

Taxonomy of the genus *Misthenkoana* Gorochov, 1990
from China: combined molecular
and morphological studies (Orthoptera,
Grylloidea, Oecanthidae, Podoscirtinae)

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Habitus male of *Misthenkoana gouriatus* Zheng, Xin, Xie & Ma, 2021.

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Taxonomy of the genus *Mistshenkoana* Gorochov, 1990 from China: combined molecular and morphological studies (Orthoptera, Grylloidea, Oecanthidae, Podoscirtinae)

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ABSTRACT

In this study, species of the genus *Mistshenkoana* Gorochov, 1990 from China are studied based on molecular marker and morphological characteristics. Two new species, *Mistshenkoana tianya* He & Wei n. sp. and *M. melanocephala* He & Wei n. sp., are described. *M. nhachangi* Gorochov, 2007 is reported from China for the first time. Female genitalia of this genus are studied for the first time, and described here for two species, *M. gouriatus* Zheng, Xin, Xie & Ma, 2021 and *M. kongtumensis* Gorochov, 1990. We sequenced the fragments of the mitochondrial cytochrome-c oxidase subunit I gene (COI, 658 bp) from five *Mistshenkoana* species and provide the Genbank number. The molecular results support morphological classification.

KEY WORDS

Crickets,
molecular markers,
morphological
characteristics,
new species.

RÉSUMÉ

Taxonomie du genre Mistshenkoana Gorochov, 1990 de Chine : études moléculaires et morphologiques combinées (Orthoptera, Grylloidea, Oecanthidae, Podoscirtinae).

Dans cette étude, les espèces du genre *Mistshenkoana* Gorochov, 1990 de Chine sont étudiées sur la base d'un marqueur moléculaire et de caractéristiques morphologiques. Deux nouvelles espèces, *Mistshenkoana tianya* He & Wei n. sp. et *M. melanocephala* He & Wei n. sp. sont décrites. *M. nhachangi* Gorochov, 2007 est signalé pour la première fois en Chine. Les genitalia femelles de ce genre sont étudiés pour la première fois, et nous décrivons ici les genitalia femelles de deux espèces, *M. gouriatus* Zheng, Xin, Xie & Ma, 2021 et *M. kongtumensis* Gorochov, 1990. Nous avons séquencé les fragments du gène de la sous-unité I de la cytochrome-c oxydase mitochondriale (COI, 658 pb) de cinq espèces de *Mistshenkoana* et nous fournissons le numéro Genbank. Les résultats moléculaires soutiennent la classification morphologique.

MOTS CLÉS

Grillons,
caractéristiques
morphologiques,
marqueurs moléculaires,
nouvelles espèces.

INTRODUCTION

Mistshenkoana Gorochov, 1990 species are small-size crickets belonging to the tribe Aphonoidini Gorochov, 2008, subfamily Podoscirtinae Saussure, 1878, and newly established family Oecanthidae Blanchard, 1845 (Campos *et al.* 2022). This genus was established by Gorochov in 1990 with four species. It is distributed in the Ryukyu Islands (Japan), China, Indo-China to Malay Archipelago, East Australia, and some islands in Western Pacific (Cigliano *et al.* 2024). Currently, this genus includes 63 species, however, only two species have been recorded in China prior to this study (Zheng *et al.* 2021; Wu *et al.* 2023; Cigliano *et al.* 2024). *Mistshenkoana* species are very similar to *Aphonoides* Chopard, 1940 species in appearance and size, but their head rostrum and hind wings are somewhat shorter (not shorter than fore wings; usually hindwings are significantly longer than forewings, as in *Aphonoides*) (Gorochov 2007). Usually, there are some small darkish spots around crossveins in distal half of *Mistshenkoana* forewings (Gorochov 2007). Gorochov (2007, 2008) systematically revised *Mistshenkoana* species and described 40 new species mainly from Southeast Asia and Oceania.

Zheng *et al.* (2021) described one new species, *Mistshenkoana gouriatus* Zheng, Xin, Xie & Ma, 2021 from China; they also reported *M. unicolor* (Walker, 1869) from Guizhou Province, China without reference or examined specimens. Wu *et al.* (2023) reported *M. kongtumensis* Gorochov, 1990 as a new record for China and described its genitalia and ovipositor. Except the above mentioned researches, few taxonomic studies have been done for this genus, even less combining molecular markers. In this study, we describe two new species, *M. tianya* He & Wei n. sp. and *M. melanocephala* He & Wei n. sp. Moreover, we provide a new record for *M. nhachangi* Gorochov, 2007 from China. Female genitalia and COI sequences of this genus are provided for the first time. The type specimens are deposited in Museum of Biology, East China Normal University (ECNU).

MATERIAL AND METHODS

SAMPLING

The specimens were collected using sweep nets during nocturnal hours and preserved in 60% alcohol. Once in the laboratory, one hind leg was dissected from each specimen and immersed in 100% alcohol at -40°C for further preservation. The remaining specimens were kept dry. Male genitalia were dissected, treated with a 10% NaOH solution for clarity, and subsequently stored in a combination of glycerol and alcohol (Randell 1964). The female genitalia were also dissected and stored in a combination of glycerol and alcohol.

ABBREVIATIONS

Institution

ECNU Museum of Biology, East China Normal University, Shanghai.

Measurement

SZ length from apex of fastigium to end of hindwing;
BL body length from apex of fastigium to posterior margin of subgenital plate;
PL pronotum length from anterior margin to posterior margin at midline;
FWL forewing length from base to apex;
HFL hind femur length from base to apex;
OL visible straight line length of ovipositor.

Spurs

ia inner apical spurs (1 to n);
oa outer apical spurs (1 to n);
is inner subapical spurs (1 to n);
os outer subapical spurs (1 to n).

Male genitalia

ec a ectophallic apodemes;
ec f ectophallic fold;
en s endophallic sclerite;
ps pseudepiphallic sclerite;
ps l pseudepiphallic lophi;
ps p pseudepiphallic paramere;
r rami;
v ventral valves.

Female ovipositor

dv dorsal valvulae;
vv ventral valvulae.

MORPHOLOGY AND TERMINOLOGIES

Specimens were studied under a Leica M125 stereo microscope. The photographs were taken with an SC2000 digital CMOS camera. Drawings were prepared based on photographs using Adobe Photoshop 2020 and Illustrator 2020. The distribution map was generated using the software ArcGIS 10.2, using the maps available on the website <https://worldclim.org>, a free public database of maps. The terminology used to describe spurs followed Desutter-Grandcolas *et al.* (2023); male genitalia morphology follows Desutter-Grandcolas (2003; 2011); female genitalia morphology follows Campos *et al.* (2020); female ovipositor morphology follows Wu *et al.* (2023).

DNA EXTRACTION AND AMPLIFICATION

Genomic DNA was extracted from right leg muscles using the AxyPrep Genomic DNA Miniprep Kit (AXYGEN), following the manufacturer's instructions. The mitochondrial cytochrome c oxidase subunit I gene (COI) fragments, measuring 658 base pairs, were sequenced using the primers LCO-1490 (GGTCAACAAATCATAAAGATATGG) and HCO-2198 (TAAACTTCAGG GTGACCAAAAATCA) (Folmer *et al.* 1994). PCR was performed with the following parameters: initial denaturation at 94°C for 3 minutes, followed by 30 cycles of 30 seconds at 94°C , 30 seconds at 45°C , and 30 seconds at 72°C , and a final extension at 72°C for 5 minutes. The GenBank accession numbers are provided in Table 1.

TABLE 1. — ECNU-specimens information and COI GenBank accession number.

