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## Monograph

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# Taxonomic review of *Rhyacobates* Esaki, 1923, with descriptions of three new species (Hemiptera: Heteroptera: Gerridae)

Zhaoqi LENG<sup>1</sup>, Anh Duc TRAN<sup>2</sup> & Zhen YE<sup>3,\*</sup>

<sup>1,3</sup>Institute of Entomology, College of Life Sciences, Nankai University, Tianjin, 300071, China.

<sup>2</sup>Faculty of Biology, VNU University of Science, Vietnam National University, Hanoi, Nguyen Trai, Thanh Xuan, Hanoi, Vietnam.

\* Corresponding author: [yezhen1987331@nankai.edu.cn](mailto:yezhen1987331@nankai.edu.cn)

<sup>1</sup> Email: [zhaoqileng0712@gmail.com](mailto:zhaoqileng0712@gmail.com)

<sup>2</sup> Email: [tran.anhduc@hus.edu.vn](mailto:tran.anhduc@hus.edu.vn)

<sup>1</sup> [urn:lsid:zoobank.org:author:89B546A1-5B53-4C03-9098-FBB36BC9EC85](https://zoobank.org/author/89B546A1-5B53-4C03-9098-FBB36BC9EC85)

<sup>2</sup> [urn:lsid:zoobank.org:author:3CB36F17-D917-4600-B888-C33B1C04259F](https://zoobank.org/author/3CB36F17-D917-4600-B888-C33B1C04259F)

<sup>3</sup> [urn:lsid:zoobank.org:author:B095C7FB-E95B-4D0D-A61F-09B0B223571F](https://zoobank.org/author/B095C7FB-E95B-4D0D-A61F-09B0B223571F)

**Abstract.** The species of *Rhyacobates* Esaki, 1923 are reviewed. Three new species, *R. bui* sp. nov. from Guangxi, China and Lạng Sơn, Vietnam, *R. elongatus* sp. nov. from Hà Tĩnh, Vietnam and *R. turgidus* sp. nov. from Sichuan and Chongqing, China are described. Supplemental descriptions, diagnoses and new distribution records are provided for the fourteen previously known species, i.e., *R. abdominalis* Andersen & Chen, 1995, *R. anderseni* Tran & Yang, 2006, *R. angustus* Tran & Nguyen, 2016, *R. chinensis* Hungerford & Matsuda, 1959, *R. constrictus* Tran & Nguyen, 2016, *R. edentatus* Andersen & Chen, 1995, *R. gongvo* Tran & Yang, 2006, *R. lundbladi* (Hungerford, 1957), *R. malaisei* Andersen & Chen, 1995, *R. recurvus* Andersen & Chen, 1995, *R. scorpio* Andersen & Chen, 1995, *R. svenhedini* (Lundblad, 1934), *R. takahashii* Esaki, 1923, and *R. zetteli* Tran & Nguyen, 2016. Photographs and line drawings of the habitus, diagnostic characteristics of both sexes, the habitat and in-situ photographs are presented. A revised key to the species of *Rhyacobates* is also provided.

**Keywords.** *Rhyacobates*, taxonomy, new species, China, Vietnam.

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## Introduction

Species of the subfamily Ptilomerinae Bianchi, 1896 are small to large-sized (length ca 4–20 mm) semi-aquatic bugs that are highly adapted to life in lotic habitats, including fast-flowing streams and torrents. Ptilomerinae exhibit a disjunct distribution pattern. The monotypic genus *Potamometroides* Hungerford, 1951 is known only from Madagascar and the remaining fifteen genera occur the eastern Palearctic and Oriental regions, extending eastward to New Guinea. Ten ptilomerine genera are found

in Southeast Asia. Among them, *Ptilomera* Amyot & Serville, 1843 and *Rheumatogonus* Kirkaldy, 1909 are the two most widespread genera, with the former extending to New Guinea; *Pleciobates* Esaki, 1930 is distributed mainly in Indochina and peninsular Malaysia; *Andersenius* Zettel & Chen, 1996 and *Pleciogonus* Chen, Nieser & Wattanachaiyingcharoen, 2002 are restricted to central Vietnam and Thailand, respectively; *Ptilomerella* Zettel, 2009 has only been found in southern Thailand and southern Myanmar; *Potamometropsis* Lundblad, 1933 is distributed in Sumatra, Borneo, Sulawesi and Philippines; *Archaeoptilomera* Zettel, 2009 and *Celerobates* Zettel, 2009 are known to occur on Borneo only; and *Floresiobates* Polhemus & Polhemus, 2008 is only known from the island of Flores in the Lesser Sunda Islands of eastern Indonesia (Zettel 1994, 2009; Zettel & Chen 1996; Polhemus & Zettel 1997; Chen *et al.* 2002, 2005; Polhemus & Polhemus 2008). Two genera are distributed in eastern Asia: *Potamometra* Bianchi, 1896, which is endemic to mainland China, and the genus of interest in this paper, *Rhyacobates* Esaki, 1923, which is distributed from Korea and China, south to Indochina (Andersen & Chen 1995; Chen *et al.* 2016).

The genus *Rhyacobates* was established by Esaki (1923), based on the type species *R. takahashii* Esaki, 1923, which was collected from the northern mountains of Taiwan Island. Hungerford & Matsuda (1959) placed *Esakobates* Lundblad, 1934 into the genus *Rhyacobates* and proposed new combinations for two species, *R. svenhedini* (Lundblad, 1934) from Sichuan, China and *R. lundbladi* (Hungerford, 1957) from Zhejiang, China. Hungerford & Matsuda (1959) also described a new species, *R. chinensis* Hungerford & Matsuda, 1959 from Inner Mongolia, China. Andersen & Chen (1995) conducted a cladistic analysis of relationships among the species of *Rhyacobates* and described five new species from China and adjacent countries, including *R. abdominalis* Andersen & Chen, 1995 from Guangdong, China, *R. edentatus* Andersen & Chen, 1995 from Guangdong and Guangxi, China, *R. malaisei* Andersen & Chen, 1995 from Myanmar, Thailand, and Yunnan, China, *R. recurvus* Andersen & Chen, 1995 from Jiangxi, China and *R. scorpio* Andersen & Chen, 1995 from Sichuan, China. Subsequently, four more species, *R. gongvo* Tran & Yang, 2006, *R. angustus* Tran & Nguyen, 2016, *R. constrictus* Tran & Nguyen, 2016 and *R. zetteli* Tran & Nguyen, 2016, all from mountainous areas of northern Vietnam, together with another species, *R. anderseni* Tran & Yang, 2006 from central Vietnam and southern China, were described. Andersen & Chen (1995) questioned the taxonomic status of *Rhyacobates imadatei* Miyamoto, 1967, which is endemic to Borneo, pointing out that this species did not fit the definition of *Rhyacobates*. Afterwards, Zettel (2009) established *Celerobates* Zettel, 2009 to hold *Rhyacobates imadatei*. Thus, prior to the present study, *Rhyacobates* contained fourteen described species.

Based on specimens of *Rhyacobates* that were collected in recent years, the present paper provides a taxonomic review of this genus. Supplemental descriptions and/or diagnoses are given for all previously known species, accompanied by photographs of habitus and diagnostic characters. New distribution data for species of *Rhyacobates* are also provided. Three new species, *R. bui* sp. nov. from Guangxi, China and Lạng Sơn, Vietnam, *R. elongatus* sp. nov. from Hà Tĩnh, Vietnam, and *R. turgidus* sp. nov. from Sichuan and Chongqing, China, are described. A checklist of *Rhyacobates*, a revised key to the species of *Rhyacobates*, in-situ photographs and a distribution map are also provided.

## Material and methods

Dried and alcohol-preserved specimens examined in this study have been deposited in the following museums or collections:

- IZAS = Institute of Zoology, Chinese Academy of Sciences, Beijing, China
- NHMW = Natural History Museum, Vienna, Austria
- NKUM = Institute of Entomology, College of Life Sciences, Nankai University, Tianjin, China
- USNM = United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA

ZRC = Zoological Reference Collection, Lee Kong Chian Natural History Museum, National University of Singapore, Singapore

ZVNU = Zoological Collection of Biological Museum, VNU University of Science, Hanoi, Vietnam

All measurements are given in millimeters (mm). Measurements, observations and dissections were made using a Zeiss Discovery V8 stereo microscope. Male genitalia were macerated in warm 5% potassium hydroxide (KOH) solution. Photographs of male genitalic structures were taken using an OLYMPUS BX53 microscope equipped with a computer-controlled Canon OLYMPUS DP72 digital camera and cellSens Standard software. All photographs except male genitalic structures were taken using a Nikon D500 camera and Nikon Z6 II camera equipped with micro and telephoto lenses. The distribution map was prepared using ArcMap ver. 10.8 software. Morphological terminology mainly follows that of Andersen & Chen (1995).

## Results

### *Taxonomic account*

Class Insecta Linnaeus, 1758  
Order Hemiptera Linnaeus, 1758  
Suborder Heteroptera Latreille, 1810  
Infraorder Gerromorpha Popov, 1917  
Superfamily Gerroidea Leach, 1815  
Family Gerridae Leach, 1815  
Subfamily Ptilomerinae Bianchi, 1896

Genus *Rhyacobates* Esaki, 1923

*Rhyacobates* Esaki, 1923: 387.

*Esakobates* Lundblad, 1934: 22 (syn. Hungerford & Matsuda 1959: 69).

