urn:lsid:zoobank.org:author:12117AA6-F556-4395-BB74-2344E20E9BBC<sup>7</sup> urn:lsid:zoobank.org:author:BF97DE18-240C-43E7-80D3-049318163C91

**Abstract.** Six new species of the genus *Rhaphidophora* Serville, 1838 are described from China: *R. hexagoniproctalis* Wang, Di & He sp. nov., *R. heterodentis* Shen, Wang & He sp. nov., *R. imbricofurca* Shen, Wang & He sp. nov., *R. glenoides* Qin, Wang & He sp. nov., *R. impressa* Wang, Qin & He sp. nov., *R. stenotermata* Zhang, Wang & He sp. nov. A key with previously described species from China is provided.

**Keywords.** Rhaphidophorinae, *Rhaphidophora*, China, key to species, new species.

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**Introduction**

The subfamily Rhaphidophorinae Walker, 1869 is distributed in East Asia, the Indo-Malayan and Papuan regions. Some species can be found in Australia and some Pacific islands (further than New

Guinea), and west to the Seychelles. Up to now, 8 genera and 180 species and subspecies have been described worldwide. The genus *Rhaphidophora* was established by Serville in 1838. In recent decades, numerous authors described new species from China, including *R. taiwana* Shiraki, 1930 and *R. sinica* Bey-Bienko, 1962 from Yunnan, *R. sichuanensis* Liu & Zhang, 2002 and *R. minuolamella* Liu & Zhang, 2002 from South China, and *R. xishuang* Gorochov, 2012 from Yunnan. Furthermore, Bian *et al.* (2017) described six species: *R. biprocera*, *R. brevispinula*, *R. incilis*, *R. longitabula*, *R. longispinula* and *R. quadarula* from China. Among them, *R. longispinula* was transferred to the genus *Neorhaphidophora* Gorochov, 1999 by Qin *et al.* (2018). Qin *et al.* (2018) also described *R. wuzhishanensis* from Hainan. Additionally, *R. quadrispina* Liu & Bian, 2021, as well as seven other species (Lu *et al.* 2022), *R. complanatis* Lu & Bian, 2022, *R. digitata* Lu & Bian, 2022, *R. duxiu* Lu & Bian, 2022, *R. mohanensis* Lu & Bian, 2022, *R. rongshuiensis* Lu & Bian, 2022, *R. shii* Lu & Bian, 2022 and *R. spinita* Lu & Bian, 2022, have continuously been reported. In the paper proposed here, six new species are described: *R. hexagoniproctalis* Wang, Di & He sp. nov., *R. heterodentis* Shen, Wang & He sp. nov., *R. imbricofurca* Shen, Wang & He sp. nov., *R. glenoides* Qin, Wang & He sp. nov., *R. impressa* Wang, Qin & He sp. nov. and *R. stenoterminalata* Zhang, Wang & He sp. nov. Furthermore, a key to all species mentioned above is given.

## Material and methods

### Sampling

Specimens were collected by hand or sweep net at night. All the morphological structures necessary for diagnostic purposes were photographed by an Olympus E-M5 III camera and edited by using a combination of Adobe Photoshop plus Illustrator. The scale bars are equal to 1 millimeter unless otherwise indicated. All type specimens are deposited in the Shanghai Entomological Museum, Chinese Academy of Sciences (SEM CAS).

The measurements and indices taken are defined below:

- BL = body length from apex of fastigium of vertex to posterior margin of subgenital plate
- FFL = length of fore or hind femora
- HBL = length of hind basitarsus
- HFL = length of fore or hind femora
- HTL = length of hind tibiae
- OvL = straight distance from visible base corner of gonangulum to apex of ovipositor
- PL = length of pronotum

## Results

### *Systematics*

Class Insecta Linnaeus, 1758  
Order Orthoptera Latreille, 1810  
Family Rhaphidophoridae Walker, 1869

Genus *Rhaphidophora* Serville, 1838

### Type species

*Rhaphidophora picea* Serville, 1838.

*Rhaphidophora hexagoniproctalis* Wang, Di & He sp. nov.  
urn:lsid:zoobank.org:act:107262A5-AF65-4CC8-8561-B3AAD573A6CE

Fig. 1

### Chinese name

六角板驼蠹

### Diagnosis

This new species is similar to *R. spinifera* Gorochov, 2013 and *R. complanatis*, but especially to *R. digitata* and *R. shii*. It differs from *R. spinifera* by the main part of the epiproct compacted (Fig. 1D) instead of elongated; from *R. complanatis* by digitate processes of the male epiproct cylindrical and shorter (Fig. 1D–E); from *R. digitata* and *R. shii* by the distance between the processes of the male epiproct which is significantly longer than the length of the process (Fig. 1D), while in the other species it is nearly equal.

### Etymology

The new specific epithet is derived from ‘epiproct’ and the Latinised Greek prefix ‘*hexagoni*’ due to the shape of the main part of the male epiproct in dorsal view.

### Material examined

#### Holotype

CHINA • ♂; Yunnan Prov., Nabanhe Reserve, television tower; alt. 1900 m; 30 Jul. 2005; Li-Zhen Li and Jin-Wen Li leg.; SEM CAS 14098450.

### Description

#### Male

BODY SIZE. Small.

HEAD. Fastigium of vertex divided into pair of plate-like processes by longitudinal furrow (Fig. 1B). Eyes protruding outward, reniform, situated at upper part of external margin of antennal sockets (Fig. 1A); lateral ocelli almost occupying nearly three quarters of lateral margins of whole tubercles, suborbicular, situated at lateral base of tubercles (Fig. 1B); median ocellus situated between two antennal sockets, oval (Fig. 1A). Maxillary palpi stout, apical segment longer than subapical one, apex inflated, almost spherical.

THORAX. Anterior and posterior margin of pronotum slightly convex (Fig. 1B); lateral lobes with ventral margins arched, posterior margins slightly concave (Fig. 1C); posterior margin of mesonotum slightly convex, posterior margin of lateral lobes slightly concave, arched (Fig. 1C); posterior margin of metanotum straight (Fig. 1C).

LEGS. Fore femur with 1 apical spine on internal genicular lobe (Fig. 1B); fore tibia ventrally with 1 internal spine, 2 external spines and 1 pair of apical spines. Middle femur with 1 apical spine on internal and external genicular lobe separately; middle tibia dorsally with 2 pairs of spines and 1 pair of apical spines, ventrally with 2 external spines and 1 pair of apical spines. Hind femur ventrally unarmed, inner genicular lobe with spinule; hind tibia dorsally with 17–18 spinules on both sides, subapical area dorsally with 1 pair of spines, apex with 1 pair of larger mediate spines and 1 pair of smaller ventral spines asymmetrically (always inner one longer), dorsal pair, which is largest one, is missing in the sole specimen (Fig. 1G–H) and seen as pair of circular pits. Hind tarsus laterally compressed, basitarsus dorsally with 5 spinules and 1 terminal spine exceeding ventral edge (Fig. 1G).

**ABDOMEN.** Abdominal tergite without distinct projection. Posterior margin of tenth abdominal tergite concave. Epiproct roughly hexagonal, with pair of digitative processes (Fig. 1D) in posterolateral corners, and with rather long lobe located between these processes and directed downwards/anteriorly as well as having bispinous apex (maybe due to shrinkage of dry specimen, Fig. 1E–F). Subgenital plate damaged, repaired structure as in Fig. 1H.