Species	Voucher	Collection site	Genbank	Data
<i>Mistshenkoana tianya</i> He & Wei n. sp.	1459	China, Hainan, Jianfengling	OR033151	this study
	1779	China, Hainan, Changjiang	OR033152	this study
	1889	China, Hainan, Changjiang	OR033153	this study
<i>Mistshenkoana melanocephala</i> He & Wei n. sp.	4276	China, Yunnan, Wenshanzhou	OR033156	this study
	4353	China, Guangxi, Baise	OR033157	this study
	4354	China, Guangxi, Baise	OR033158	this study
	1422	China, Guangdong, Shaoguan	OR033154	this study
<i>Mistshenkoana gouriatius</i> Zheng, Xin, Xie & Ma, 2021	316	China, Zhejiang, Lin'an	OR033140	this study
	1434	China, Zhejiang, Lin'an	OR033141	this study
	1435	China, Zhejiang, Lin'an	OR033142	this study
	1499	China, Fujian, Wuyishan	OR033143	this study
	2016	China, Zhejiang, Quzhou	OR033144	this study
	2017	China, Zhejiang, Quzhou	OR033145	this study
	2221	China, Zhejiang, Lin'an	OR033146	this study
	2368	China, Zhejiang, Lishui	OR033147	this study
	2391	China, Zhejiang, Taishun	OR033148	this study
	2401	China, Zhejiang, Taishun	OR033149	this study
<i>Mistshenkoana kongtumensis</i> Gorochov, 1990	3810	China, Guangdong, Shaoguan	OR033150	this study
	1405	China, Zhejiang, Hangzhou	OR033136	this study
	2015	China, Zhejiang, Quzhou	OR033137	this study
<i>Mistshenkoana nhachangi</i> Gorochov, 2007	4304	China, Guangxi, Fangchenggang	OR033138	this study
	1372	China, Hainan, Changjiang	OR033139	this study
<i>Aphonoides wuyiensis</i> Yin & Zhang, 2001	513	China, Yunnan, Xishuangbanna	OQ118087	this study

MOLECULAR ANALYSES

The COI sequences isolated from *Mistshenkoana* species, together with that of *Aphonoides wuyiensis* Yin & Zhang, 2001, were used for distance tree. The evolutionary history was inferred using the Neighbor-Joining method (Saitou & Masatoshi 1987). The optimal tree is shown. The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the distance tree. The evolutionary distances were computed using the Maximum Composite Likelihood method (Ronquist *et al.* 2012) and are in the units of the number of base substitutions per site. This analysis involved 24 nucleotide sequences. Codon positions included were 1st + 2nd + 3rd + Noncoding. All ambiguous positions were removed for each sequence pair (pairwise deletion option). There were a total of 658 positions in the final dataset. Evolutionary analyses were conducted in MEGA11 (Tamura *et al.* 2021). To estimate the number of molecular operational taxonomic units (MOTUs), two methods were employed: Automatic Barcode Gap Discovery (ABGD) and Assemble Species by Automatic Partitioning (ASAP). The ABGD analysis was conducted online (<https://bioinfo.mnhn.fr/abi/public/abgd/abgdweb.html>) with the default settings, using a relative gap width ($X = 1.2$) and intraspecific divergence (P) values between 0.001 and 0.100 with the K2P model (Puillandre *et al.* 2012). The ASAP analysis was performed using web browser (<https://bioinfo.mnhn.fr/abi/public/asap/>) with the Jukes-Cantor (JC69) model and default settings (Puillandre *et al.* 2021).

RESULTS

MOLECULAR STUDY

We obtained 23 COI gene sequences from five *Mistshenkoana* species, including the newly reported *M. tianya* He & Wei n. sp. and *M. melanocephala* He & Wei n. sp., as well as *Aphonoides wuyiensis* as the outgroup. According to the COI gene tree, there are clear boundaries delimitating three clusters, with five species identified by ABGD and ASAP analysis (Fig. 1).

SYSTEMATICS

Class INSECTA Linnaeus, 1758
 Order ORTHOPTERA Latreille, 1810
 Family OECANTHIDAE Blanchard, 1845
 Subfamily PODOSCIRTINAE Saussure, 1878

Genus *Mistshenkoana* Gorochov, 1990

Mistshenkoana Gorochov, 1990: 20.

TYPE SPECIES. — *Mistshenkoana kongtumensis* Gorochov, 1990.

DIAGNOSIS. — Body small and slender. Head, pronotum and legs with many strong setae. Rostrum of head between antennal cavities somewhat narrower than scape and with more or less truncate apex (Fig. 2). Three ocellus arranged in a triangle (Fig. 6). Maxillary palpi spiny. Inner tympanum open, but outer one obliterated (only a small, weakly distinct concavity) (Fig. 3). Hind femora with a wide ventral gutter. Wings long (hind wings distinctly longer than fore wings),

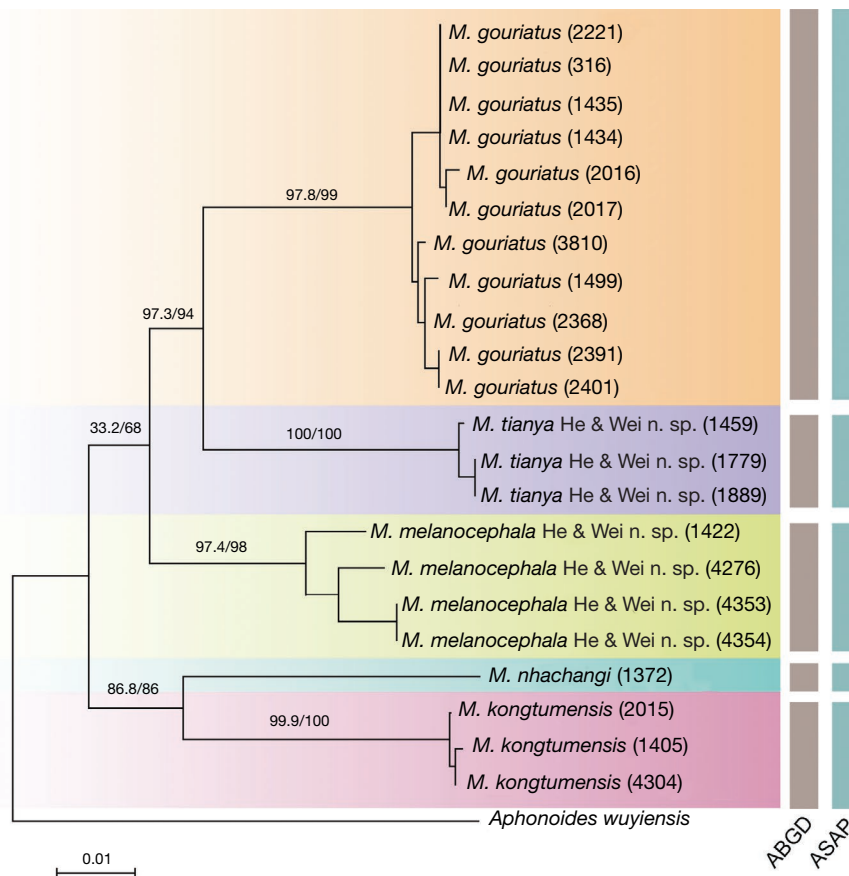


FIG. 1. — The distance tree among *Misthenkoana* Gorochov, 1990 species inferred from the COI fragment (658 bp) using the Neighbor-Joining method. The evolutionary distances were computed using the Maximum Composite Likelihood method and are in the units of the number of base substitutions per site. The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the distance tree. The MOTUs was shown by color bars based on ABGD and ASAP analysis in grey and green respectively.

fore wings Sc with several branches, distal half of forewings usually with small darkish spots around crossveins. Hind tibiae serrulated, with short and thin spines among subapical spurs, sparser as closer to the apex; with six inner and five outer subapical spurs; three inner and three outer apical spurs, outer spurs short (the middle one longer; the other two equal in length) and the inner spurs long (superior one longest, inferior one shortest) (Fig. 4). Male anal plate with a small median projection (usually bifurcate) at proximal part; male genital plate longer than those in other genera of Podoscirtinae (in connection with long spermatophore ampulla) and usually with ventral longitudinal concavity. Male genitalia: pseudepiphallic sclerite without arms, lophi separated by a triangular indentation apically. Apex of ovipositor drilling (more or less rounded with large teeth on dorsal and ventral surfaces).

Misthenkoana tianya He & Wei n. sp.
(Figs 2A, B; 3A, B; 4A; 5; 6A; 7)

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TYPE MATERIAL. — **Holotype.** China • ♂ (1459); Hainan Prov., Jianfengling National Forest Park; 18°49'N, 108°90'E; 9.VIII.2018; Zhu-Qing He leg.; ECNU; GenBank: OR033151.