### Type species

*Rhyacobates takahashii* Esaki, 1923.

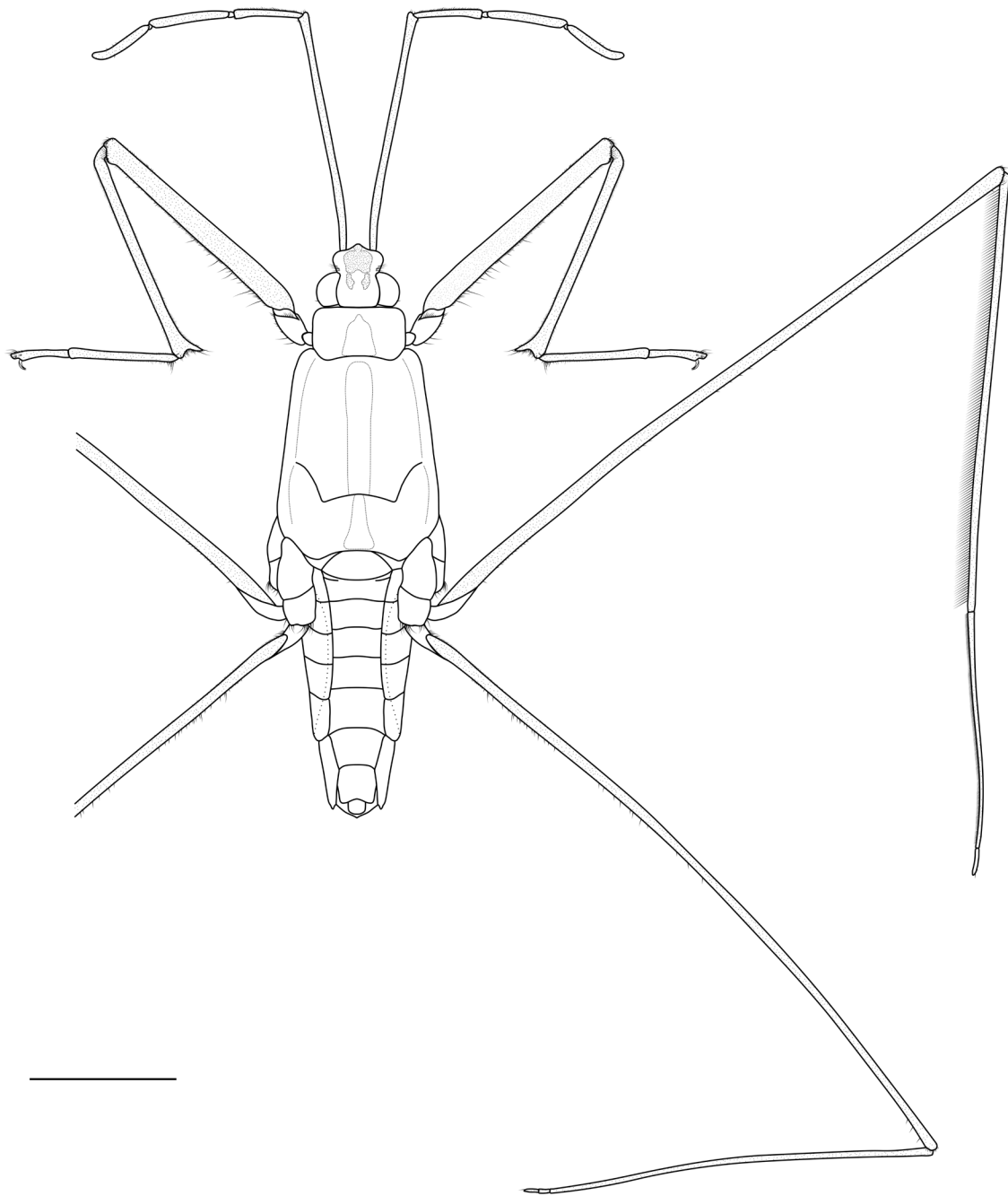
### Diagnosis

Medium-sized (Figs 1–2), females 6.79–12.21, males 5.42–8.41, females distinctly larger than males in the same species (Figs 3–5). Dorsum mainly blackish with silvery pubescence, pronotum with a median yellowish marking (Figs 3–4). Antennal tubercles pronounced, angularly produced in dorsal view; antennal segment I longer than other three segments combined, segment II shorter than segment III, segment IV curved, with whitish groove at distal two-fifths (Figs 1–2). Fore femur slender, subapically without tooth on ventral surface. Middle femur with black spines along proximal three quarters of ventral margin, but usually not in distinct row. Middle coxa without apical spine, not elongate. Middle and hind tarsi without claws (Fig. 1). Female: posterior abdominal segments curved dorsad or nearly straight (Fig. 5); segment VII usually modified, length of sternum VII about twice the length of sternum VI. Female gonocoxa directed caudad, usually completely withdrawn into sternum VII. Male genitalia: pygophore simple, without lateral process; proctiger laterally produced into rounded or angular lobes (Figs 6–7); paramere long and curved dorsad, without long setae (Fig. 8).

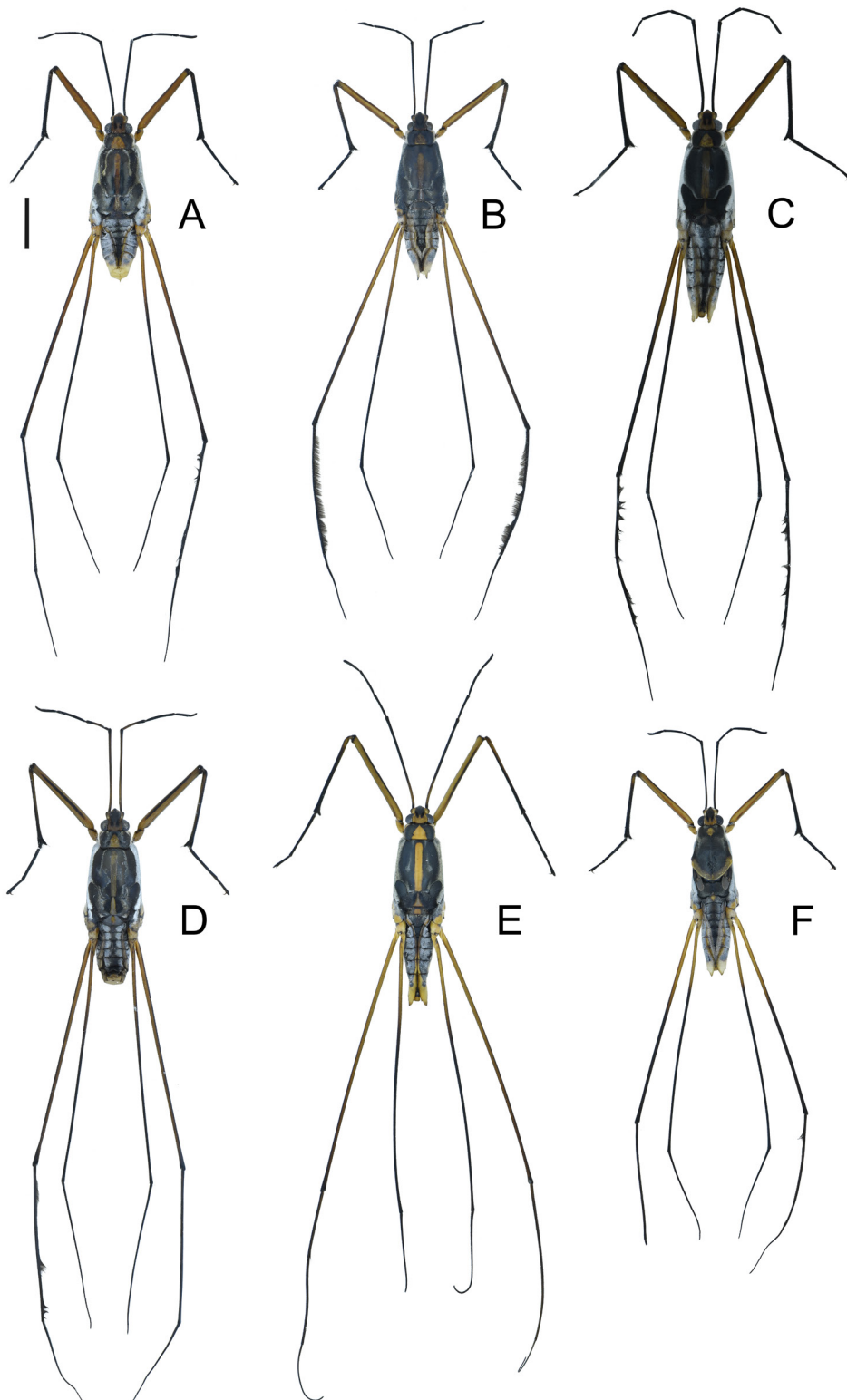
### Comparative notes

The differences between *Rhyacobates* and its closely related genera (i.e., *Heterobates* and *Pleciobates*) were summarized by Andersen & Chen (1995). Three genera described after the study of Andersen & Chen (1995), *Andersenius*, *Pleciogonus* and *Celerobates* are also closely related to *Rhyacobates*.