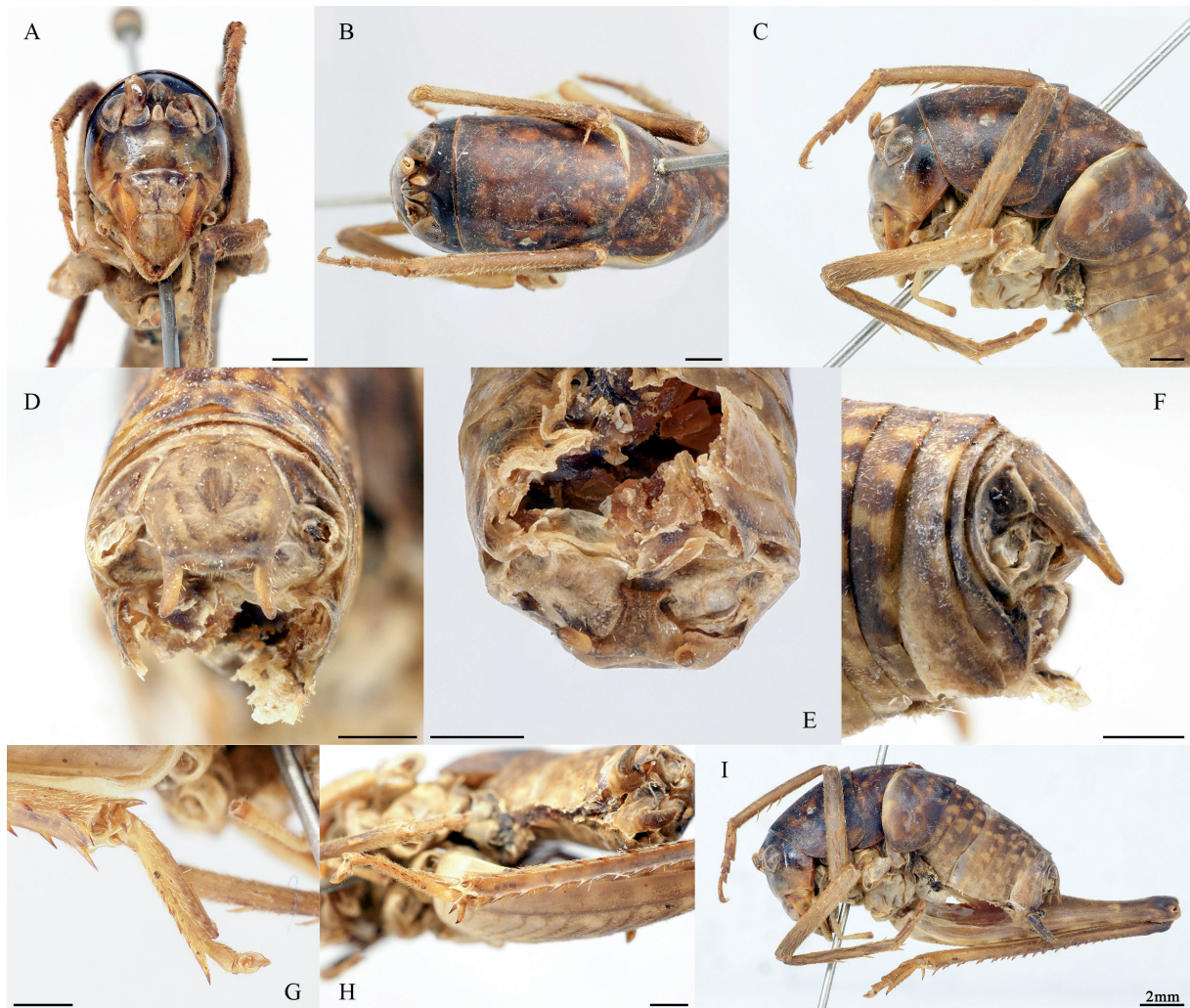
**COLORATION.** Body dark brown with yellowish spots, ventral surface brown, external surface of hind femora with stripes.

### Female

Unknown.

### Measurements (mm)

BL: ♂ 12.0; PL: ♂ 5.2; FFL: ♂ 6.0; HFL: ♂ 14.5; HTL: ♂ 12.5; HBL: ♂ 3.2.



**Fig. 1.** *Rhaphidophora hexagoniproctalis* Wang, Di & He sp. nov., holotype, ♂ (SEM CAS 14098450). **A.** Head in frontal view. **B–C.** Head and thorax in dorsal and lateral view, respectively. **D–F.** Apex of abdomen in rear dorsal, ventral and lateral view, respectively. **G–H.** Right hind tarsus in externally lateral and dorsal view, respectively. **I.** Body in lateral view.

## Distribution

China (Yunnan).

*Rhaphidophora heterodentis* Shen, Wang & He sp. nov.  
urn:lsid:zoobank.org:act:9B19055E-CAF2-43E8-99D3-1FF3AF8230E4

Fig. 2

## Chinese name

异齿驼螽

## Diagnosis

The new species is rather similar to *R. brevispinula* Bian, Zhu & Shi, 2017, *R. spinita* and *R. quadrispina*, but differs from them by the upper apical half of the epiproct lamellated and irregularly incised at the terminal end, instead of becoming a pair of separated spines (Fig. 2D).

## Etymology

The new specific epithet is derived from the Latin ‘dens’ and the Latinised Greek prefix ‘hetero-’, referring to the irregular tooth of the upper apex of the male epiproct.

## Material examined

### Holotype

CHINA • ♂; Yunnan Prov., Dulong River township, Maku village, Moon Waterfall; alt. 1166 m; 22 Aug. 2019; Zi-Hao Shen leg.; SEM CAS 14098451.

## Description

### Male

BODY SIZE. Medium.

HEAD. Fastigium of vertex divided into pair of plate-like processes by longitudinal furrow (Fig. 2B). Eyes protruding outward, reniform, situated at upper part of external margin of antennal sockets (Fig. 2A); lateral ocelli suborbicular, situated at lateral base of tubercles (Fig. 2B); median ocellus situated between two antennal sockets, oval (Fig. 2A). Maxillary palpi strong, apical segment longer than subapical one, apex inflated, almost spherical (Fig. 2C).

THORAX. Anterior and posterior margin of pronotum slightly convex (Fig. 2B), lateral lobes with ventral margins arched, posterior margins slightly concave (Fig. 2C); posterior margin of mesonotum slightly convex, posterior margin of lateral lobes slightly concave, arched (Fig. 2C); posterior margin of metanotum straight.

LEGS. Fore femur with 1 apical spine on internal genicular lobe (Fig. 2B); fore tibia ventrally with 1 internal spine, 2 external spines and 1 pair of apical spines. Middle femur with 1 apical spine on internal and external genicular lobe separately; middle tibia dorsally with 2 pairs of spines and 1 pair of apical spines, ventrally with 2 external spines, 1 internal spine and 1 pair of apical spines. Hind femur ventrally unarmed, internal genicular lobe with 1 spinule; hind tibia dorsally with 21 external spinules and 20 internal spinules, subapical area dorsally with 1 pair of spines; apex with 1 pair of long dorsal spines, 1 pair of short ventral spines and 1 pair of medium long mediate spines asymmetrically, tip of the longest apical spine exceeded tip of metatarsal terminal spine (Fig. 2G–H). Hind tarsus laterally compressed, basitarsus dorsally with 5 spinules and 1 terminal spine exceeding ventral edge (Fig. 2G).

ABDOMEN. Posterior margin of tenth abdominal almost straight. Basal portion of epiproct subquadrate, upheaved aside middle (Fig. 2D–E); its more distal portion curved downwards and consisting of 2 parts: upper (posterior) part lamellar, elongate, narrowing to irregularly notched apex having pair of rather narrow and angular lateral lobules; lower (anterior) part wider than upper one and widely divided into pair of decurved hooks (Fig. 2F). Posterior margin of subgenital plate wide, widely concave in middle, subapical with 1 pair of styli (Fig. 2E); styli almost conical, basal half wide, apical half slender, apex acute.



**Fig. 2.** *Rhaphidophora heterodentis* Shen, Wang & He sp. nov., holotype, ♂ (SEM CAS14098451). **A.** Head in frontal view. **B–C.** Head and thorax in dorsal and lateral view, respectively. **D–F.** Apex of abdomen in rear dorsal, ventral and lateral view, respectively. **G–H.** Left hind tarsus in inner lateral and dorsal view. **I.** Body in lateral view.

**COLORATION.** Body reddish brown, ventral surface yellowish brown. Scape and pedicel of antennae pale brown, flagellum darkish in dorsal surface. Eyes darkish brown, ocelli pale. Legs pale brown, external surface hind femur with darkish stripes and pale spots. Spines of hind tibiae darkish.

#### **Female**

Unknown.

#### **Measurements (mm)**

BL: ♂ 14.0; PL: ♂ 6.0; FFL: ♂ 7.0; HFL: ♂ 16.5; HTL: ♂ 15.0; TBL: ♂ 3.7.

#### **Distribution**

China (Yunnan).

*Rhaphidophora imbricofurca* Shen, Wang & He sp. nov.  
urn:lsid:zoobank.org:act:C7088F26-8DD7-4455-9E48-E1C6AFD84E50  
Fig. 3

#### **Chinese name**

叠叉驼螽

#### **Diagnosis**

The new species is similar to *R. spinita* and the previous species, but differs from *R. spinita* by the upper apical part of the epiproct lamellated then diverged to a pair of short spines (Fig. 3D) instead of becoming a pair of long spines directly; and differs from the previous species in the upper apex of the epiproct notched symmetrically (Fig. 3D).

#### **Etymology**

The new specific epithet is derived from the Latin ‘*imbrico*’ and ‘*furca*’, and refers to the overlapped forks of the male epiproctal apex.

#### **Material examined**

##### **Holotype**

CHINA • ♂; Yunnan Prov., Yingjiang, Nabang town, Rongshuwang; alt. 516 m; 24 Aug. 2019; Zi-Hao Shen leg.; SEM CAS 14098466.