Paratypes. China • 2 ♀ (1779, 1889); Hainan Prov., Changjiang, Baomeiling Provincial Nature Reserve; 19°17'N, 109°05'E; 18.III.2019; Zhu-Qing He leg.; ECNU; GenBank: OR033152; OR033153.

ETYMOLOGY. — The specific epithet *tianya* is for the Chinese phonetic alphabet 天涯. This means the end of sky, and it also refers to Hainan Island, where is the type locality of the new species. Chinese name: 天涯纤须蠃.

DIAGNOSIS. — Almost uniform yellowish brown. Hind femur spotted (different from other species of this genus in China) (Fig. 2A, B; 6A). Hind wings slightly longer than forewings (Fig. 5A), comb of tegminal Sc with 6-7 branches. Pseudepiphallic lophi bearing two semicircular-like projections apically.

DISTRIBUTION. — China (Hainan).

DESCRIPTION

Male

Head. Vertex broad and flattened. Head wider than anterior margin of pronotum; frontal rostrum convex, densely pubescent (Fig. 2A, B). Median ocellus smallest of the three ocelli, ovoid (Fig. 6A); lateral ocelli larger and flatter than middle one, transversely ovoid. Eyes strongly prominent and large, about 1/2 the length of head.

Thorax. Pronotum broad, finely pubescent; posterior margin longer than anterior; anterior margin straight and posterior slightly convex; two eyelike spots of pronotum disc distinct and smooth (Fig. 5A). Longitudinal veins of forewings parallel,

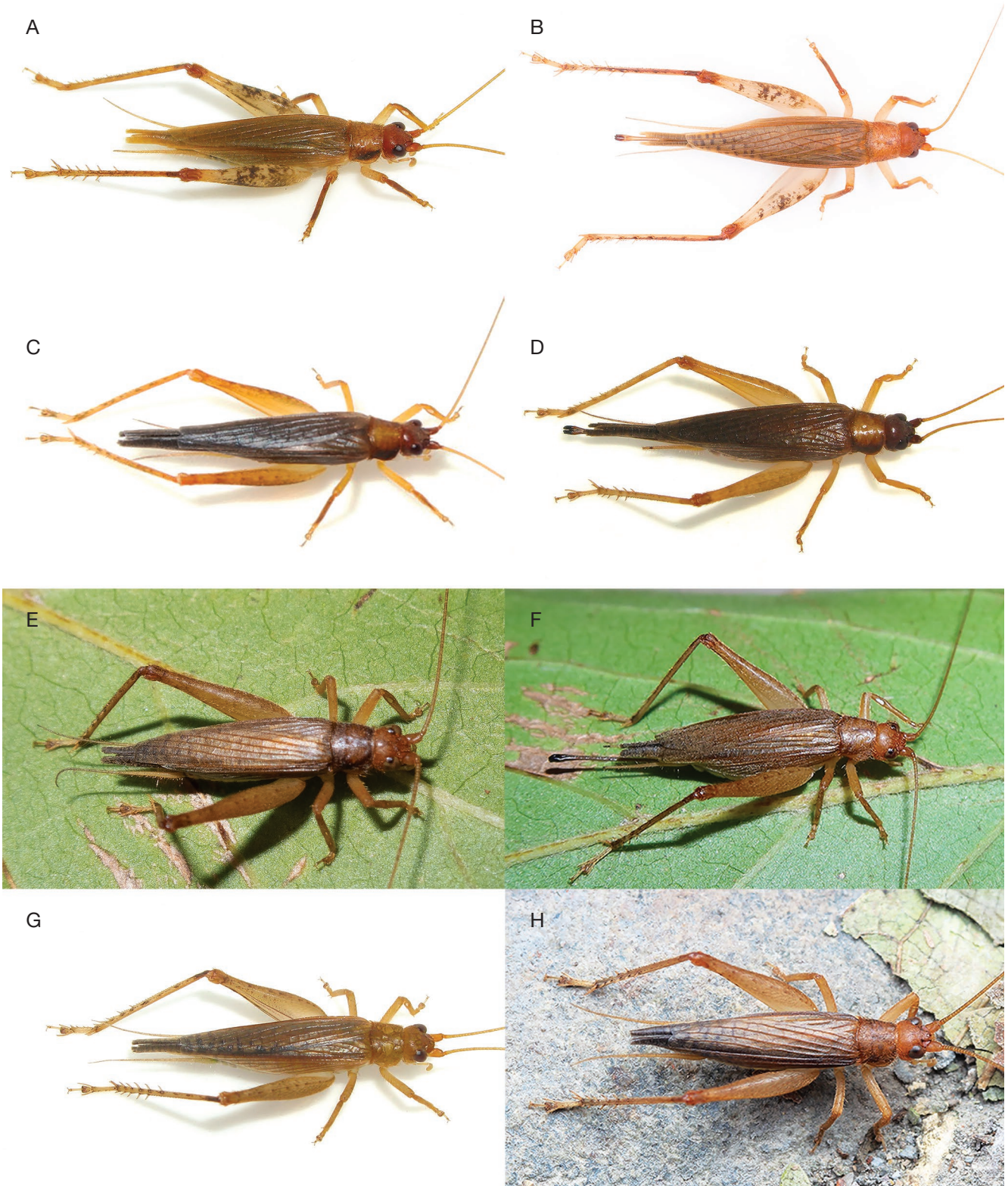


FIG. 2. — *Mistshenkoana* Gorochov, 1990 living specimens: **A, B**, *M. tianya* He & Wei n. sp. male (**A**), female (**B**); **C, D**, *M. melanocephala* He & Wei n. sp. male (**C**), female (**D**); **E, F**, *M. gouriatius* Zheng, Xin, Xie & Ma, 2021 male (**E**), female (**F**); **G**, *M. nhachangi* Gorochov, 2007 male; **H**, *M. kongtumensis* Gorochov, 1990 male. Not to scale.

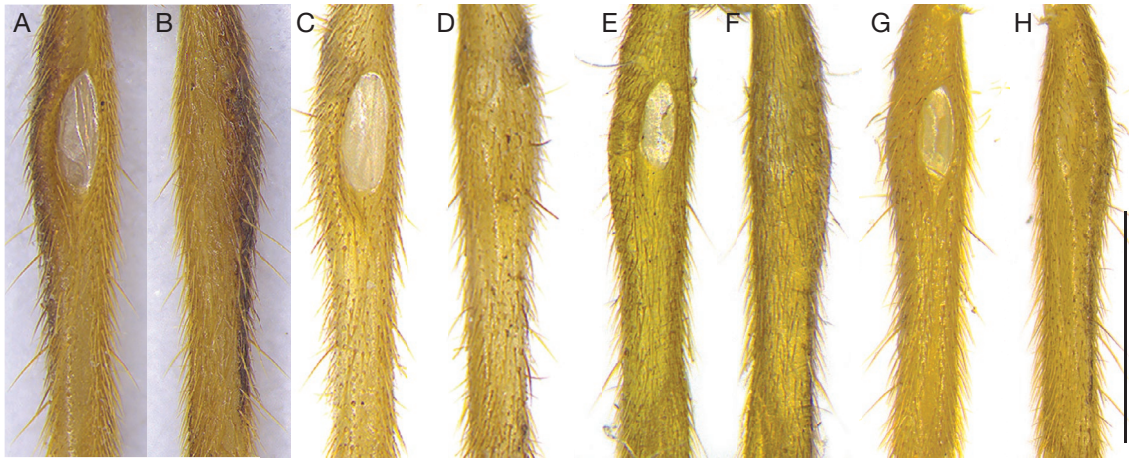


FIG. 3. — *Mistshenkoana* inner and outer side of fore tibia: **A, B**, *M. tianya* He & Wei n. sp. (ECNU-1459); **C, D**, *M. melanocephala* He & Wei n. sp. (ECNU-4276); **E, F**, *M. kongtumensis* Gorochov, 1990 (ECNU-4304); **G, H**, *M. gouriatus* Zheng, Xin, Xie & Ma, 2021 (ECNU-2016). Scale bar: 1 mm.



FIG. 4. — *Mistshenkoana* Gorochov, 1990 spurs and spines on hind tibia in dorsal view: **A**, *M. tianya* He & Wei n. sp. (ECNU-1459): **oa3**, behind tibia, hardly visible; **B**, *M. melanocephala* He & Wei n. sp. (ECNU-4276); **C**, *M. nhachangi* Gorochov, 2007 (ECNU-1372); **D**, *M. gouriatus* Zheng, Xin, Xie & Ma, 2021 (ECNU-2016). Scale bar: 1 mm. Abbreviations: see Material and methods.