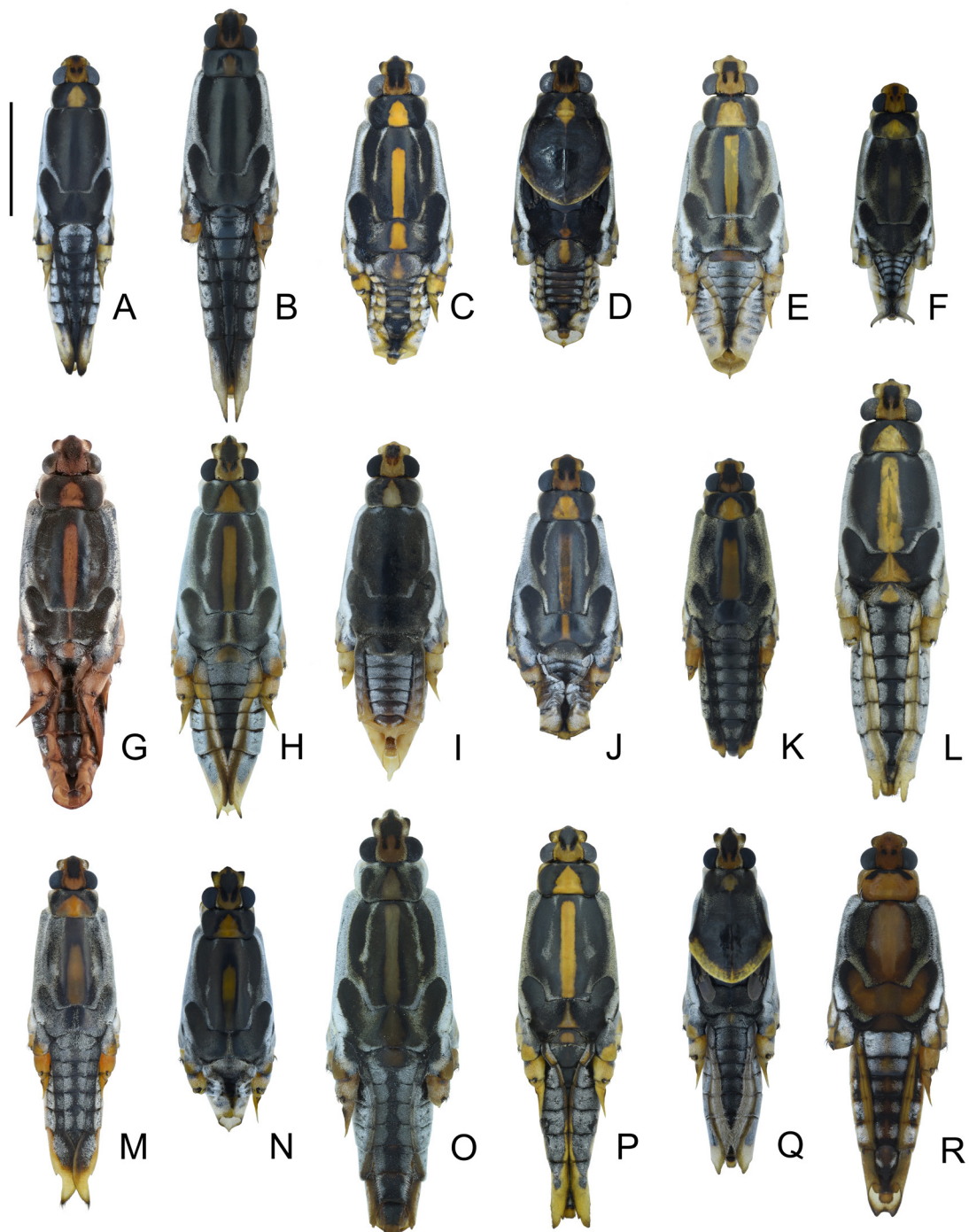
However, *Rhyacobates* can be distinguished from *Andersenius* by the hind coxa, which is shorter than wide in the former. In *Andersenius*, the hind coxa is distinctly longer than wide, i.e., 3.5–4.0 times as long as wide in the female and 1.2–2.0 times as long as wide in the male. *Rhyacobates* can also be distinguished from *Pleciogonus* by connexival segment VI of the female, which is simple, without a long caudal process (Figs 1–2). *Rhyacobates* can be distinguished from *Celerobates* by the absence of distinct claws in the middle and hind tarsi (Fig. 1).



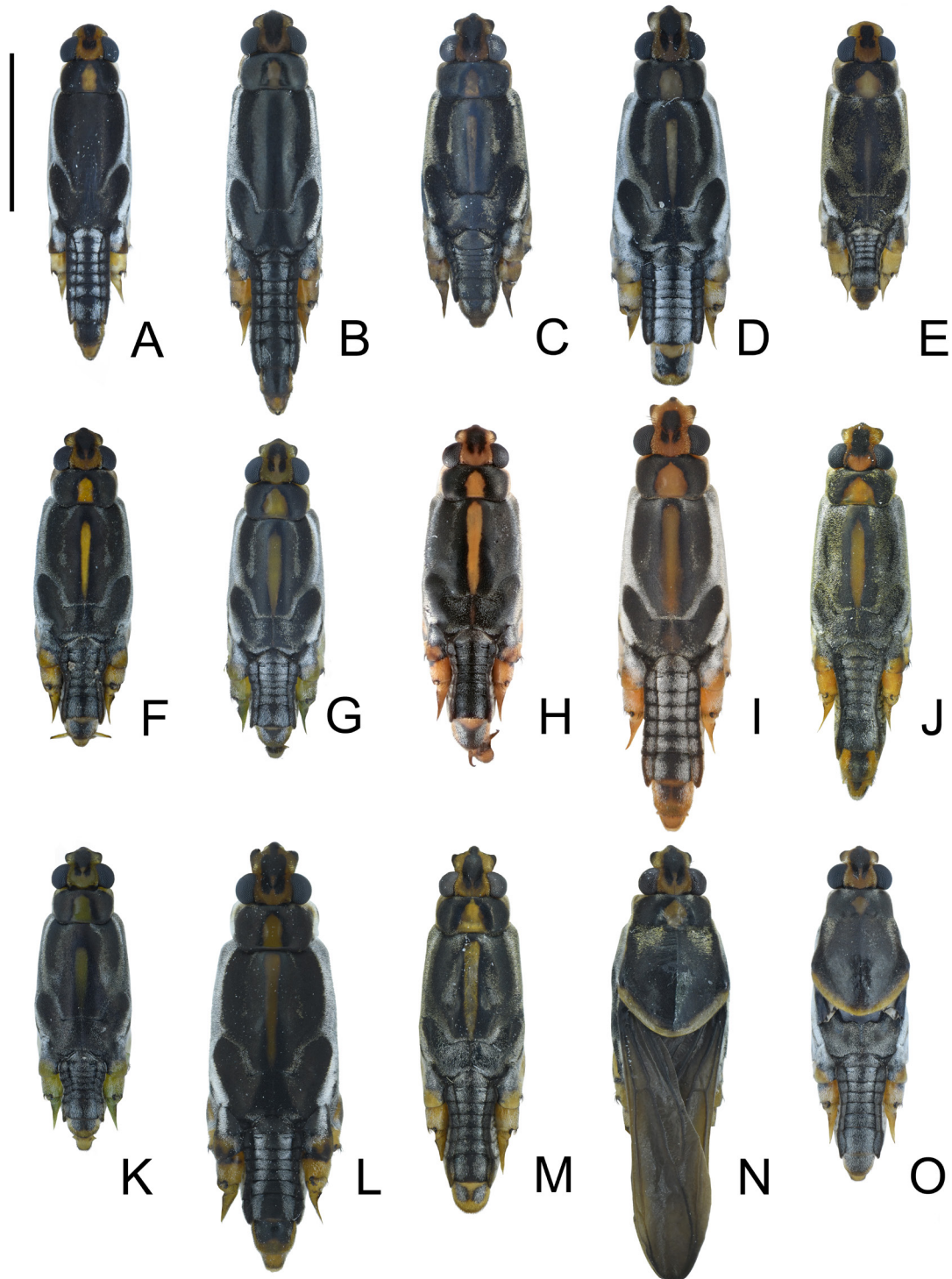
**Fig. 1.** *Rhyacobates scorio* Andersen & Chen, 1995. Apterous female, dorsal habitus. Scale bar = 3 mm.



**Fig. 2.** Habitus of *Rhyacobates* spp. in dorsal view (females), apterous form if not stated otherwise. **A.** *R. abdominalis* Andersen & Chen, 1995. **B.** *R. chinensis* Hungerford & Matsuda, 1959. **C.** *R. lundbladi* (Hungerford, 1957). **D.** *R. scorpio* Andersen & Chen, 1995. **E.** *R. svenhedini* (Lundblad, 1934). **F.** *R. takahashii* Esaki, 1923, dealated macropterous female. Scale bar = 3 mm.



**Fig. 3.** Photographs of bodies of *Rhyacobates* spp. in dorsal view (females), apterous form if not stated otherwise. **A.** *R. bui* sp. nov. **B.** *R. elongatus* sp. nov. **C.** *R. turgidus* sp. nov., apterous form. **D.** *R. turgidus* sp. nov., dealated macropterous form. **E.** *R. abdominalis* Andersen & Chen, 1995. **F.** *R. anderseni* Tran & Yang, 2006. **G.** *R. angustus* Tran & Nguyen, 2016, holotype (ZVNU). **H.** *R. chinensis* Hungerford & Matsuda, 1959. **I.** *R. constrictus* Tran & Nguyen, 2016. **J.** *R. edentatus* Andersen & Chen, 1995. **K.** *R. gongvo* Tran & Yang, 2006. **L.** *R. lundbladi* (Hungerford, 1957). **M.** *R. malaisei* Andersen & Chen, 1995. **N.** *R. recurvus* Andersen & Chen, 1995. **O.** *R. scorpio* Andersen & Chen, 1995. **P.** *R. svenhedini* (Lundblad, 1934). **Q.** *R. takahashii* Esaki, 1923, dealated macropterous form. **R.** *R. zetteli* Tran & Nguyen, 2016. Scale bar = 3 mm.