#### **Description**

##### **Male**

**BODY SIZE.** Medium to large.

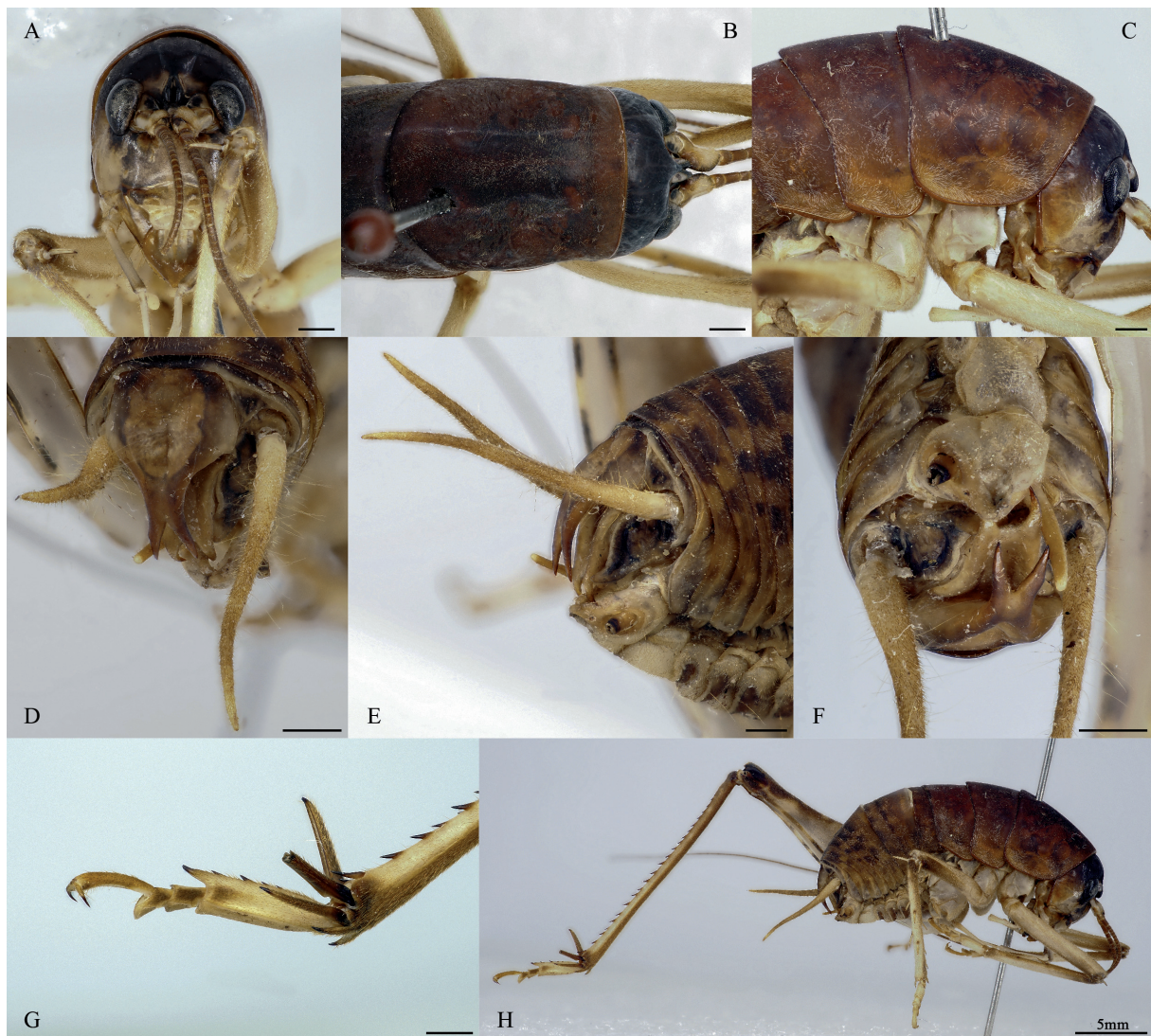
**HEAD.** Fastigium of vertex divided into pair of plate-like processes by longitudinal furrow (Fig. 3B). Eyes reniform, situated near upper part of external margin of antennal sockets (Fig. 3A); lateral ocelli almost occupying nearly three quarters of lateral margins of whole tubercles, situated at lateral base of tubercles, oval (Fig. 3C); median ocellus situated between antennal sockets, oval (Fig. 3A). Apical segment of maxillary palpi longer than subapical segment, apex inflated, almost spherical.

**THORAX.** Anterior margin of pronotum straight, posterior margin of pronotum convex (Fig. 3C), lateral lobes longer than high, ventral margin arched, posterior margin slightly concave (Fig. 3B); posterior margin of mesonotum slightly convex (Fig. 3B); posterior margin of metanotum almost straight.

**LEGS.** Fore coxa dorsally with spine; fore femur with 1 apical spine on internal genicular lobe (Fig. 3A); fore tibia ventrally with 2 external spines, 1 internal spine and 1 pair of apical spines. Anterior margin

of middle coxa dorsally with 1 spinule; middle femur with 1 long apical spine on internal and external genicular lobe separately; middle tibia dorsally with 3 external and 2 internal spines, ventral surface with 2 external and 1 internal spine, apex with 1 pair of spines dorsally and ventrally separately. Hind femur ventrally unarmed, inner genicular lobe with 1 spinule; hind tibia dorsally with 22 spinules on both sides, subapical area dorsally with 1 pair of spines, apex with 1 pair of long dorsal spines, 1 pair of short ventral spines, and 1 pair of medium long mediate spines asymmetrically, largest apical spine broken (Fig. 3G); hind tarsus laterally compressed, basitarsus dorsally with 4 spinules and 1 long terminal spine longer than ventral edge (Fig. 3G).

ABDOMEN. Each abdominal tergite without processes. Base of epiproct almost trapezoidal; its more distal portion directed downwards, divided into lamellar upper (posterior) and lower (anterior) parts: upper part narrower, narrowest in distal third, with apex deeply and angularly notched as well as forming pair of diverged spines (Fig. 3D); lower part wider, apically with more rounded notch and pair of lateral



**Fig. 3.** *Rhaphidophora imbricofurca* Shen, Wang & He sp. nov., holotype, ♂ (SEM CAS 14098466). **A.** Head in frontal view. **B–C.** Head and thorax in lateral and dorsal view, respectively. **D–F.** Apex of abdomen in right rear dorsal, lateral and ventral view, respectively. **G.** Left hind tarsus in inner lateral view. **H.** Body in lateral view.



(shorter than above-mentioned spines) hooks (Fig. 3E–F). Apex of subgenital plate almost angular, sub apex with 1 pair of styli almost cylindrical (Fig. 3F).

**COLORATION.** Body darkish brown. Head dorsally darkish, face pale, within antennal sockets with 1 pair of blackish patches, below eyes with 1 pair of darkish patches almost circular; eyes blackish brown, ocelli pale. Legs yellowish brown, genicular lobes darkish; basal half of hind femora with oblique yellowish stripes on external margin, dorsal surface with pale patches; spines of hind tibiae blackish.

#### **Female**

Unknown.

#### **Measurements (mm)**

BL: ♂ 18.0; PL: ♂ 7.5; FFL: ♂ 9.0; HFL: ♂ 21.0; HTL: ♂ 19.0; HBL: ♂ 4.2.

#### **Distribution**

China (Yunnan).

*Rhaphidophora glenoides* Qin, Wang & He sp. nov.

urn:lsid:zoobank.org:act:CB2CBD2B-9556-4AE4-A212-85E0E4FB6C2A

Figs 4–5

#### **Chinese name**

窝端驼螽

#### **Diagnosis**

This species differs from *R. sichuanensis* in the dorsal surface of the male epiproct with 2 crooked carinae, surface between carinae with oval concave (Figs 4D, 5A), while *R. sichuanensis* has almost straight but unparallel carinae, surface between carinae with narrower, shallower and longer concave. The new species differs from *R. xishuang* in having few basitarsal spines and basal one third of male epiproct with broader concave.

#### **Etymology**

The new specific epithet is derived from the Latinised Greek ‘*glene*’ and refers to the small pit of the male epiproctal terminal.

#### **Material examined**

##### **Holotype**

CHINA • ♂; Hunan Prov., Zhangjiajie National Forest Park; alt. 500–600 m; 12–15 Sep. 2018; Sai-Nan Zhang and Yan-Yan Qin leg.; SEM CAS 14098452.

#### **Description**

##### **Male**

**BODY SIZE.** Medium.

**HEAD.** Fastigium of vertex divided into pair of plate-like processes by longitudinal furrow (Fig. 4B). Eyes protruding outward, reniform, situated near upper part of external margin of antennal sockets (Fig. 4A); lateral ocelli almost occupying half of lateral margins of whole tubercles, situated at lateral base of tubercles, suborbicular (Fig. 4C); median ocellus situated between antennal sockets, oval (Fig. 4A).

Maxillary palpi stout, apical segment nearly equal to subapical segment, apex inflated, almost spherical (Fig. 4C).

THORAX. Anterior margin of pronotum straight, posterior margin of pronotum convex (Fig. 4B), posterior part of ventral margin of lateral lobes arched, posterior margin slightly concave (Fig. 4C); posterior margin of mesonotum distinctly convex; posterior margin of metanotum straight (Fig. 4C).