FIG. 5. — Male morphological features of *Mistshenkoana tianya* He & Wei n. sp. (ECNU-1459): **A**, male body in dorsal view; **B-D**, male genitalia in dorsal, ventral and lateral view, respectively. Scale bars: 1 mm. Abbreviations: see Material and methods.

costal area of tegmina with only a few crossveins irregularly situated between branches of Sc. Forewings slightly shorter than hindwings, comb of tegminal Sc with 6-7 branches. Distal half of forewings usually with small darkish spots around crossveins.

Legs. Only inner side of fore tibia with elongate-ovoid tympanum, pitted (Fig. 3A, B). Hind tibiae serrulated, with short and thin spines among subapical spurs, sparser as closer to the apex (os5-os4:3, os4-os3:3, os3-os2:1, os2-os1:0; is6-is5:3, is5-is4:1, is4-is3:1, is3-is2:0, is2-is1:0); with six inner and five outer subapical spurs; three inner and three outer apical spurs, outer spurs short (middle one longer; other two equal in length) and the inner spurs long (superior one longest, inferior one shortest) (Fig. 4A).

Male genitalia. Pseudepiphallic sclerite broadly triangular, slightly concave, without arms; lophi big, separated by a roughly triangular indentation apically, apically bearing two semicircular-like projections and armed with setose. Pseudepiphallic plate inconspicuous between lophi; posterior margin

convex. Pseudepiphallic parameres spindly, more or less concave on inner side. Rami connected to pseudepiphallic sclerite. Ectophallic fold unobtrusive, visible just below the lophi, regularly narrowed toward apex, reaching posterior margin of pseudepiphallic parameres; ectophallic apodemes thick. Ventral valves united as one membranous lobe. Endophallic sclerite evident, more or less V-shaped. No dorsal cavity (Fig. 5B-D).

Female

Similar to male, but slightly larger than male, with distinct dark brown ornament on dorsum (Fig. 2B; 7A).

Ovipositor. Dorsal valvulae blunt at end, possessing three projections on apical margin and an irregularly elevated surface (Fig. 7B, C). Ventral valvulae blade-shaped, apically blunt. Protrusion of its lateral margin short and thick (Fig. 7B, C).

Female genitalia. Copulatory papilla longer than wide, funnel-shaped, with ventral aperture; posterior margin slightly invaginated like “w” form (Fig. 7D-F).

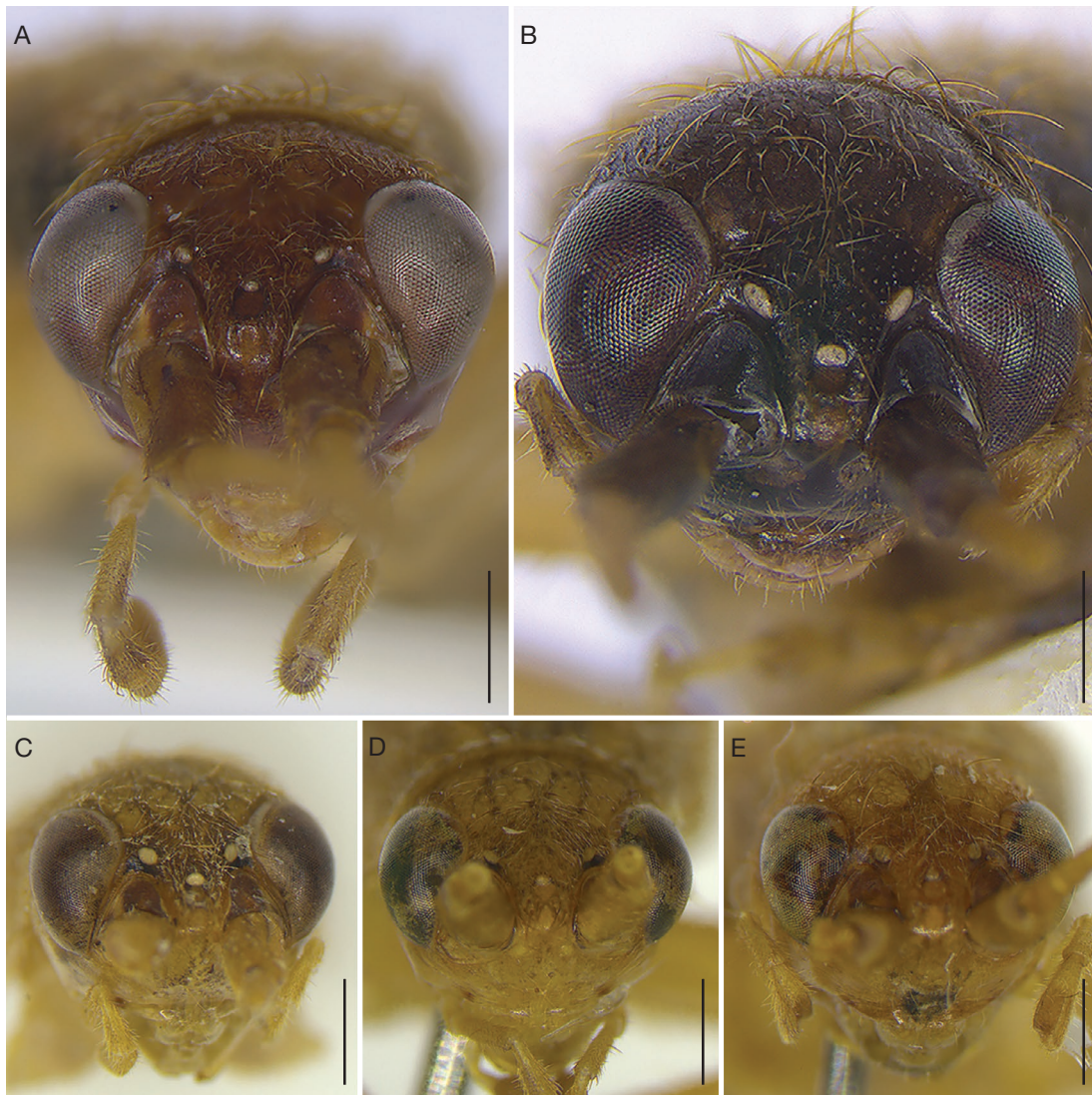


FIG. 6. — *Mistshenkoana* Gorochov, 1990 face in front view: **A**, *M. tianya* He & Wei n. sp. (ECNU-1459); **B**, *M. melanocephala* He & Wei n. sp. (ECNU-4276); **C**, *M. nhachangi* Gorochov, 2007 (ECNU-1372); **D**, *M. kongtumensis* Gorochov, 1990 (ECNU-4304); **E**, *M. gouriatius* Zheng, Xin, Xie & Ma, 2021 (ECNU-2016). Scale bars: 1 mm.

Coloration. Body yellowish brown. Head brown; clypeus and labrum yellowish. Pronotum yellowish brown. Slight darkening around crossveins in distal half of forewings. Darkened bases of spines on hind tibiae. Small darkish spots near spines (Fig. 2A, B; 5A).

Measurements (mm). Holotype • SZ: 16.1; BL: 12.0; PL: 2.0; FWL: 10.3; HFL: 7.6;

Paratypes • 2 ♀: SZ: 16.9-18.9; BL: 12.5-12.9; PL: 1.6-2.1; FWL: 11.1-11.7; HFL: 7.1-7.9; OL: 9.6-10.2.

Mistshenkoana melanocephala He & Wei n. sp.
(Figs 2C, D; 3C, D; 4B; 6B; 8; 9)

[urn:lsid:zoobank.org:act:D35D08E8-88C0-4AC5-9C3C-99E42E634410](https://doi.org/10.21203/rs.3.rs-2888888/v1)

TYPE MATERIAL. — Holotype. China • ♂ (4276); Yunnan Prov., Wenshan Prefecture, Malipo County; 23°13'N, 104°71'E; 10.VII.2021; Zhu-Qing He leg.; ECNU; GenBank: OR033156.