**Fig. 4.** Photographs of bodies of *Rhyacobates* spp. in dorsal view (males), apterous form if not stated otherwise. **A.** *R. bui* sp. nov. **B.** *R. elongatus* sp. nov. **C.** *R. turgidus* sp. nov. **D.** *R. abdominalis* Andersen & Chen, 1995. **E.** *R. anderseni* Tran & Yang, 2006. **F.** *R. chinensis* Hungerford & Matsuda, 1959. **G.** *R. edentatus* Andersen & Chen, 1995. **H.** *R. gongvo* Tran & Yang, 2006. **I.** *R. lundbladi* (Hungerford, 1957). **J.** *R. malaisei* Andersen & Chen, 1995. **K.** *R. recurvus* Andersen & Chen, 1995. **L.** *R. scorpio* Andersen & Chen, 1995. **M.** *R. svenhedini* (Lundblad, 1934), apterous form. **N.** *R. svenhedini*, macropterous form. **O.** *R. takahashii* Esaki, 1923, dealated macropterous form. Scale bar = 3 mm.

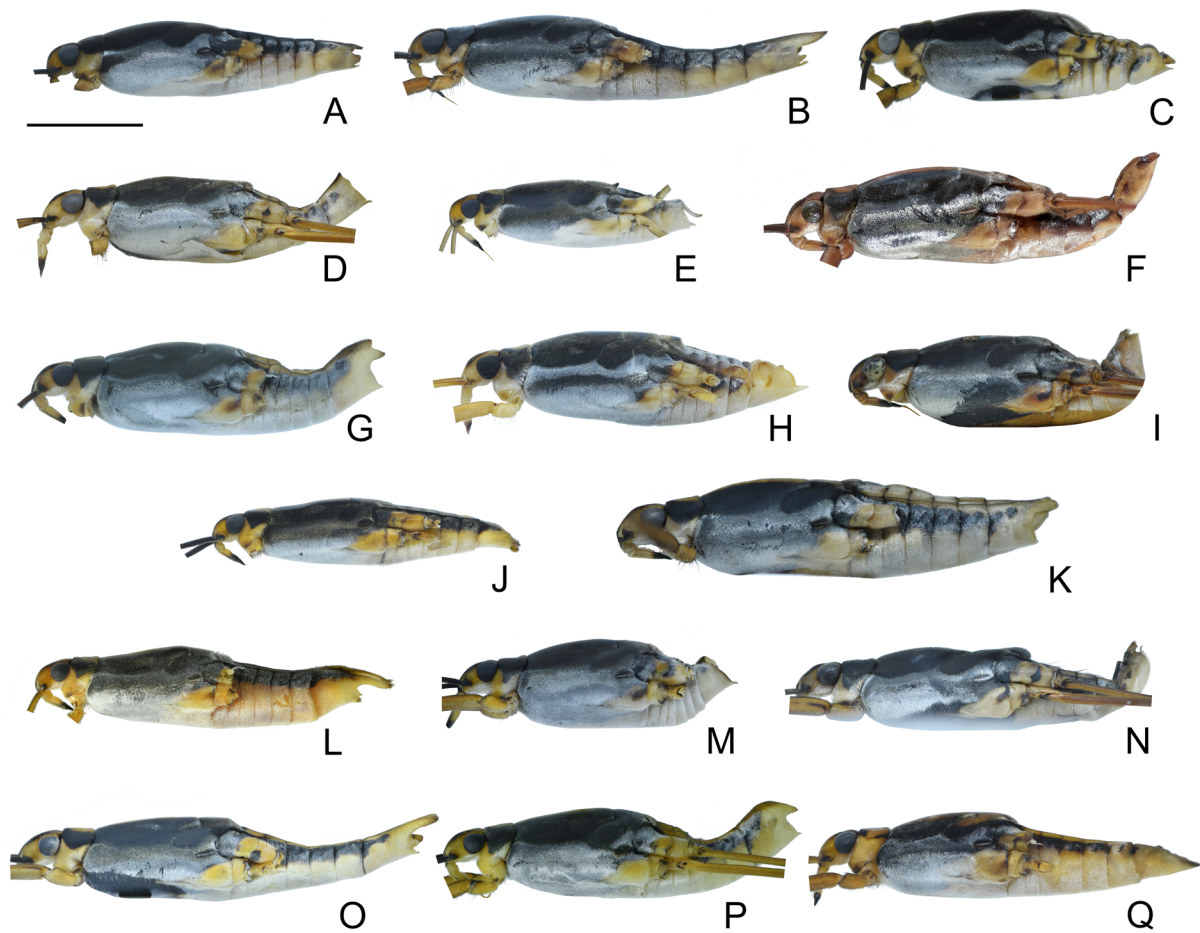
## Distribution

The genus *Rhyacobates* is distributed from eastern Asia (the Korean Peninsula, mainland China, and Taiwan Island) to Indochina (Myanmar, Thailand, and Vietnam) (Fig. 9).

## Biology and ecology

### Habitats

Species of *Rhyacobates* inhabit foot-hill and mountainous streams, rivers and sometimes pools. Most species are found only in running water with relatively cool temperatures (Fig. 10A–C). Elevations of habitats have been recorded from 22 to 2041 m, but mostly between 500 and 1000 m. Streams with emergent rocks in the current are typical habitats of *Rhyacobates*, as the rocks offer necessary resting areas for these skaters (Esaki 1923; Tran & Yang 2006; Tran & Nguyen 2016).



**Fig. 5.** Photographs of bodies of *Rhyacobates* spp. in lateral view (apterous females). **A.** *R. bui* sp. nov. **B.** *R. elongatus* sp. nov. **C.** *R. turgidus* sp. nov. **D.** *R. abdominalis* Andersen & Chen, 1995. **E.** *R. anderseni* Tran & Yang, 2006. **F.** *R. angustus* Tran & Nguyen, 2016, holotype (ZVNU). **G.** *R. chinensis* Hungerford & Matsuda, 1959. **H.** *R. constrictus* Tran & Nguyen, 2016. **I.** *R. edentatus* Andersen & Chen, 1995. **J.** *R. gongvo* Tran & Yang, 2006. **K.** *R. lundbladi* (Hungerford, 1957). **L.** *R. malaisei* Andersen & Chen, 1995. **M.** *R. recurvus* Andersen & Chen, 1995. **N.** *R. scorpio* Andersen & Chen, 1995. **O.** *R. svenhedini* (Lundblad, 1934). **P.** *R. takahashii* Esaki, 1923. **Q.** *R. zetteli* Tran & Nguyen, 2016. Scale bar = 3 mm.



**Living forms**

Usually, most adults found in the populations are the apterous form (Fig. 11A–D). However, in some rare situations, a population may completely consist of macropterous and dealated form, e.g., of *R. chinensis* (Fig. 12B). Tran & Nguyen (2016) reported one macropterous specimen (with dealated wings) of *R. zetteli* inhabiting an unshaded, tiny water flow ca 500 m away from the population in the main stream, indicating that the macropterous form might have good flying ability.



**Fig. 6.** Proctiger of *Rhyacobates* spp. in dorsal view (males). **A.** *R. bui* sp. nov. **B.** *R. elongatus* sp. nov. **C.** *R. turgidus* sp. nov. **D.** *R. abdominalis* Andersen & Chen, 1995. **E.** *R. anderseni* Tran & Yang, 2006. **F.** *R. angustus* Tran & Nguyen, 2016. **G.** *R. chinensis* Hungerford & Matsuda, 1959. **H.** *R. constrictus* Tran & Nguyen, 2016. **I.** *R. edentatus* Andersen & Chen, 1995. Scale bar = 0.2 mm.

### Perching behavior

Although most species of *Rhyacobates* can stride on torrent or fast-running water, they spend plenty of time resting on waterside rocks (Figs 11A–B, E, 12A–C, 13, 14A–D), which was first observed by Esaki (1923). They are very alert and when potential enemies (predators or larger animals) are detected nearby, they will jump into the water and stride irregularly at an extremely fast speed (Fig. 11D). Esaki (1923) hypothesized that this swift gliding may cause disturbance of the water and make the insects unrecognizable to the predators.

### Predatory behavior

Apparently, individuals of *Rhyacobates* access the water surface and stride against the torrent when they are searching for food. We have observed that they can rapidly locate living insects floating nearby. They sometimes jump onto waterside rocks soon after they catch their prey, where they can feed on it undisturbed (Fig. 13).