LEGS. Fore coxa inflated, dorsally with 1 spinule; fore femur with 1 apical spine on internal genicular lobe (Fig. 4H); fore tibia ventrally with 2 external spines, 1 internal spine and 1 pair of apical spines. Middle coxa dorsally with 2 spiniform processes; middle femur with 1 apical spine on internal and



**Fig. 4.** *Rhaphidophora glenoides* Qin, Wang & He sp. nov., holotype, ♂ (SEM CAS 14098452). **A.** Head in frontal view. **B–C.** Head and thorax in dorsal and lateral view, respectively. **D–F.** Apex of abdomen in left dorsal, lateral and rear ventral view, respectively. **G.** Right hind tarsus in outer lateral view. **H.** Body in lateral view.

external genicular lobe separately; middle tibia dorsally with 2 pairs of spines and 1 pair of apical spines; ventrally with 2 external spines and 1 pair of apical spines. Hind femur ventrally unarmed, with 1 spinule on internal genicular lobe; hind tibia dorsally with 17–18 spinules on both sides, subapical area dorsally with 1 pair of spines, apex with 1 pair of long dorsal spines and 2 pairs of ventral shorter spines asymmetrically, largest-apical spine exceeding tip of metatarsal terminal spine (Fig. 4G); hind tarsus laterally compressed, basitarsus dorsally with 1 spinule and terminal spine (Fig. 4G).

**ABDOMEN.** Abdominal tergite without obvious projection, posterior margin of tenth abdominal tergite concave (Fig. 4D). Epiproct simple, more or less triangular but slender, with basal part wider than apical part, basal three fifths having elongate pale oval concavity between pair of dorsolateral carinae, and small dorsomedian pit along apical fourth of epiproct behind convergence of lateral carinae (Figs 4D, 5). Subapical part of subgenital plate with 1 pair of styli, nearly cylindrical, apex acute (Fig. 4E), styli longer than distance between them (Fig. 4D). Cerci slender, subconical, apex obtuse (Fig. 4E).

**COLORATION.** Body reddish-brown, face light, eyes dark, ocelli light. Legs yellowish-brown, external surface of hind femora with oblique stripes.

#### Female

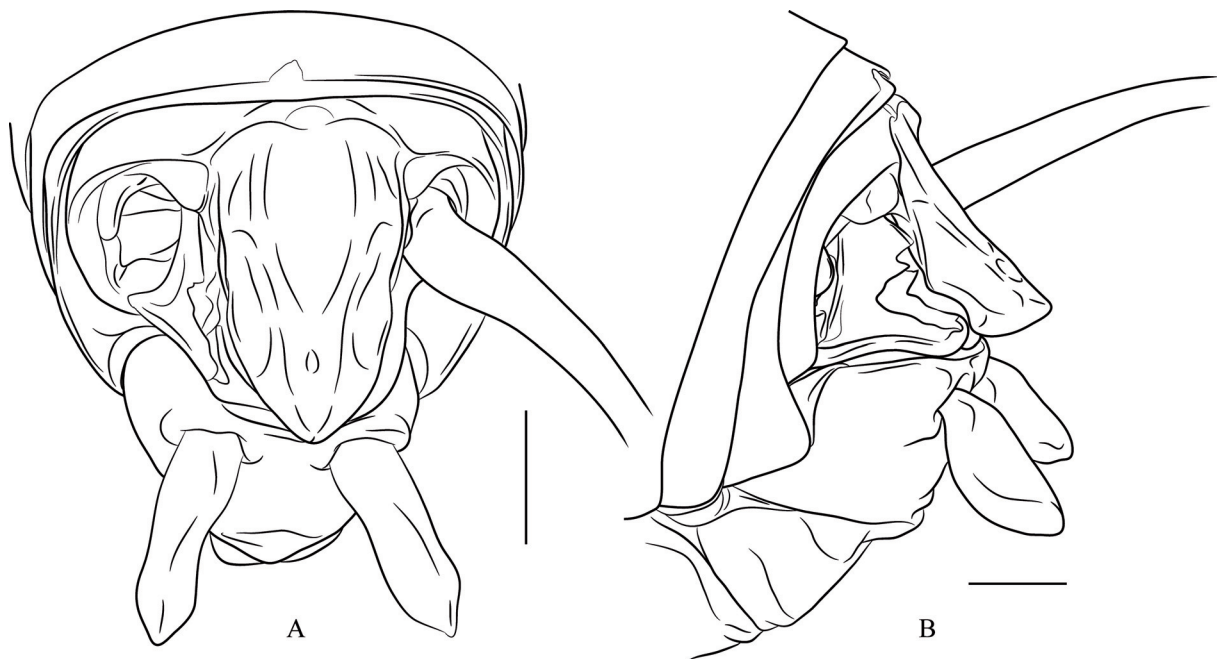
Unknown.

#### Measurements (mm)

BL: ♂ 15.0; PL: ♂ 7.0; FFL: ♂ 7.5; HFL: ♂ 18.0; HTL: ♂ 16.0; HBL: ♂ 3.8.

#### Distribution

China (Hunan).



**Fig. 5.** Line drawing of *Rhabdophora glenoides* Qin, Wang & He sp. nov., male epiproct. **A.** Dorsal view. **B.** Lateral view.

*Rhaphidophora impressa* Wang, Qin & He sp. nov.  
urn:lsid:zoobank.org:act:B38A9455-48AE-4366-8224-D53E4FE774BE  
Figs 6–8

**Chinese name**

圆印驼螽

**Diagnosis**

The new species is similar to those species bearing a simple male epiproct. It differs from the previous species by the apex of the male epiproct only plump without being vertically expanded (Fig. 8B), and bears a circular imprint at the bottom of the epiproctal concavity (Fig. 8A); from *R. setiformis* Qin, Jiang, Liu & Li, 2018 by the apex of the male epiproct swell not depressed (Figs 8B, 9A), the concavity of the male epiproct being not narrow and prolonged from base to apex; and from *R. duxiu* in the shape of the male epiproctal concavity and the length of the female subgenital plate.



**Fig. 6.** *Rhaphidophora impressa* Wang, Qin & He sp. nov., holotype, ♂ (SEM CAS 14098455). **A.** Head in frontal view. **B–C.** Head and thorax in dorsal and lateral view, respectively. **D–F.** Apex of abdomen in rear dorsal, lateral and ventral view, respectively. **G.** Left hind tarsus in outer lateral view. **H.** body in lateral view.

## Etymology

The new specific epithet is derived from the Latin ‘*imprimo*’ and stands for the circular imprint of the epiproctal concavity in the male.

## Material examined

### Holotype

CHINA • ♂; Hunan Prov., Yueyang, Pingjiang, Fushoushan National Forest Park; alt. 1079 m; 18 Sep. 2016; Ri-Xin Jiang, Ji-Bao Jiang, Sheng-Nan Liu and De-Yao Zhou leg.; SEM CAS 14098455.

### Paratypes

CHINA • 1 ♂; same locality as for holotype; alt. 1070–1270 m; 15 Sep. 2018; Yan-Yan Qin and Sai-Nan Zhang leg; SEM CAS 14098453 • 1 ♀; same collection data as for preceding; SEM CAS 14098454.

## Description

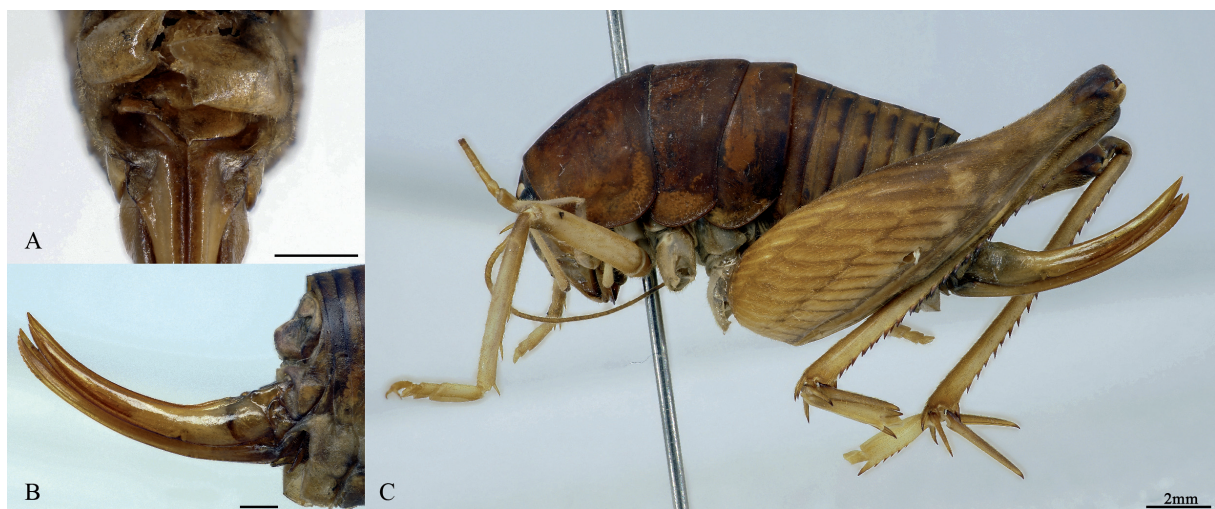
### Male

BODY SIZE. Medium to small.

HEAD. Fastigium of vertex divided into pair of plate-like processes by longitudinal furrow (Fig. 6B). Eyes protruding outward, reniform, situated near upper part of external margin of antennal sockets (Fig. 6A); lateral ocelli situated at lateral base of rostral tubercles, suborbicular, nearly occupying three fourths of lateral margin of rostral tubercles (Fig. 6C); median ocellus situated between antennal sockets, oval (Fig. 6A). Maxillary palpi strong, apical segment longer than subapical segment, apex inflated, almost spherical.