Paratypes. China • 1 ♀ nymph (4353); Guangxi Prov., Baise City, Napo County, Pingmeng Town; 22°95'N, 106°00'E; 8.VII.2021; Zhu-Qing He leg.; ECNU; GenBank: OR033157; OR033158 • 1 ♂ (4354); Guangxi Prov., Baise City, Napo County, Pingmeng Town; 22°95'N, 106°00'E; 8.VII.2021; Zhu-Qing He leg.; ECNU; GenBank: OR033158 • 1 ♀ (1422); Guangdong Prov., Chebaling National Nature Reserve; 24°73'N, 114°27'E; 3.VIII.2018; Zhu-Qing He leg.; ECNU; GenBank: OR033154.

ETYMOLOGY. — Species name *melanocephala* refers to its black head. Chinese name: 黑头纤须蛾.

DIAGNOSIS. — Almost uniform dark brown. Head of the new species dark brown (lower half of head lighter in other species). Hind wings obviously longer than forewings (Fig. 8A), comb of tegminal Sc with 6-7 branches. Darkened bases of spines of hind tibiae (Fig. 4B). This species resembling *M. tianya* He & Wei n. sp. based on genitalia, but pseudepiphallal lophi without projections apically.

DISTRIBUTION. — China (Guangdong, Guangxi, Yunnan).



FIG. 7. — Female morphological features of *Mistshenkoana tianya* He & Wei n. sp. (ECNU-1889): **A**, female body in dorsal view; **B**, **C**, female ovipositor in dorsal and ventral view, respectively; **D**, **E**, female genitalia in dorsal, ventral and lateral view, respectively. Scale bars: **A**, 1 mm; **B**, **C**, 0.5 mm; **D**, **E**, 0.25 mm. Abbreviations: see Material and methods.

DESCRIPTION

Male

Head. Vertex broad and flattened. Head wider than the anterior margin of pronotum; frontal rostrum convex, densely pubescent (Fig. 2C, D). Median ocellus smallest of the three ocelli, ovoid (Fig. 6B); lateral ocelli larger and flatter than middle one, transversely ovoid. Eyes strongly prominent and large, about half head length.

Thorax. Pronotum broad, finely pubescent; posterior margin longer than anterior; anterior margin straight and posterior slightly convex; two eyelike spots of pronotum disc distinct and smooth (Fig. 8A). Longitudinal veins of forewings parallel, costal area of tegmina with only a few crossveins irregularly situated between branches of Sc. Forewings obviously shorter than hindwings, uncovered portion shorter than hind femur, comb of tegminal Sc with 6-7 branches. Distal half of forewings usually with small darkish spots around crossveins.

Legs. Only inner side of fore tibia with elongate-ovoid tympanum, pitted (Fig. 3C, D). Hind tibiae serrulated, with short and thin spines among subapical spurs, sparser as closer to the

apex (os5-os4:3, os4-os3:3, os3-os2:1, os2-os1:0; is6-is5:3, is5-is4:1, is4-is3:1, is3-is2:0, is2-is1:0); with six inner and five outer subapical spurs; three inner and three outer apical spurs, outer spurs short (the middle one longer; the other two equal in length) and the inner spurs long (superior one longest, inferior one shortest) (Fig. 4B).

Male genitalia. Pseudepiphallic sclerite broadly triangular, slightly concave, without arms; lophi big and membranous, separated by a roughly triangular, small indentation and covered with setae apically. Pseudepiphallic plate inconspicuous between lophi; posterior margin convex. Pseudepiphallic parameres spindly, more or less concave on inner side. Rami connected to pseudepiphallic sclerite. Ectophallic fold unobtrusive, visible just below the lophi, regularly narrowed toward apex, reaching posterior margin of pseudepiphallic parameres; ectophallic apodemes thick. Ventral valves united as one membranous lobe. Endophallic sclerite evident, more or less V-shaped. No dorsal cavity (Fig. 8B-D).

Female

Similar to male (Fig. 9A).

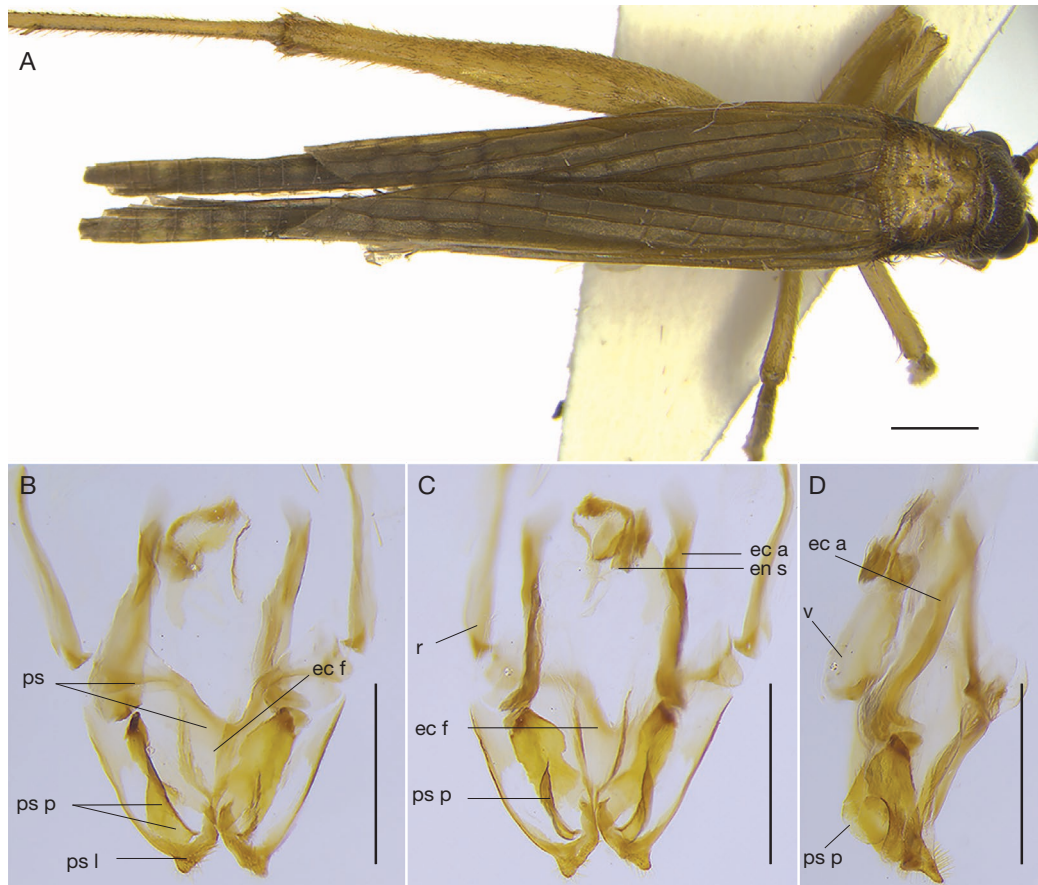


FIG. 8. — Male morphological features of *Mistshenkoana melanocephala* He & Wei n. sp. (ECNU-4276): **A**, male body in dorsal view; **B-D**, male genitalia in dorsal, ventral and lateral view, respectively. Scale bars: 1 mm. Abbreviations: see Material and methods.



FIG. 9. — Female morphological features of *Mistshenkoana melanocephala* He & Wei n. sp. (ECNU-1422): **A**, female body in dorsal view; **B, C**, female ovipositor in dorsal and ventral view, respectively; **D, E, F**, female genitalia in dorsal, ventral and lateral view, respectively. Scale bars: **A**, 1 mm; **B-C**, 0.5 mm; **D-E**, 0.25 mm. Abbreviations: see Material and methods.