### Mating behavior

During mating, the male jumps onto the dorsum of a female, ‘hugging’ the female with its fore legs (Figs 12A–D, 13, 14B–C). The entire mating process may happen while skating on the water surface (Fig. 12D) or on waterside rocks (Figs 12A–C, 13, 14B–C). The adults of *Rhyacobates* are often found as copulating pairs; they tend to remain connected even after being captured, seemingly too unwilling



**Fig. 7.** Proctiger of *Rhyacobates* spp. in dorsal view (males). **A.** *R. gongvo* Tran & Yang, 2006. **B.** *R. undbladi* (Hungerford, 1957). **C.** *R. malaisei* Andersen & Chen, 1995. **D.** *R. recurvus* Andersen & Chen, 1995. **E.** *R. scorpio* Andersen & Chen, 1995. **F.** *R. svenhedini* (Lundblad, 1934). **G.** *R. takahashii* Esaki, 1923. **H.** *R. zetteli* Tran & Nguyen, 2016. Scale bar = 0.2 mm.



**Fig. 8.** Paramere of *Rhyacobates* spp. in lateral view. **A.** *R. bui* sp. nov. **B.** *R. elongatus* sp. nov. **C.** *R. turgidus* sp. nov. **D.** *R. abdominalis* Andersen & Chen, 1995. **E.** *R. anderseni* Tran & Yang, 2006. **F.** *R. chinensis* Hungerford & Matsuda, 1959. **G.** *R. edentatus* Andersen & Chen, 1995. **H.** *R. lundbladi* (Hungerford, 1957). **I.** *R. malaisei* Andersen & Chen, 1995. **J.** *R. recurvus* Andersen & Chen, 1995. **K.** *R. scorpio* Andersen & Chen, 1995. **L.** *R. svenhedini* (Lundblad, 1934). **M.** *R. takahashii* Esaki, 1923. Scale bar = 0.2 mm.

to separate from their mates. Abdominal segment VII of the female is elongate and highly modified, and the genital segments are often withdrawn into it (Figs 3, 5). We hypothesize that this structure might help females reject an unwanted mating.

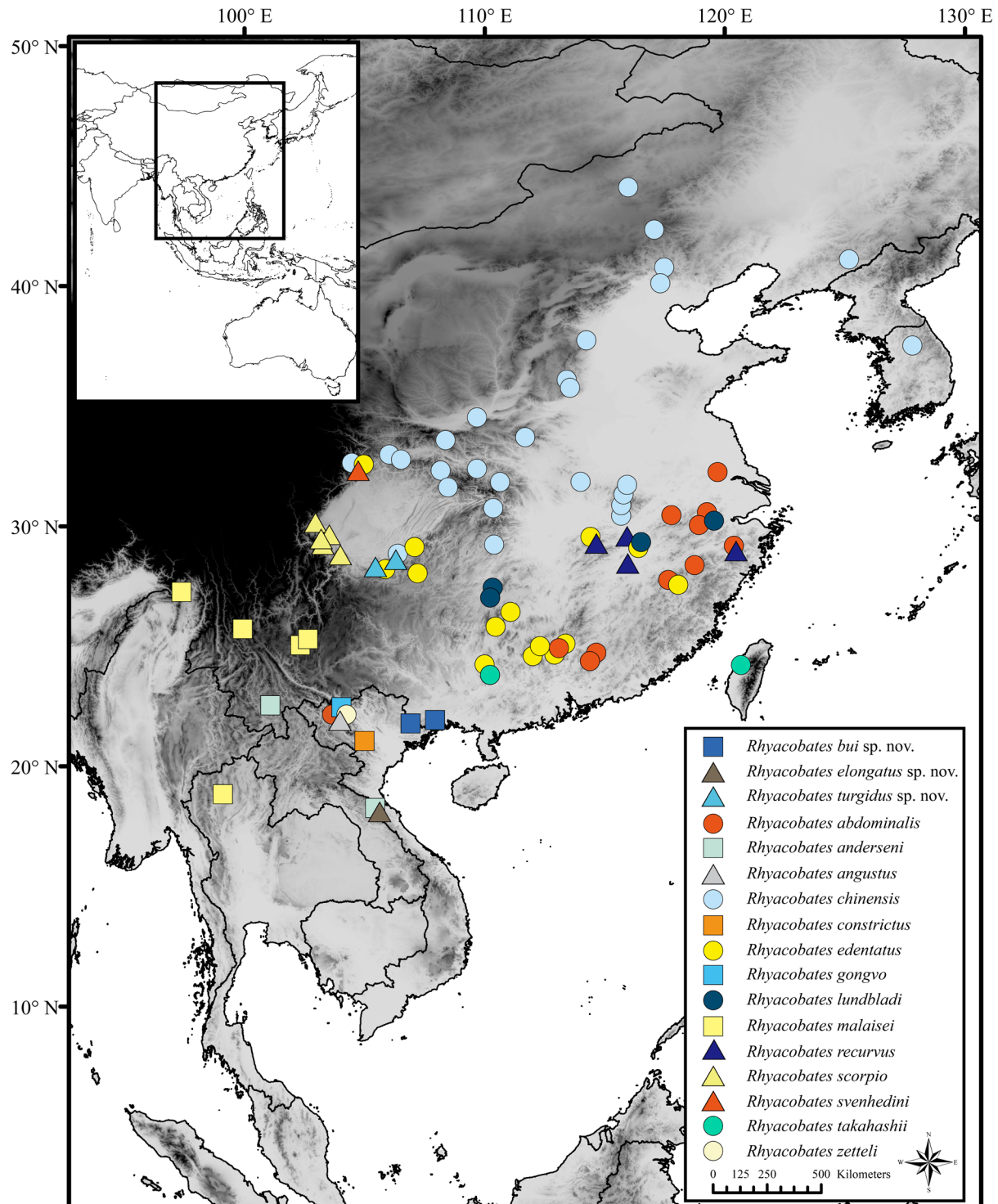
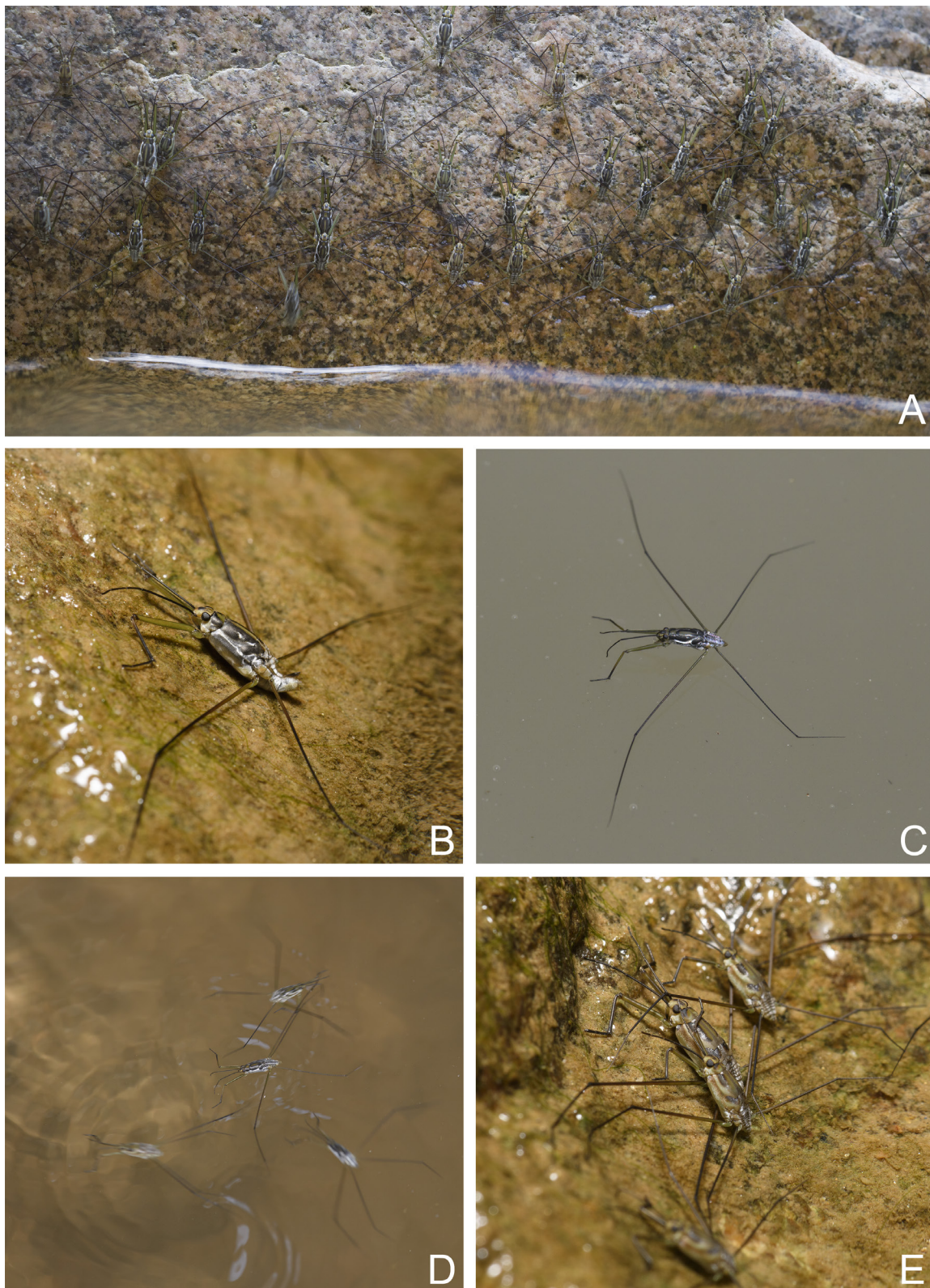