THORAX. Anterior margin of pronotum straight, posterior margin convex (Fig. 6B), posterior part of ventral margin of lateral lobes arched, posterior margin emarginate (Fig. 6C); Posterior margin of mesotergum slightly projected, posterior part of ventral margin of lateral lobes emarginate, arched; posterior margin of metanotum straight (Fig. 6C).

LEGS. Fore coxa inflated, dorsally with 1 spinule; fore femur with 1 apical spine on internal genicular lobe (Fig. 6B); ventral surface of fore tibia with 2 external and 1 internal spine, apex with 1 pair of



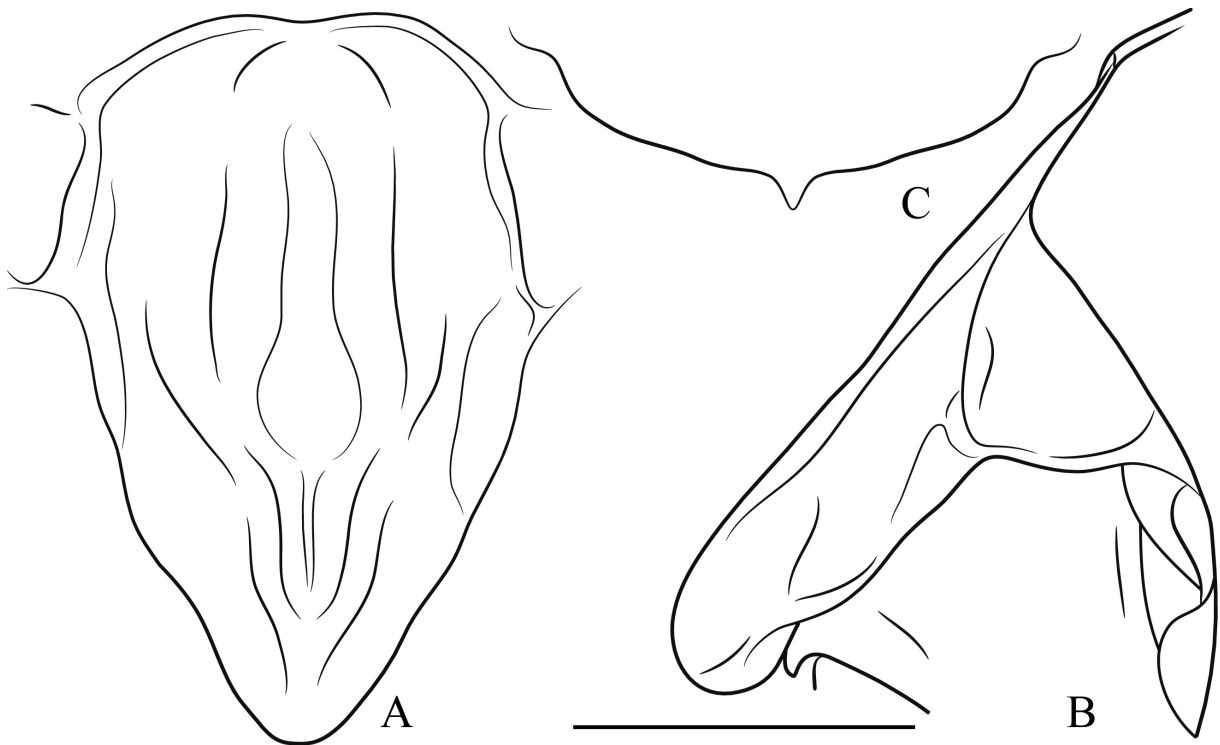
**Fig. 7.** *Rhapsidophora impressa* Wang, Qin & He sp. nov., paratype, ♀ (SEM CAS 14098454). **A.** Subgenital plate of female in ventral view. **B.** Ovipositor in lateral view. **C.** Body in lateral view.

spines on ventral surface. Anterior margin of middle coxa dorsally with 1 pair of spiniform processes; mid femur with 1 apical spine on internal and external genicular lobe separately; mid tibia dorsally with 1 pair of spines and 1 pair of apical spines, ventrally with 2 pairs of external spines and 1 pair of apical spines. Hind femur ventrally unarmed, with 1 spinule on internal genicular lobe; hind tibia dorsally with 17–18 spinules on both dorsal margins, subapical area dorsally with 1 pair of spines, apex with 1 pair of dorsal long spines and 2 pairs of shorter ventral spines asymmetrically, the largest apical spine slightly surpassing tip of terminal basitarsal spine (Fig. 6G); hind tarsus laterally compressed, basitarsus with 2 spinules and a terminal spine on dorsal surface, dorsal tip longer than ventral edge (Fig. 6G).

**ABDOMEN.** Abdominal tergite without processes, posterior margin of tenth abdominal tergite emarginate (Fig. 6D). Epiproct similar to that of previous species but with basal portion trapezoidal, more distal portion elongately triangular, concavity between dorsolateral carinae drop-shaped, base of concavity widened and expanding to middle forming circular imprint, apex of concavity constricted and narrowing to epiproctal end (Figs 6D, 8A). Subgenital plate roughly semicircular, sub apex with pair of stout styli with apex enlarged (Fig. 6E–F). Cerci elongated, basal part wider than apical part, nearly conical, apex obtuse (Fig. 6E).

#### Female

Similar to male. Hind basitarsus with 4–5 spinules and a terminal spine on dorsal surface. Subgenital plate transverse and short, near semicircular, hind margin pointed in middle (Figs 7A, 8C). Ovipositor longer than half length of hind femora, narrower from base to apex gradually, evenly upcurved, ventral margin serrated near apex (Fig. 7B).



**Fig. 8.** Line drawing of *Rhaphidophora impressa* Wang, Qin & He sp. nov. **A.** Male epiproct in dorsal view. **B.** Male epiproct in lateral view. **C.** Renatured hind margin of female subgenital plate in rear ventral view.

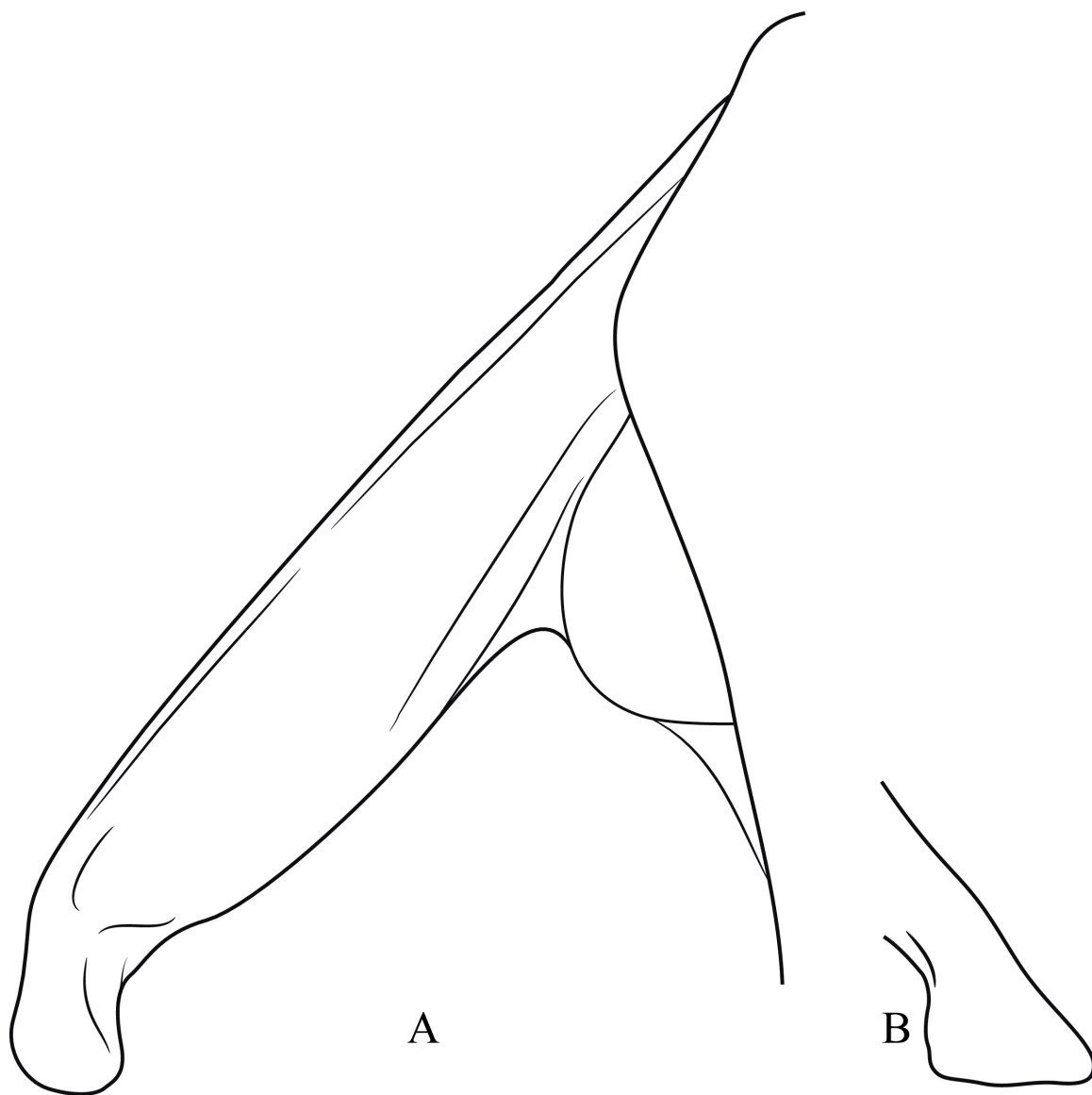
**COLORATION.** Body reddish brown in thoracic tergites and dark brown with yellowish patches in rest part; face pale brown, eyes darkish, ocelli pale. Legs tawny, external surface of hind femora with oblique darkish stripes and pale patches.