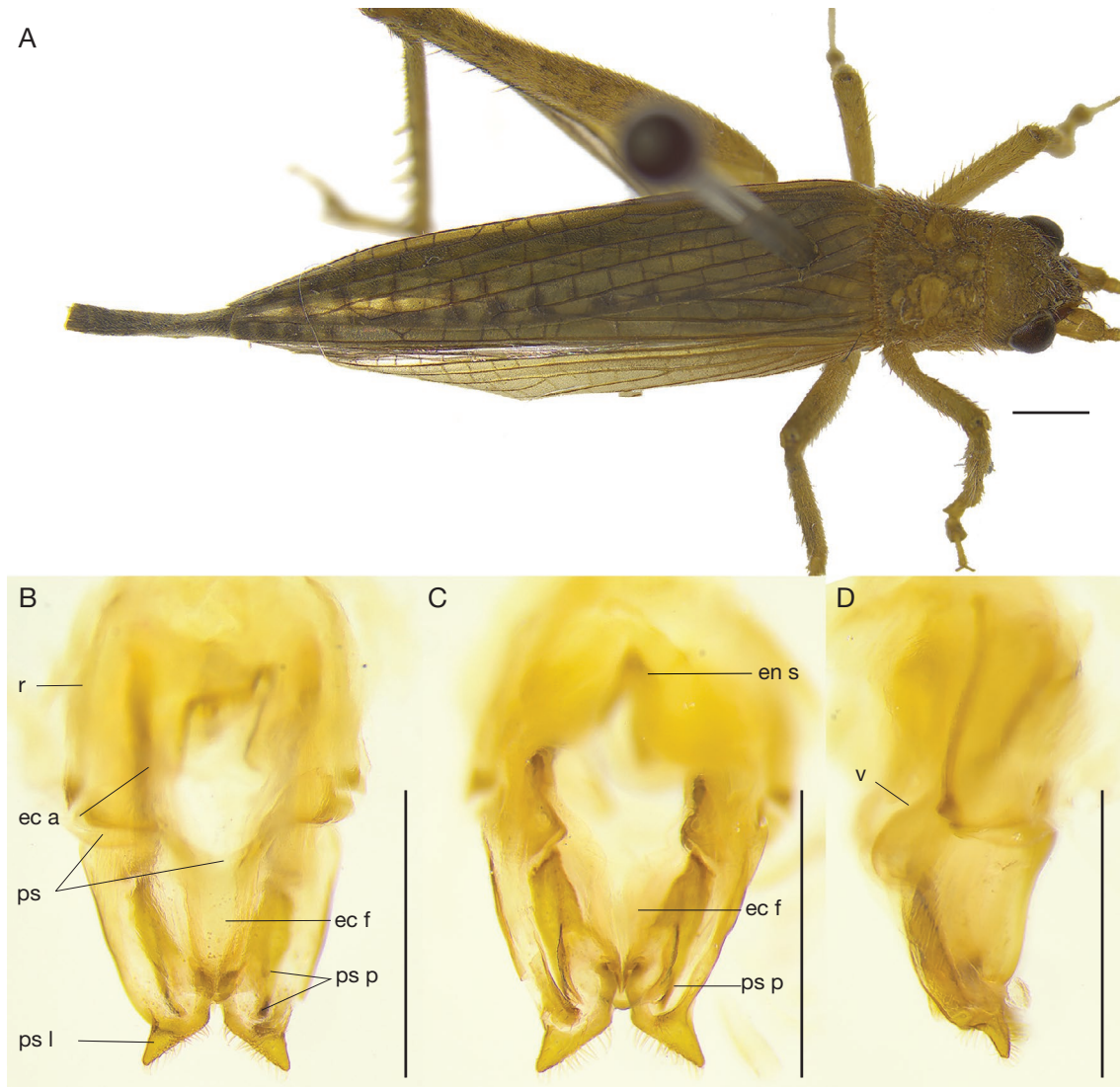


FIG. 10. — Male morphological features of *Mistshenkoana nhachangi* Gorochov, 2007 (ECNU-1372): **A**, male body in dorsal view; **B-D**, male genitalia in dorsal, ventral and lateral view, respectively. Scale bars: 1 mm. Abbreviations: see Material and methods.

Ovipositor. Dorsal valvulae apically blunt, armed with projections on the apical margin and an irregularly elevated surface. Ventral valvulae blunt at the end, apical margin depressed inwards (Fig. 9B, C).

Female genitalia. Copulatory papilla longer than wide, funnel-shaped, with ventral aperture; posterior margin rounded in dorsal and ventral views, acuminate in lateral view (Fig. 9D-F).

Coloration. Body dark brown. Head dark brown; clypeus and labrum dark brown. Pronotum brown. Legs yellowish brown. Slight darkening around crossveins in distal half of forewings. Darkened bases of spines of hind tibiae. Small darkish spots near spines (Fig. 2C, D).

Measurements (mm). Holotype: SZ: 16.3; BL: 10.6; PL: 1.9; FWL: 10.3; HFL: 7.6;

Paratypes: ♂: SZ: 16.5; BL: 11.2; PL: 1.5; FWL: 9.6; HFL: 7.0. ♀: SZ: 19.7; BL: 11.8; PL: 1.9; FWL: 12.1; HFL: 8.9; OL: 9.0.

Mistshenkoana nhachangi Gorochov, 2007
(Figs 2G; 4C; 6C; 10)

Mistshenkoana nhachangi Gorochov, 2007: 260.

MATERIAL. — China • 1 ♂ (1372); Hainan Prov., Changjiang, Baomeiling Provincial Nature Reserve; 19°17'N, 109°05'E; 11.VIII.2018; Zhu-Qing He leg.; ECNU; GenBank: OR033139.

DIAGNOSIS. — Almost uniform light yellowish brown (Figs 2G; 10A). Hindwings distinctly longer than forewings. Comb of tegminal Sc with 8-9 branches. Slight darkenings around majority of crossveins in distal half of tegminal dorsal part. Darkened bases of spines of hind tibiae (Fig. 4C). This species resembling to *M. kongtumensis* in size and shape, but different in ocelli, hind wings and genitalia.



FIG. 11. — Male morphological features of *Mistshenkoana kongtumensis* Gorochov, 1990 (ECNU-4304): **A**, male body in dorsal view; **B**, **D**, male genitalia in dorsal, ventral and lateral view, respectively. Scale bars: 1 mm. Abbreviations: see Material and methods.

Ocelli of this species distinctly larger (Fig. 6C, D); hindwings of this species distinctly longer than forewings, while those of *M. kongtumensis* slightly longer than forewings; genitalia of this species more slender (Fig. 10B-D).

MEASUREMENTS (MM). — ♂ SZ: 13.1; BL: 9.8; PL: 1.8; FWL: 8.5; HFL: 6.3.

DISTRIBUTION. — China (Hainan); Vietnam.

Mistshenkoana kongtumensis Gorochov, 1990
(Figs 2H; 3E, F; 6D; 11; 12)

Mistshenkoana kongtumensis Gorochov, 1990: 20; 2007: 259. — Wu *et al.* 2023: 117.

MATERIAL. — China • 1 ♂ (1405); Zhejiang Prov., Jiande City; 29°48'N, 119°29'E; Zhu-Qing He leg.; ECNU; GenBank: OR033136 • 1 ♀ (2015); Zhejiang Prov., Quzhou City, Kaihua County, Gutian Mountain; 29°25'N, 118°14'E; 8.X.2018; Zhu-Qing He leg.; ECNU; GenBank: OR033137 • 1 ♂ (4304); Guangxi Prov., Fangchenggang City, Dongzhong Town; 21°62'N, 107°54'E; 5.VII.2021; Zhu-Qing He leg.; ECNU; GenBank: OR033152; OR033138.

DIAGNOSIS. — Almost uniform light yellowish brown (Fig. 2H; 11A; 12A). Slight darken around majority of crossveins in distal half of tegminal dorsal part. Small and elongate ocelli (shorter than areas between them) (Fig. 6D). Hind wings slightly longer than forewings. Comb of tegminal Sc with 6-7 branches (Fig. 11A). Male genitalia: pseudepiphallal sclerite without arms, lophi separated by a triangular indentation apically (Fig. 11B-D). Apex of ovipositor drilling with large teeth on hind and ventral surfaces (Fig. 12B, C).

DISTRIBUTION. — China (Guangxi, Yunnan, Zhejiang); Vietnam.

DESCRIPTION

Female genitalia

Copulatory papilla longer than wide; slightly curved downwards in lateral view; anterior half wider than posterior half in dorsal and ventral views; posterior apex rounded (Fig. 12D-F).

Measurements (mm)

♂: SZ: 12.6-12.9; BL: 10.4-10.7; PL: 1.6-1.7; FWL: 7.8-8.3; HFL: 6.0-6.1.