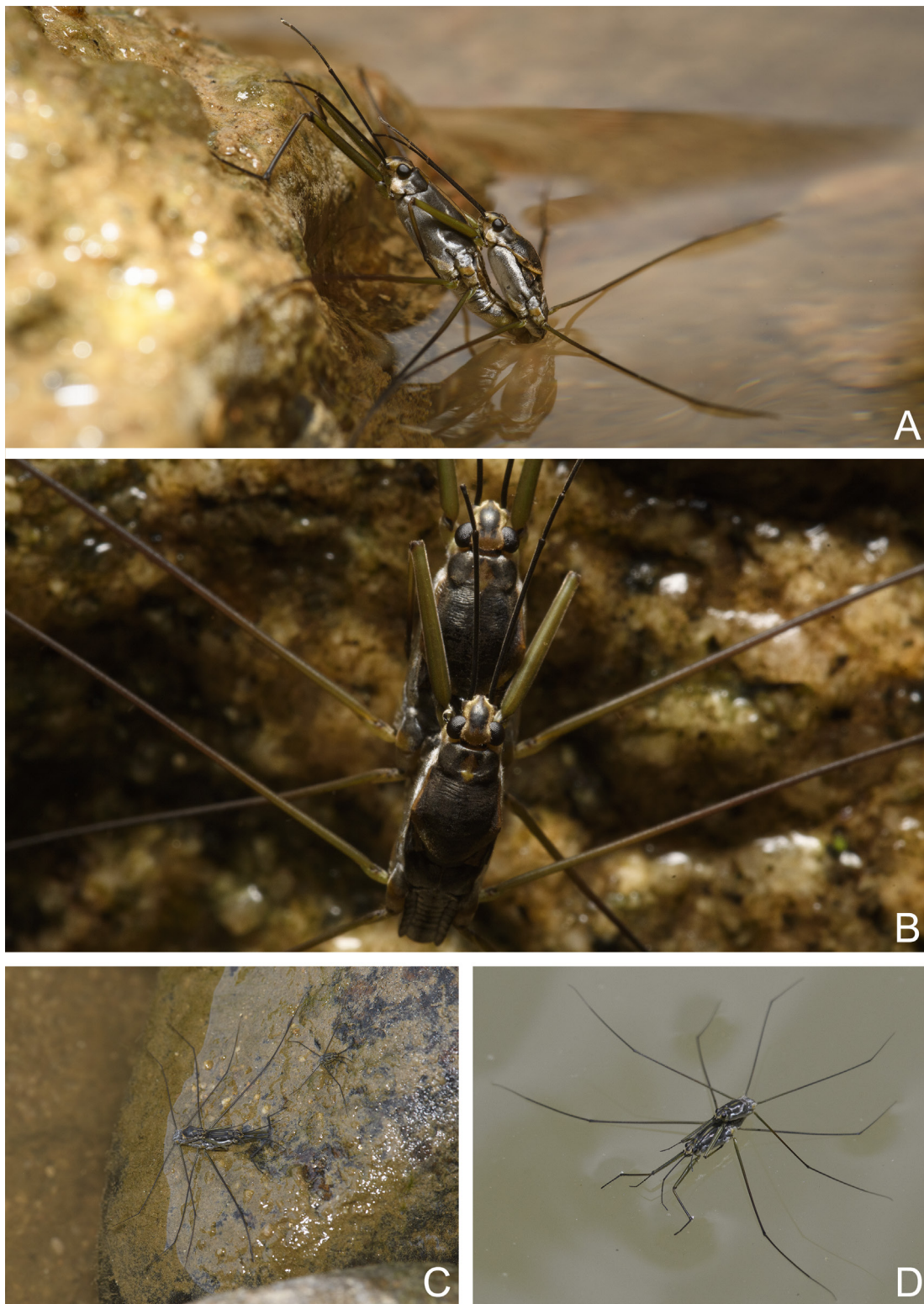
Fig. 9. Distribution map of *Rhyacobates* spp.



**Fig. 10.** Habitat of *Rhyacobates* spp. **A.** Habitat of *R. chinensis* Hungerford & Matsuda, 1959, a muddy mountain stream. **B.** Habitat of *R. chinensis* Hungerford & Matsuda, 1959, a muddy river near the mountain. **C.** Habitat of *R. recurvus* Andersen & Chen, 1995, a mountain stream with emerged rocks.



**Fig. 11.** *Rhyacobates chinensis* Hungerford & Matsuda, 1959, live habitus in situ. **A.** A group of nymphs and adults resting on a riverside rock. **B.** Individual of apterous female resting on rock. **C.** Individual of apterous male striding on the water surface. **D.** A group of nymphs and adults shifting on the water surface when disturbed. **E.** Nymphs resting on rock. Images not to scale.

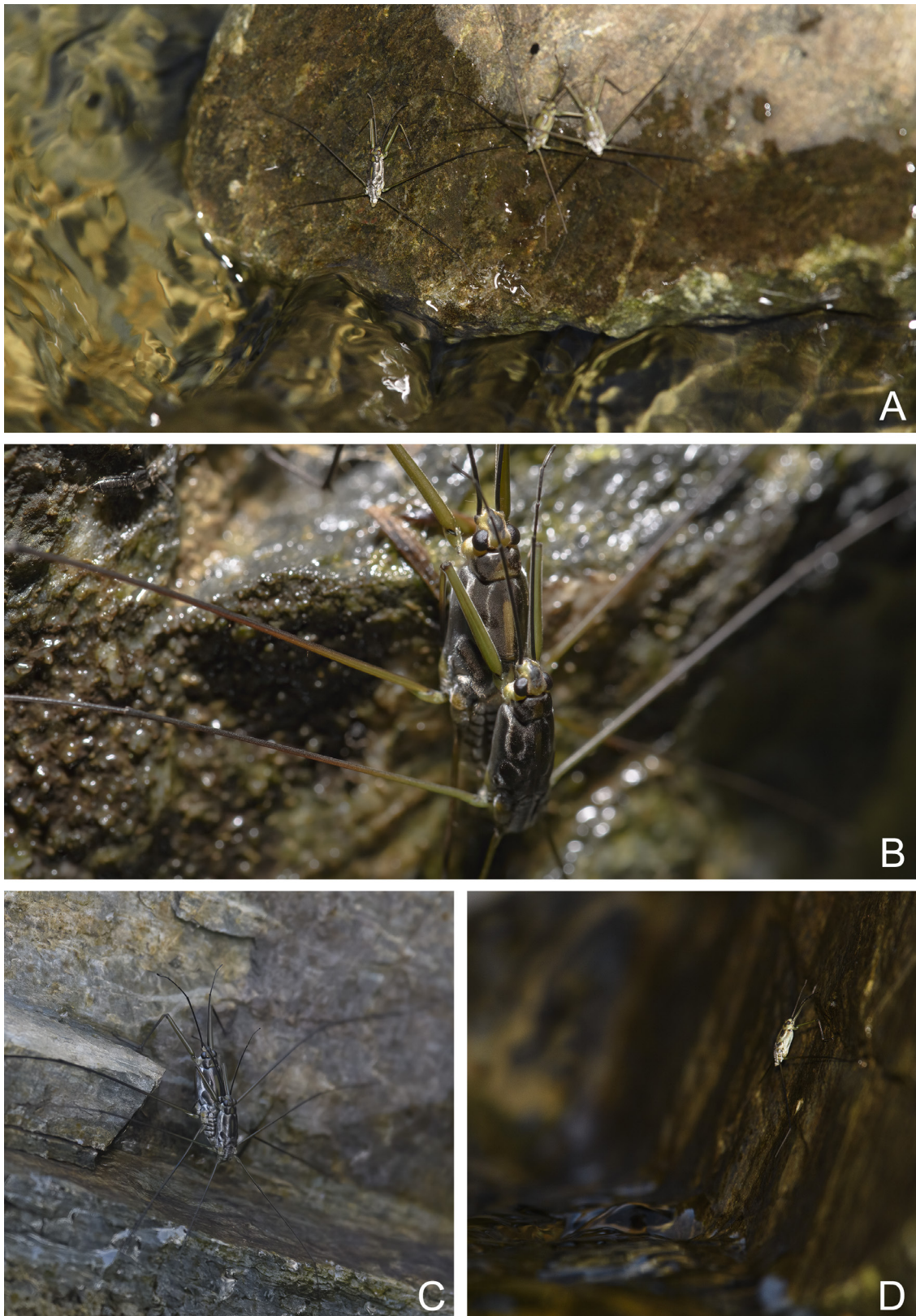


**Fig. 12.** *Rhyacobates chinensis* Hungerford & Matsuda, 1959, in copulation. **A.** Dealated macropterous male mating with apterous female, lateral view. **B.** Dealated macropterous male mating with dealated macropterous female, dorsal view. **C.** Dealated macropterous male mating with apterous female, dorsal view. **D.** Apterous male mating with apterous female on the water surface, dorsal view. Images not to scale.



**Fig. 13.** *Rhyacobates chinensis* Hungerford & Matsuda, 1959, in copulation. Apterous male mating and seizing the dealated macropterous female using its fore leg on a riverside rock, while the female is feeding on its prey.





**Fig. 14.** *Rhyacobates recurvus* Andersen & Chen, 1995, live habitus in situ. **A.** Nymphs and adult resting on a rock over a vortex, dorsal view. **B–C.** Apterous male mating with apterous female on a riverside rock, dorsal view. **D.** A nymph resting on a riverside rock, lateral view. Images not to scale.