**Measurements (mm)**

BL: ♂ 13.0–15.0, ♀ 14.0; PL: ♂ 5.5–6.2, ♀ 5.7; FFL: ♂ 5.5–6.5, ♀ 5.4; HFL: ♂ 14.0–14.5, ♀ 15.0; HTL: ♂ 12.0–13.5, ♀ 13.8; HBL: ♂ 3.0–3.2, ♀ 3.5; OvL: ♀ 8.0.

**Distribution**

China (Hunan).



**Fig. 9.** Line drawings. **A.** *Rhaphidophora setiformis* Qin, Jiang, Liu & Li, 2018, male epiproct in lateral view. **B.** *Rhaphidophora xishuang* Gorochov, 2012, apex of male epiproct in lateral view (after Gorochov 2012).

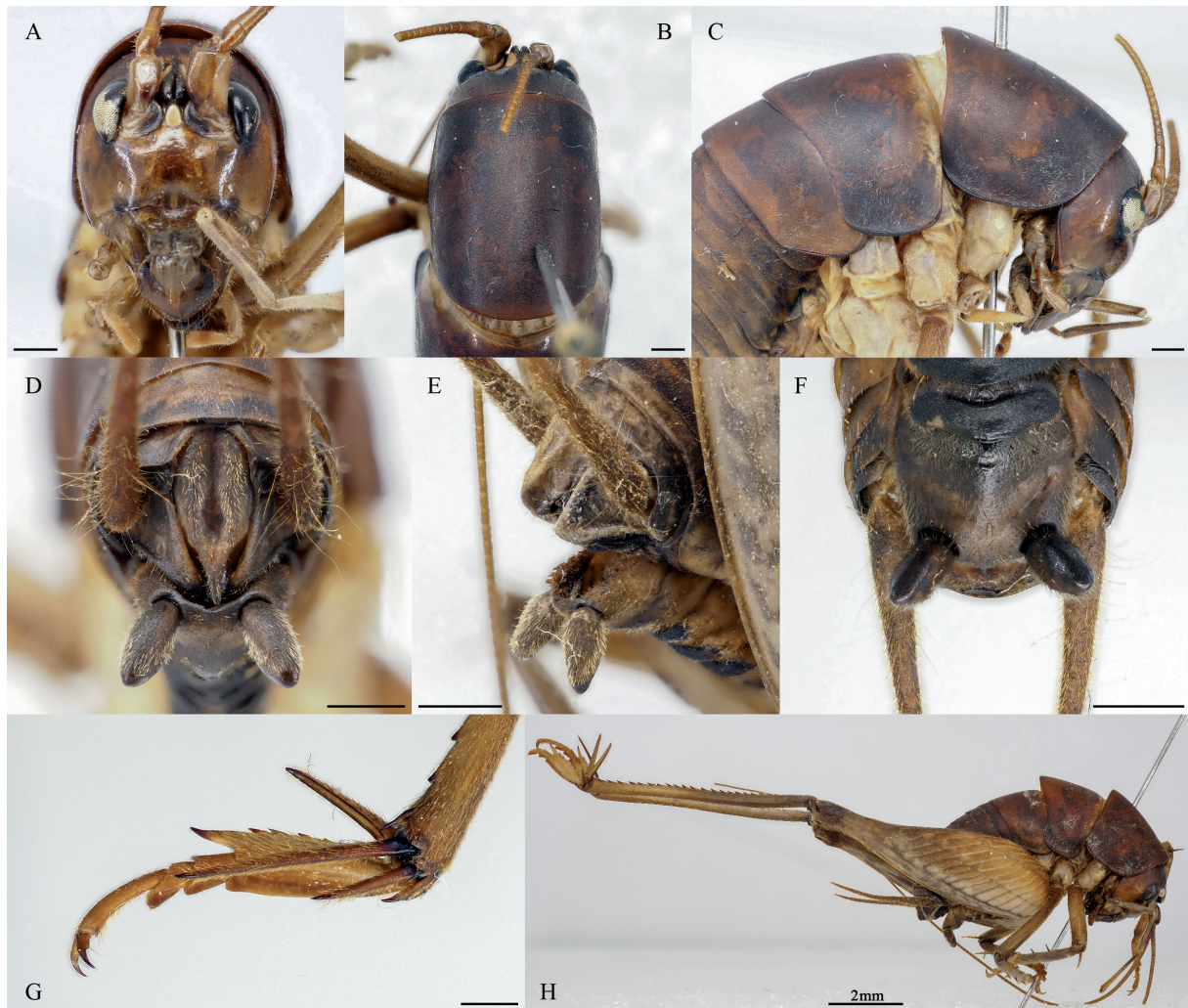
*Rhaphidophora stenoterminata* Zhang, Wang & He sp. nov.  
urn:lsid:zoobank.org:act:A544B78A-2F25-4E2B-AFD1-9E64FDAB07B4  
Figs 10–13

**Chinese name**

窄端驼螽

**Diagnosis**

The new species differs from species with a simple male epiproct by the unique undulated bilateral carinae at the basal part of the male epiproct, for other differences see the key to all Chinese species below.



**Fig. 10.** *Rhaphidophora stenoterminata* Zhang, Wang & He sp. nov. **A–D, F.** Paratype, ♂ (SEM CAS 14098456). **E, G–H.** Holotype, ♂ (SEM CAS 14098457). **A.** Head in frontal view. **B–C.** Head and thorax in dorsal and lateral view, respectively. **D–F.** Apex of abdomen in rear dorsal, lateral and ventral view, respectively. **G.** Left hind tarsus in lateral view. **H.** Body in lateral view.



### Etymology

The new specific epithet is derived from the Latinised Greek ‘*stenos*’ and the Latin ‘*termin*’, referring to the narrowly elongated apex of the male epiproct.

### Material examined

#### Holotype

CHINA • ♂; Guangdong Prov.; Nanling National Forest Park; alt. 900 m; 24–30 Sep. 2019; Tao Zhang leg.; SEM CAS 14098457.

#### Paratypes

CHINA • 3 ♂♂, 3 ♀♀; same collection data as for holotype; SEM CAS 14098456, 14098458, 14098460 to 14098463 • 2 ♂♂, 1 ♀ nymph; same locality as for holotype; alt. over 1000 m; 15 Sep. 2019; Tao Zhang leg.; SEM CAS 14098459, 14098464, 14098465.

### Description

#### Male

BODY SIZE. Large.



**Fig. 11.** *Rhapsidophora stenoterminata* Zhang, Wang & He sp. nov. **A–B.** Paratype, ♀ (SEM CAS 14098460). **A.** Subgenital plate of female in ventral view. **B.** Ovipositor in lateral view. **C.** Paratype, ♀ (SEM CAS 14098462), body in lateral view.

**HEAD.** Fastigium of vertex divided into pair of plate-like processes by longitudinal furrow (Fig. 10C). Eyes situated near upper part of external margin of antennal sockets (Fig. 10A); lateral ocelli situated at lateral base of tubercles, oval, nearly occupying two third of lateral margin of tubercles (Fig. 10B); median ocellus situated between antennal sockets, oval (Fig. 10A). Apical segment of maxillary palpus slightly longer than subapical segment, apex inflated, almost spherical (Fig. 10H).