♀: SZ: 16.9; BL: 11.4; PL: 2.0; FWL: 9.8; HFL: 8.9; OL: 6.8.

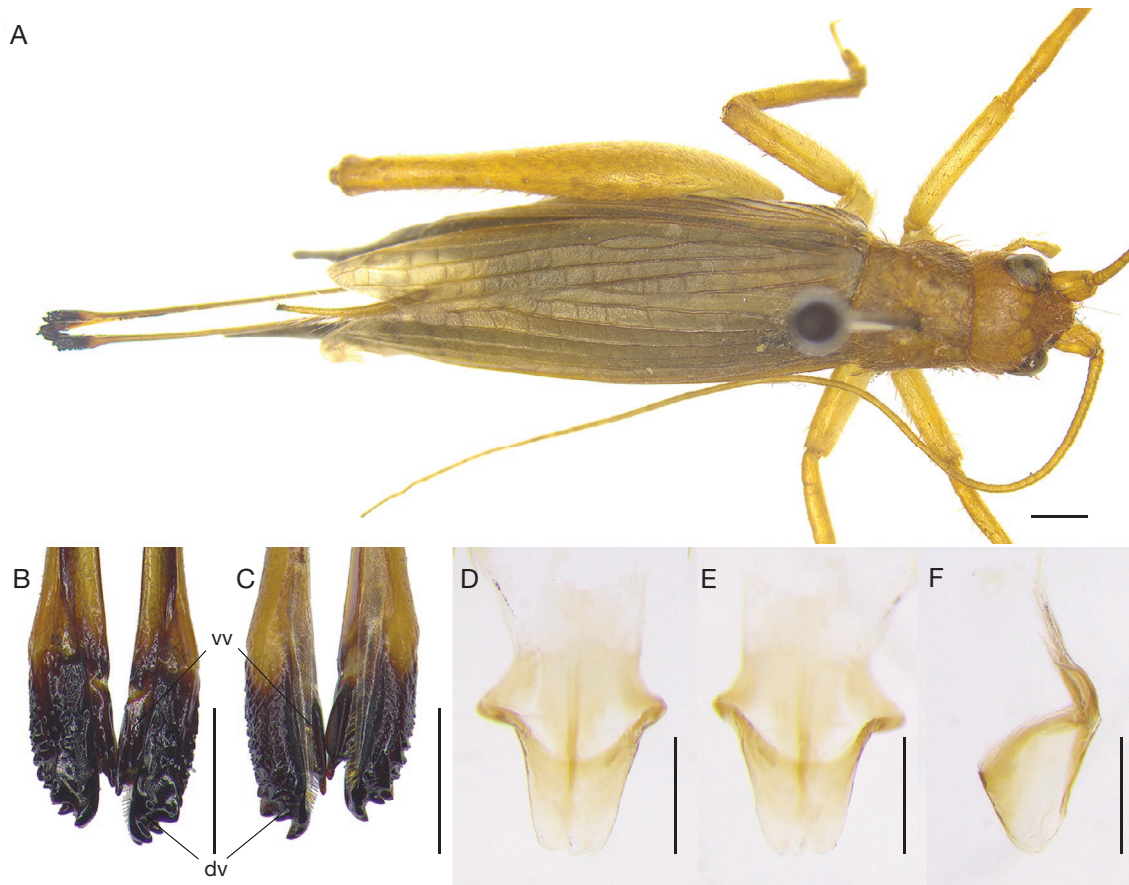


FIG. 12. — Female morphological features of *Mistshenkoana kongtumensis* Gorochov, 1990 (ECNU-2015): **A**, female body in dorsal view; **B, C**, female ovipositor in dorsal and ventral view, respectively; **D, E**, female genitalia in dorsal, ventral and lateral view, respectively. Scale bars: A, 1 mm; B, C, 0.5 mm; D, E, 0.25 mm. Abbreviations: see Material and methods.

Mistshenkoana gouriatius

Zheng, Xin, Xie & Ma, 2021

(Figs 2E, F; 3G, H; 4D; 6E; 13; 14)

Mistshenkoana gouriatius Zheng, Xin, Xie & Ma, 2021: 419.

MATERIAL. — **China** • 1 ♂ (1499); Fujian Prov., Nanping City, Wuyishan City, Wuyishan National Park; 27°67'N, 117°96'E; 7.IV.2018; Zhu-Qing He leg.; ECNU • 2 ♂ (1434, 1435); Zhejiang Prov., Hangzhou City, Lin'an District, Tianmu Mountain; 30°35'N, 119°45'E; 17.VIII.2018; Zhu-Qing He leg.; ECNU; GenBank: OR033141; OR033142 • 1 ♀ (2221); Zhejiang Prov., Hangzhou City, Lin'an District, Tianmu Mountain; 30°35'N, 119°45'E; 6.IX.2019; Zhu-Qing He leg.; ECNU; GenBank: OR033146 • 1 ♀, 1 ♂ (2016, 2017); Zhejiang Prov., Quzhou City, Kaihua County, Gutian Mountain; 29°25'N, 118°14'E; 8.X.2018; Zhu-Qing He leg.; ECNU; GenBank: OR033144; OR033145 • 1 ♀ (2368); Zhejiang Prov., Lishui City, Qingyuan County, Baishanzu Nature Reserve; 27°75'N, 119°20'E; 2.X.2019; Zhu-Qing He leg.; ECNU; GenBank: OR033147 • 1 ♂ and 1 ♀ (2391, 2401); Zhejiang Prov., Wenzhou City, Taishun County, Wuyanling National Nature Reserve; 27°72'N, 119°67'E; 3.X.2019; Zhu-Qing He leg.; ECNU; GenBank: OR033148; OR033149 • 1 ♀ (3810); Guangdong Prov., Shaoguan City, Ruyuan, Babaoshan Management and Protection Station; 24°93'N, 113°03'E; 15.IX.2020; Tao Zhang leg.; ECNU; GenBank: OR033150.

DIAGNOSIS. — Almost uniform light yellowish brown (Fig. 2H; 13A; 14A). Hind wings slightly longer than forewings. Comb of tegminal Sc with 6-7 branches (Fig. 13A). Darkened bases of spines of hind tibiae (Fig. 4D). Male genitalia as in Figure 13B-D. Apex of ovipositor drilling with large teeth on hind and ventral surfaces (Fig. 14B, C). This species resembling *M. kongtumensis* in size and shape, but distinguished by the pronotum and genitalia. In this species, the prosternum is dark at the edges and light in the middle, but that of *M. kongtumensis* is unicolor (Fig. 2E, F, H). Pseudepiphallid lophi of this species bear two semicircular-like projections apically, while that of *M. kongtumensis* do not (Fig. 9B-D; 13B-D).

DISTRIBUTION. — China (Fujian, Guangdong, Guangxi, Hunan, Zhejiang).

DESCRIPTION

Female genitalia

Copulatory papilla longer than wide, funnel-shaped, with ventral aperture; posterior margin wavy in dorsal and ventral views (Fig. 14D-F).

Measurements (mm)

♂: SZ: 11.3-13.6; BL: 12.4-14.3; PL: 1.7-1.9; FWL: 8.3-9.0; HFL: 6.4-7.6;
♀: SZ: 11.3-16.2; BL: 12.7-12.8; PL: 1.5-2.1; FWL: 7.7-10.7; HFL: 6.4-8.0; OL: 6.5-6.6.