*Rhyacobates bui* sp. nov.

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Figs 3A, 4A, 5A, 6A, 8A, 15–16

### Diagnosis

Body length of apterous females 8.81–9.30, of apterous males 6.50–6.91. In both sexes, mesonotum and metanotum completely black, without median yellow stripe (Figs 3A, 4A). Female: posterior margin of mediotergite VII with a distinctly long, slender median process (Fig. 16A, D); posterior margin of abdominal segment VII with five processes, including a blunt process terminating each connexivum, a pair of blunt processes laterally, and a semicircular median process ventrally (Fig. 16D–G). Male: middle trochanter with 3–4 small spines; middle femur with scattered small spines arranged in a row, but with irregular distance between spines (Fig. 16J); length of middle tibia ca 1.6 times length of hind tibia; proctiger laterally with subtrapezoid lobes, dorsally with brownish setae (Figs 6A, 16K); paramere relatively slender, strongly curved at basal third, distal part tapering towards distinctly curved and narrow apex (Figs 8A, 16L).

### Etymology

This species dedicated to Prof. Wenjun Bu (Institute of Entomology, Nankai University, China), in recognition of his contributions to the study of the taxonomy, phylogeny and biogeography of Heteroptera.

### Material examined

#### Holotype (Fig. 15A)

CHINA • ♀ (apterous); Guangxi Province, Fang-cheng-gang City, Shang-si County, Shi-wan-da-shan; 21°54'4.1" N, 107°54'22.1" E; 300–400 m a.s.l.; 13 Aug. 2019; Zhen Ye and Si-qi Wang leg.; NKUM.

#### Paratypes (Fig. 15B)

CHINA • 3 ♂♂ (apterous); same collection data as for holotype; NKUM.

VIETNAM • 10 ♂♂, 3 ♀♀ (apterous); Lạng Sơn Province, Lộc Bình, Mẫu Sơn, upstream of Long Đầu stream; 21°48'59.3" N, 106°59'56.3" E; 7 Nov. 2020; A.D. Tran *et al.* leg.; TAD20-37; ZVNU • 1 ♂, 1 ♀ (apterous); same collection data as for preceding; NHMW • 1 ♂, 1 ♀ (apterous); same collection data as for preceding; NKUM • 2 ♂♂, 2 ♀♀ (apterous); same collection data as for preceding; ZRC.

### Description

#### Apterous female

MEASUREMENTS. Body length 8.81–9.30 (holotype 8.81), width 2.34–2.52 (holotype 2.52), head width 1.41, interocular width 0.75, eye length (dorsal view) 0.62; relative lengths of antennal segments I–IV: 3.34:1.02:1.12:0.71; pronotum: length 0.72, width 1.51; mesonotum: length 2.34, width 2.52 (holotype 2.52); metanotum: length 0.84, width 2.21; abdomen length (ventral view) 4.16; abdominal sternum VII: length 1.16, width 1.15; abdominal mediotergite I: length 0.35, width 0.92; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 3.56:2.84:1.46:0.78, middle leg: 10.01:5.94:2.63:0.44, hind leg: 10.16:3.88:0.11:0.17.

COLORATION. Median black spot of head reduced, indistinctly bifid or dissolved into smaller spots posteriorly (Fig. 3A). Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum completely black, without yellow markings (Figs 3A, 16A). Connexivum dorsally blackish. Venter of female mainly light yellow, except mesosternum and mesopleuron black laterally (Fig. 16B). Abdominal venter light yellow.

**ABDOMEN.** Abdomen relatively long, nearly straight, gradually tapering towards apex (Figs 5A, 16C). Connexiva erect on abdominal segments I–VI, parallel to each other above mediotergites, reflexed over terminal mediotergites (Fig. 16A, D). Abdominal mediotergite I not swollen, fully covered with silvery pubescence (Fig. 3A). Posterior margin of mediotergite VII with a distinctly long median process (Fig. 16A, D), about half the length of mediotergite VII (excluding the process). Abdominal segment VII elongate, nearly as long as three preceding abdominal segments, completely enclosing genital segments. Abdominal dorsal margin not curved in lateral view (Figs 5A, 16C). Posterior margin of abdominal segment VII with five processes, including a blunt process terminating each connexivum, a pair of blunt processes laterally, and a semicircular median process ventrally (Fig. 16D–G).

#### **Apterous male**

**MEASUREMENTS.** Body length 6.50–6.91, width 1.62–1.97. head width 1.21, interocular width 0.52, eye length (dorsal view) 0.54; relative lengths of antennal segments I–IV: 3.11:0.88:0.98:1.08; pronotum: length 0.70, width 1.35; mesonotum: length 1.87, width 1.62; metanotum: length 0.65, width 1.60; abdomen length (ventral view) 2.72; abdominal sternum VII: length 0.38, width 0.52; abdominal mediotergite I: length 0.22, width 0.57; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 3.01:2.34:0.78:0.52, middle leg: 8.88:4.65:2.10:0.38, hind leg: 8.56:2.97:0.11:0.15.

**COLORATION.** Median black spot of head reduced, indistinctly bifid or dissolved in smaller spots posteriorly (Figs 4A, 16H). Pronotum and mesonotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum completely black, without yellow markings (Figs 4A, 16H). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 16I). Abdominal venter light yellow.

**ABDOMEN.** Abdominal mediotergite I not swollen, nearly completely covered by silvery pubescence (Fig. 4A).

**LEG.** Middle trochanter with 3–4 small spines; middle femur with a row of irregularly-spaced small spines (Fig. 16J).

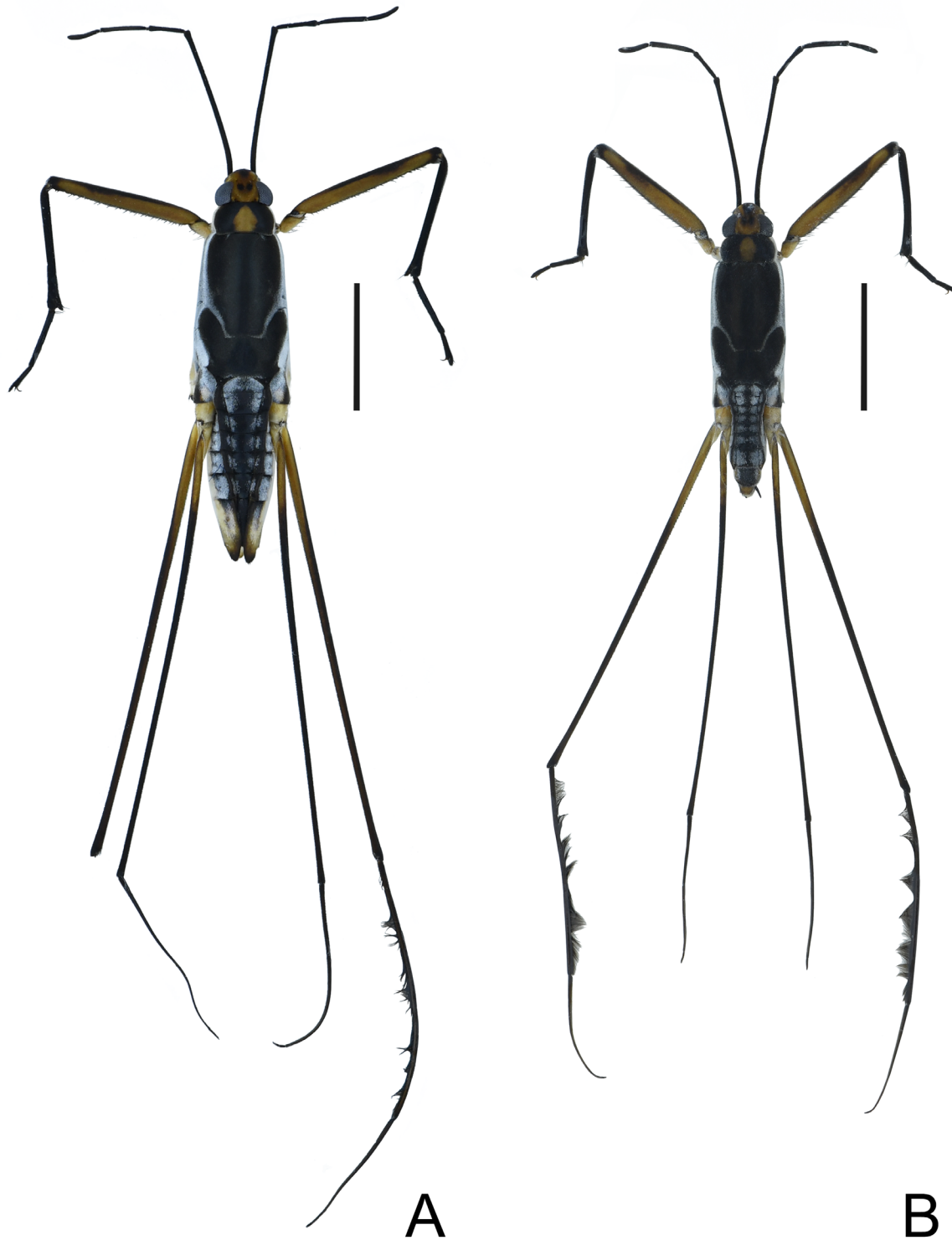
**GENITALIA.** Abdominal segment VIII ventro-laterally depressed. Pygophore large, ovate. Proctiger laterally with subtrapezoid lobes, dorsally with brownish setae (Figs 6A, 16K). Paramere relatively slender, strongly curved basal third, distal part tapering towards distinctly curved and narrowed apex (Figs 8A, 16L).