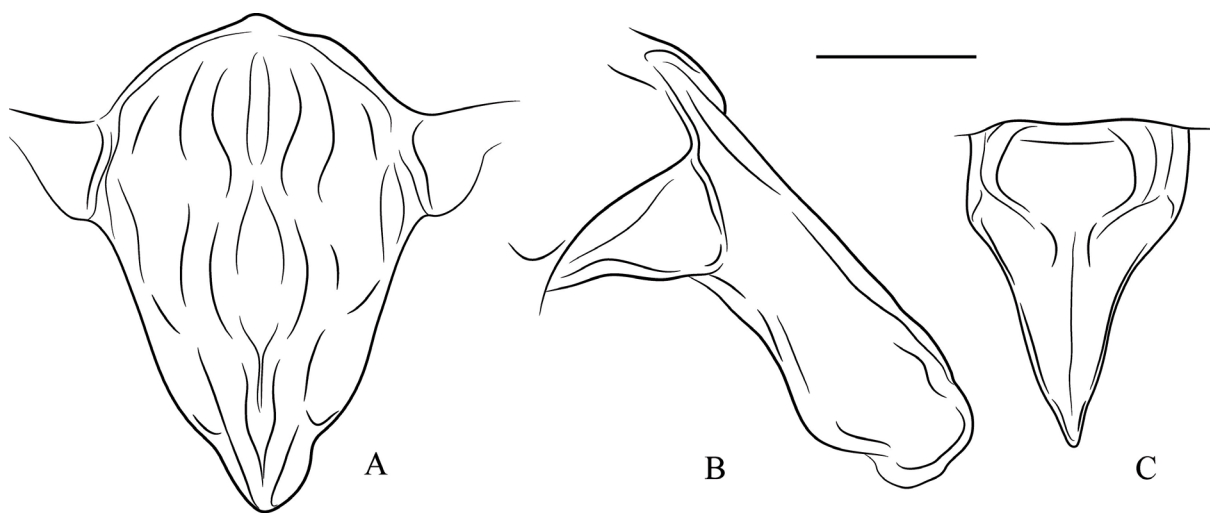
**THORAX.** Anterior margin of pronotum straight, posterior margin of pronotum projected (Fig. 10B), length of lateral lobes nearly equal to width, posterior margin of ventral surface arched; posterior margin emarginate; posterior margin of mesotergum obviously projected, posterior margin of metanotum straight (Fig. 10C).

**LEGS.** Fore coxa dorsally with 1 apical spine; fore femur with 1 apical spine on internal genicular lobe; fore tibia with 2 external and 1 internal spine on ventral surface, apex with 1 pair of spines on ventral surface, dorsal surface unarmed. Anterior margin of middle coxa dorsally with 1 spinule; middle femur with 1 pair of apical spines on dorsal surface and ventral surface separately; middle tibia with 2 pairs of spines and 1 pair of apical spines on dorsal surface, ventral surfaces with 2 external spines and 1 pair of apical spines. Hind femur ventrally unarmed, inner genicular lobe with 1 spinule; hind tibia dorsally with 20–21 spinules on both sides, subapical area dorsally with 1 pair of spines, apex with 1 pair of dorsal long spines and 2 pairs of shorter spines asymmetrically, largest apical spine protruding over tip of terminal basitarsal spine (Fig. 10G); hind tarsus laterally compressed, basitarsus with 3–5 spinules and 1 large terminal spine on dorsal surface (Fig. 10G).

**ABDOMEN.** Abdominal tergite without processes, posterior margin of tenth abdominal tergite emarginate (Fig. 10D). Epiproct fusiform, apex narrower elongated and vertically expanded, pair of longitudinal carinae sinuated, at basal two third of epiproct nearly ‘8’ shape present, and converging into apical one third (Figs 10D, 12A–B). Cerci slender, nearly conical, basal half wide, apical half slender, apex acute (Fig. 10E–F). Subgenital plate trapezoidal, base wider than apex, lateral corners with 1 pair of robust styli almost cylindrical (Fig. 10F).

### Female

Similar to male. Subgenital plate slender, basal fourth wide, rest part abruptly narrow, apex pointed (Figs 11A, 12C). Ovipositor wide (lateral view), base stout, basal half wider than apical half, evenly upcurved, ventral margin serrated near apex (Fig. 11B).



**Fig. 12.** Line drawing of *Rhaphidophora stenoterminata* Zhang, Wang & He sp. nov. **A.** Male epiproct in dorsal view. **B.** Male epiproct in lateral view. **C.** Female subgenital plate in rear ventral view.



**Fig. 13.** Habitus of *Rhaphidophora stenoterminata* Zhang, Wang & He sp. nov. **A.** Male. **B.** Female.

**COLORATION.** Body dorsal surface darkish and reddish brown (Fig. 13), ventral surface relatively paler, abdominal projection dark. Face dark, eyes blackish, ocelli light. Legs light, dorsal surface of hind femora and tibiae dark, external margin of femora with dark oblique stripes, apex of femora dark.

**Measurements (mm)**

BL: ♂ 14.0–17.0, ♀ 13.0–17.0; PL: ♂ 6.5–7.5, ♀ 8.0–8.5; FFL: ♂ 8.0–8.5, ♀ 8.3; HFL: ♂ 19.5–21.0, ♀ 21.0–21.5; HTL: ♂ 18.5, ♀ 18.5; HBL: ♂ 4.0–4.5, ♀ 4.0–4.5; OvL: ♀ 12.5–13.0.

**Distribution**

China (Guangdong).

**Key to known species of the genus *Rhaphidophora* from China**

1. Known only from female ..... 2
  - Known from male or both sexes ..... 4
2. Female subgenital plate elongated, apical half acutely constricted ..... *R. mohanensis* Lu & Bian, 2022
  - Female subgenital not elongated, roughly equilateral triangular. .... 3
3. Width of female subgenital plate of moderate size (wider than half width of base of ventral valve, Lu *et al.* 2022: fig. 13f) ..... *R. rongshuiensis* Lu & Bian, 2022
  - Subgenital plate of female extremely small (much narrower than half width of valve base, Liu & Zhang 2002: fig. 6) ..... *R. minuolamella* Liu & Zhang, 2002
4. Male epiproct simple, roughly ligulate (Figs 4–6, 8, 10, 12) ..... 5
  - Male epiproct specialized, with appended structure (Figs 1–3) ..... 18
5. Apex of male epiproct truncate and not elongated (Gorochov 1999: fig. 272; Bian *et al.* 2017: fig. 7d–e) ..... 6
  - Apex of male epiproct narrowly rounded or elongated ..... 7
6. Male epiproct longer than width, terminal narrowly truncate (Gorochov, 1999: fig. 272) ..... *R. sinica* Bey-Bienko, 1962
  - Male epiproct subquadrate, terminal broadly truncate (Bian *et al.* 2017: fig. 7d–e) ..... *R. quadrula* Bian, Zhu & Shi, 2017

|   |   |
|---|---|
| 7. Apex of male epiproct extended (Bian <i>et al.</i> 2017: fig. 1d; Qin <i>et al.</i> 2018: fig. 26) .....   | 8   |
| – Apex of male epiproct not protruded, narrowly rounded .....   | 9   |
| 8. Tip of elongated apical part of male epiproct enlarged to a pair of tubercles (Bian <i>et al.</i> 2017: fig. 1d) .....   | <i>R. biprocera</i> Bian, Zhu & Shi, 2017           |
| – Apical part of male epiproct elongated to a digitation (Qin <i>et al.</i> 2018: fig. 26) .....  | <i>R. wuzhishanensis</i> Qin, Jiang, Liu & Li, 2018 |
| 9. Apex of male epiproct dorsoventrally incrassated (Figs 5B, 9B) (Bian <i>et al.</i> 2017: fig. 4e) .....  | 10  |
| – Apex of male epiproct not vertically incrassated (Fig. 9A) .....  | 15  |
| 10. Upper part of incrassated apex bears conical tip (Fig. 4D–E) (Bian <i>et al.</i> 2017: fig. 4e) .....   | 11  |
| – This vertically incrassated apex without protuberance (Figs 10D–E, 12B) .....   | 14  |
| 11. Conical tip pointed almost backward (upward); lower part expanded, hoof-shaped, hind margin truncate (Bian <i>et al.</i> 2017: fig. 4e) .....   | <i>R. longitabula</i> Bian, Zhu & Shi, 2017         |
| – Conical tip pointed downward (rearward); lower part unspecialized (Figs 5B, 9B) .....   | 12  |
| 12. Hind basitarsus dorsally armed with more than 5 spinules .....  | <i>R. xishuang</i> Gorochoy, 2012                   |
| – Hind basitarsus dorsally armed with only 1–2 spinules .....   | 13  |
| 13. Base only slightly concave between lateral carinae of male epiproct, convergence of lateral carinae almost at apex .....  | <i>R. sichuanensis</i> Liu & Zhang, 2002            |
| – Basal half broadly oval concave between lateral carinae of male epiproct, a pit exists in about apical fourth of epiproct behind convergence of lateral carinae .....   | <i>R. glenoides</i> Qin, Wang & He sp. nov.         |
| 14. Space between lateral carinae of male epiproct oval at basal half, apex of male epiproct rounded in lateral view; female subgenital plate not elongate .....  | <i>R. incilis</i> Bian, Zhu & Shi, 2017             |
| – Space between lateral carinae of male epiproct constricted at basal third, apical third of male epiproct sharply narrowed, apex of male epiproct truncate in lateral view; female subgenital plate elongate ..... | <i>R. stenoterminata</i> Zhang, Wang & He sp. nov.  |
| 15. Apex of male epiproct flat, narrow in lateral view (Fig. 9A; Qin <i>et al.</i> 2018: fig. 20) .....   | <i>R. setiformis</i> Qin, Jiang, Liu & Li, 2018     |
| – Apex of male epiproct not flat, plumpy (Fig. 6F) .....  | 16  |
| 16. Circular imprinting at bottom of male epiproct groove .....   | <i>R. impressa</i> Wang, Qin & He sp. nov.          |
| – Groove of male epiproct with smooth surface; female subgenital plate elongate .....   | 17  |
| 17. Male epiproct gradually narrowed behind; female subgenital plate sharply pointed behind, ovipositor with dorsal margin inconspicuously finely crenulate .....   | <i>R. taiwana</i> Shiraki, 1930                     |
| – Male epiproct sharply narrowed behind; female subgenital plate elongated and gradually narrowed, ovipositor with dorsal margins smooth .....  | <i>R. duxiu</i> Lu & Bian, 2022                     |
| 18. Male epiproct entirely lamellate (Fig. 1E–F) .....  | 19  |
| – Male epiproct thick and delaminated in apical half (Figs 2D, F, 3D–E) .....   | 24  |
| 19. Male epiproct with pair of inward directed spines at lateral corner and pair of smaller outwardly directed spines subapically .....   | <i>R. quadridentata</i> Qin, Jiang, Liu & Li, 2018  |
| – Male epiproct with a pair of long processes at lateral corner .....   | 20  |