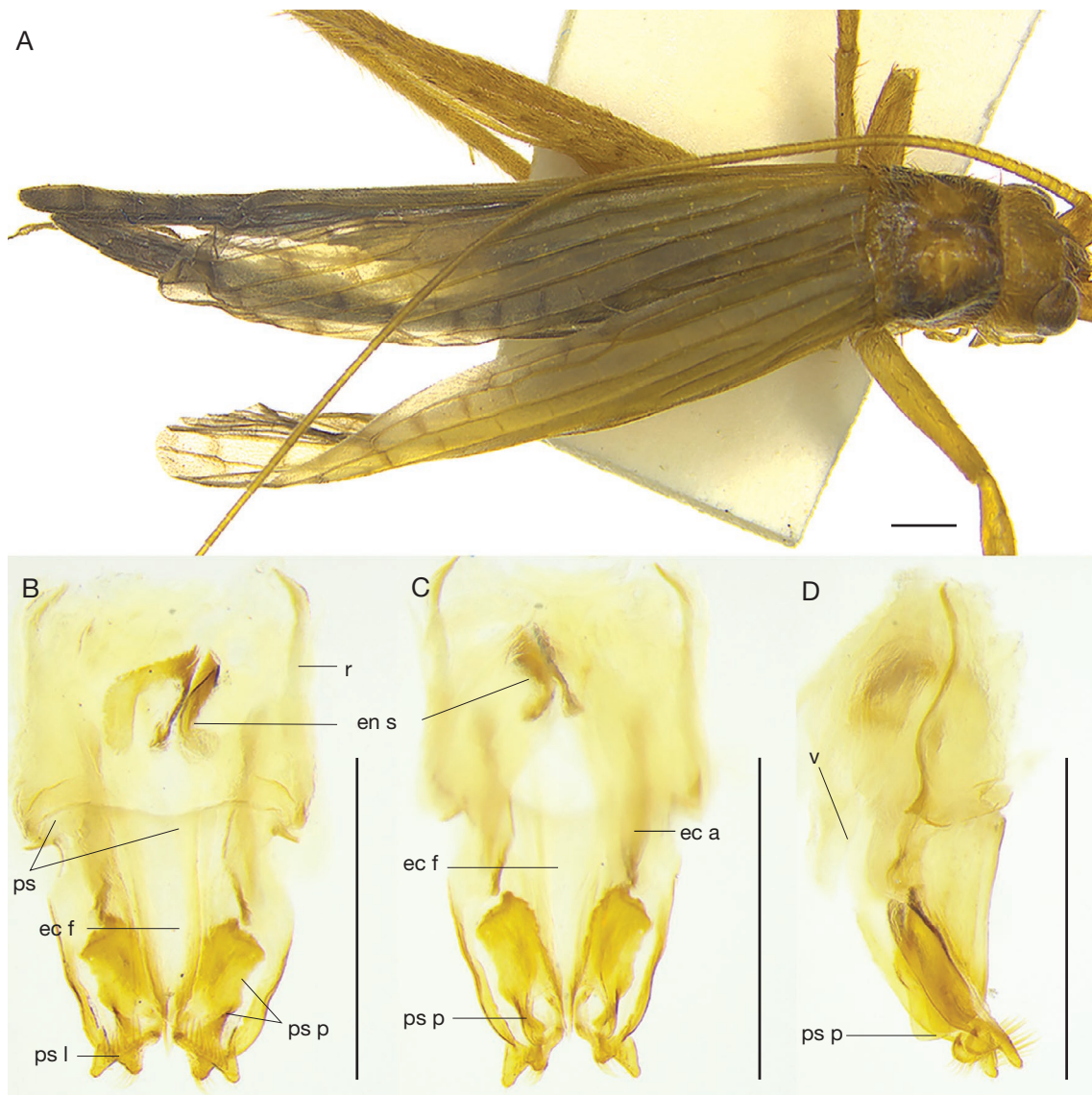


FIG. 13. — Male morphological features of *Mistshenkoana gouriatus* Zheng, Xin, Xie & Ma, 2021 (ECNU-2016): **A**, male body in dorsal view; **B-D**, male genitalia in dorsal, ventral and lateral view, respectively. Scale bars: 1 mm. Abbreviations: see Material and methods.

DISCUSSION

Taxonomic studies on *Mistshenkoana* are very few (Gorochov 1990, 2007, 2008; Tan *et al.* 2021; Zheng *et al.* 2021; Wu *et al.* 2023). Although Gorochov (2007) described many new species from Indo-Malayan, Zheng *et al.* (2021) first reported a new species of *Mistshenkoana* from China only in 2021. In 2023, Wu *et al.* recorded *M. kongtumensis* from China. In this study, we not only describe two new species and provide a new record from China, but also provide fragments of COI gene sequences of all five species mentioned above.

The specimens of *M. gouriatus* described by Zheng *et al.* (2021) are collected from Guangxi and Hunan. In our study, this species is newly reported from Zhejiang, Fujian and Guangdong, which shows that it is widely distributed in China. Another example is *M. kongtumensis*. The holotype of *M. kongtumensis* was collected from Vietnam, however, it is

also distributed as east as Zhejiang. These two samples reflect insufficient surveys of crickets in China, and underestimation of their biological diversity. According to the temperature map (mean temperature of the coldest quarter) (Fig. 15), this genus is mainly distributed in warmer parts of China, thus, we suggest more surveys should be conducted in south China in a future survey.

Mistshenkoana species are similar in morphology. Their male genitalia are also simple in structure and have few usable characteristics for classification. To validate our morphological studies, we sequenced the fragments of COI genes from these species. The molecular results reveal congruences in our morphological classification. Thus, researches are encouraged to provide COI gene sequences when new species are published, which can facilitate identification (Dong *et al.* 2018; Tan *et al.* 2021; Li *et al.* 2021). It is also helpful in matching females in future studies.



FIG. 14. — Female morphological features of *Misthenkoana gouriatus* Zheng, Xin, Xie & Ma, 2021 (ECNU-2221): **A**, female body in dorsal view; **B**, **C**, female ovipositor in dorsal and ventral view, respectively; **D**, **E**, female genitalia in dorsal, ventral and lateral view, respectively. Scale bars: A, 1 mm; B, C, 0.5 mm; D, E, 0.25 mm. Abbreviations: see Material and methods.

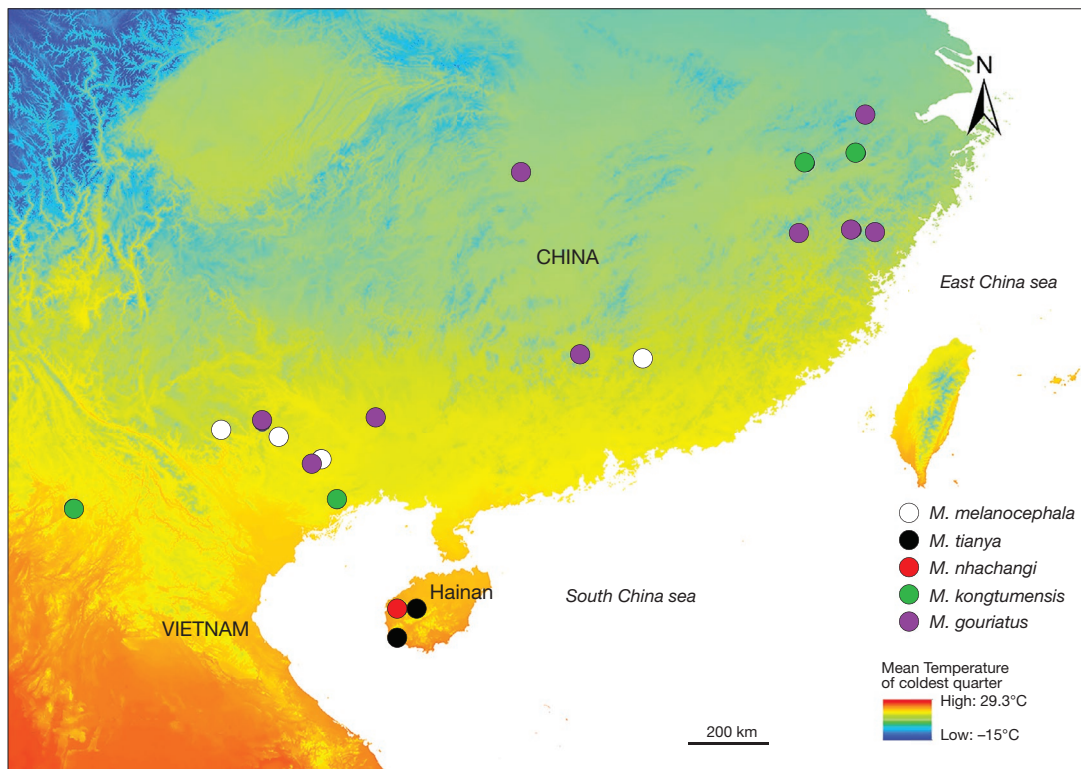


FIG. 15. — Distribution of *Misthenkoana* Gorochov, 1990 species from China.

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