20. Processes of lateral corner conical, margin between straight; subgenital plate of male with a pair of stout tubercles subapically ..... *R. brevispinula* Bian, Zhu & Shi, 2017  
 – Processes of lateral corner digitate, in between with a lobe apically bispinous ..... 21
21. Digitate processes compressed in apical half; lobe in between small .....  
 ..... *R. complanatis* Lu & Bian, 2022  
 – Digitate processes not compressed; lobe in between large ..... 22
22. Distance between base of digitate processes distinctly longer than their length; lobe down-folded and pointed anteriorly (maybe due to shrinkage of dry specimen) .....  
 ..... *R. hexagoniproctalis* Wang, Di & He sp. nov.  
 – Distance between base of digitate processes almost equal to their length; lobe only slightly folded at base ..... 23
23. Digitate processes long, about half of entire epiproct length (process included), and outward bent at basal one third; female subgenital plate transverse ..... *R. digitata* Lu & Bian, 2022  
 – Digitate processes short, about third of entire epiproct length (process included), slightly and evenly outward curved; female subgenital plate not transverse as above ..... *R. shii* Lu & Bian, 2022
24. Upper part of delaminated apical half of male epiproct becomes pair of large spines from base, wider than lower part ..... 25  
 – Upper part of delaminated apical half of male epiproct medially or apically cracked, narrower than lower part ..... 26
25. Spines of upper part long and stout; lower part downcurved and cracked in apex to pair of small spines, in between emarginated ..... *R. spinita* Lu & Bian, 2022  
 – Spines of upper part short and robust; lower part also with pair of smaller robust spines, margin in between straight (Liu *et al.*: fig. 1g) ..... *R. quadrispina* Liu & Bian, 2021
26. Upper part distinctly constricted and cracked at half; lower part moderately expanded, longer than upper part ..... *R. imbricofurca* Shen, Wang & He sp. nov.  
 – Upper part slightly constricted in middle and apically incised, margin of incision irregular; lower part considerably expanded, shorter than upper part ..... *R. heterodentis* Shen, Wang & He sp. nov.

## Discussion

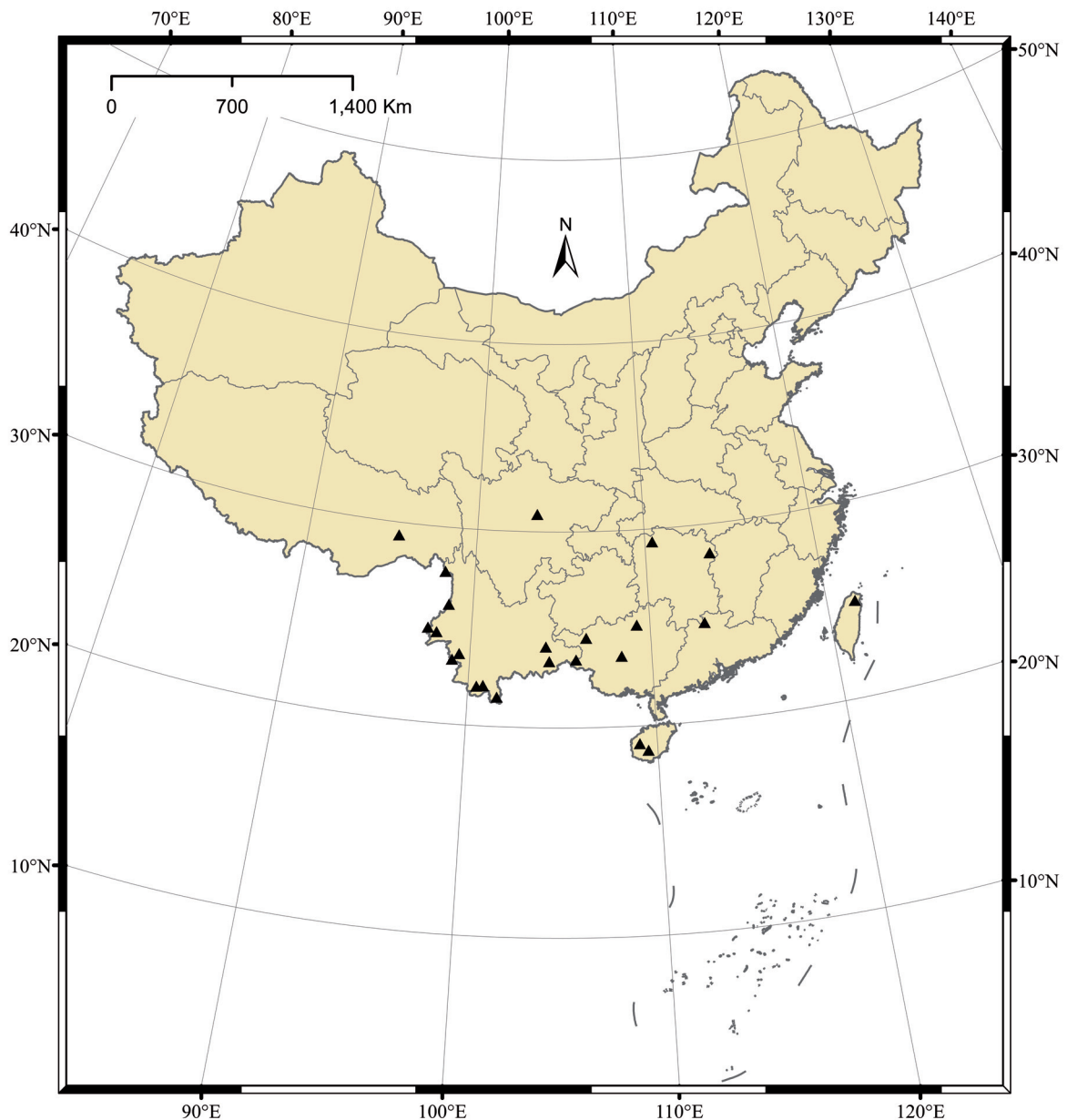
Up to now, there are 27 species of the genus *Rhaphidophora* distributed in China including the six species described in this study (Fig. 14). Most species are distributed in the southern regions of the Yangtze River, with Yunnan being the hotspot, consisting of eleven species. The current classification of these species is primarily based on morphological features, especially the male epiproct. However, it is worth noting that many species were described based on few samples, and these morphological features should be reevaluated in future studies. During our field investigations, we have encountered species of Rhaphidophorinae many times at night in central, east and south China. However, their population sizes are small, and they can be challenging to capture due to their swift movement and ability to climb high on tree branches, which distinguishes them from species of Aemodogryllinae Jacobson, 1905. Therefore, more efficient collecting methods are needed, and it is expected that there are undescribed species in those areas.

Qin (2020) erroneously synonymized *R. setiformis* with *R. xishuang* in her doctoral dissertation, because the male epiproct apex of the former species is not vertically incrassated and without a conical tip as in the latter species (Fig. 9A–B). Additionally, the hind basitarsus of *R. setiformis* has 2 to 3 spinules, while that of *R. xishuang* has 5 to 6.

Camel crickets, as wingless orthopterans with limited migratory capabilities, are ideal organisms for biogeographic research. Zhu *et al.* (2022) conducted phylogeographic studies on the genus *Diestramima* Storozhenko, 1990 in China, which revealed that Yunnan is the likely origin of this genus, consistent with the biodiversity of *Rhaphidophora* in China. In future studies, it is encouraged to collect DNA samples, as molecular studies can provide insights into the phylogeny of the genus *Rhaphidophora*.

### Acknowledgements

We thank Chang-Teng Yang and his colleagues, Nanling National Forest Park Administration, for their help in our field work. This work was sponsored by the National Animal Collection Resource Center of



**Fig. 14.** Distribution of *Rhaphidophora* Serville, 1838 in China.

China, the Biological Resources Program of Chinese Academy of Sciences (No. KFJ-BRP-017-39) and the Key Project of Science and Technology Committee of Shanghai (No. 19DZ1204105).

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