#### **Distribution**

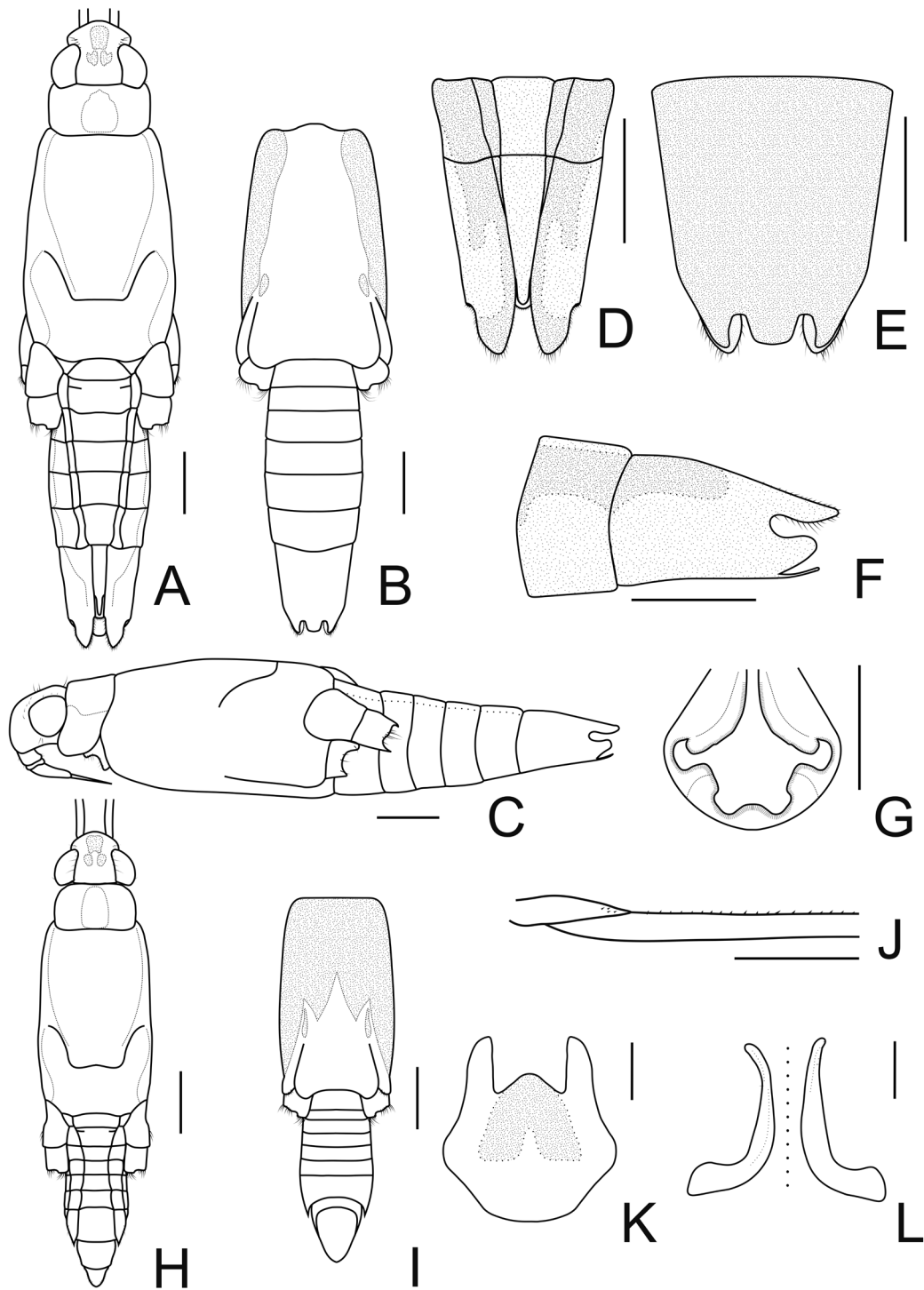
China: Guangxi. Vietnam: Lạng Sơn.

#### **Comparative notes**

This new species is closely related to *R. elongatus* sp. nov. in having an elongate medial process on the posterior margin of mediotergite VII and five processes on abdominal segment VII of the female, including two connexival processes, two lateral blunt processes and a semicircular median process on the ventral side (Figs 16D–F, 18D–F). However, the abdominal mediotergite I of *R. bui* sp. nov. is fully covered with silvery pubescence, which is much denser than in *R. elongatus* (Fig. 3A–B). The connexival processes of abdominal segment VII of *R. bui* are much shorter and blunter (Fig. 16D) than those of *R. elongatus* (Fig. 18D). The abdomen of the female of *R. bui* is almost straight (Fig. 16C), whereas that of *R. elongatus* is curved dorsad in the caudal part (Fig. 18C). These two species are also related to five species (i.e., *R. angustus*, *R. lundbladi*, *R. svenhedini*, *R. takahashii*, and *R. zetteli*) in having the median process on the posterior margin of mediotergite VII in the female, but this structure in *R. bui* and



**Fig. 15.** Habitus of *Rhyacobates bui* sp. nov., dorsal view. **A.** Holotype, apterous female (NKUM). **B.** Paratype, apterous male (NKUM). Scale bar = 3 mm.



**Fig. 16.** Morphological features of *Rhyacobates bui* sp. nov. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, dorsal view. **E.** Abdominal end of female, ventral view. **F.** Abdominal end of female, lateral view. **G.** Abdominal end of female, distal view. **H.** Body of male, dorsal view. **I.** Body of male, excluding head and prothorax, ventral view. **J.** Basal part of right middle leg of male, ventral view. **K.** Proctiger of male, dorsal view. **L.** Left paramere, lateral aspect, two different views. Scale bars: A–J = 1 mm; K–L = 0.2 mm.

*R. elongatus* is much longer than that of the five latter species. Furthermore, both *R. bui* and *R. elongatus* have entirely black mesonota and metanota (Figs 3A–B, 4A–B), without yellow stripes (in both sexes), which is a character state shared with *R. constrictus*. Females of *R. bui* and *R. elongatus* can be easily separated from *R. constrictus* by the following characteristics: (1) *R. bui* and *R. elongatus* have slender bodies (Fig. 3A–B), whereas *R. constrictus* has a wider, stouter body (Fig. 3I); (2) the posterior margin of mediotergite VII of *R. bui* and *R. elongatus* has a median process (Figs 16A, D, 18A, D), whereas that of *R. constrictus* lacks a median process (Figs 3I, 26B); (3) the posterior margin of abdominal segment VII of *R. bui* and *R. elongatus* has five processes (Figs 16D–F, 18D–F), whereas that of *R. constrictus* has only one median process ventrally (Fig. 26A–B; also see Tran & Nguyen 2016: figs 36–39).

***Rhyacobates elongatus* sp. nov.**

[urn:lsid:zoobank.org:act:34F2BA54-0EE7-4FF0-BE46-11B774AB7BE9](https://zoobank.org/act:34F2BA54-0EE7-4FF0-BE46-11B774AB7BE9)

Figs 3B, 4B, 5B, 6B, 8B, 17–18

**Diagnosis**

Body length of apterous females 11.25–11.88, of apterous males 7.70–8.00. In both sexes, mesonotum and metanotum completely black, without median yellow stripe (Figs 3B, 4B). Female: posterior margin of mediotergite VII with a distinctly long median process (Fig. 18A, D); posterior margin of abdominal segment VII with five processes, including an elongate, tapering process terminating each connexivum, a pair of blunt processes laterally, and a semicircular median process ventrally (Fig. 18D–F). Male: middle trochanter with 4–5 small spines on distal part; middle femur with small spines along its length, with irregular distances between spines (Fig. 18I); length of middle tibia ca 1.4 times length of hind tibia; proctiger laterally with broadly rounded lobes (Figs 6B, 18J); paramere relatively stout, curved at basal fourth, distal part tapering towards slightly curved and rounded apex (Figs 8B, 18K).

**Etymology**

The name *elongatus* refers to the pair of elongate connexival processes of sternum VII and also to the elongate medial process on posterior margin of mediotergite VII of the female (Figs 2B, 18A, D–F).

**Material examined**

**Holotype** (Fig. 17A–B)

VIETNAM • ♀ (apterous); Hà Tĩnh Province, Vũ Quang National Park, Khe Nam Châm stream, site #2, downstream; 18°17'20.7" N, 105°21'38.5" E; 21 Apr. 2022; A.D. Tran *et al.* leg.; TAD2209; ZVNU.

**Paratypes** (Fig. 17C)

VIETNAM • 4 ♂♂, 6 ♀♀ (apterous), 7 ♂♂, 1 ♀ (macropterous); same collection data as for holotype; ZVNU • 1 ♂, 1 ♀ (apterous); same collection data as for holotype; NKUM • 2 ♂♂, 2 ♀♀ (apterous), 1 ♂ (macropterous); same collection data as for holotype; ZRC • 4 ♂♂, 1 ♀ (apterous); Hà Tĩnh Province, Vũ Quang National Park, Khe Nam Châm stream, site #1, upstream; 18°17'31.5" N, 105°21'18.7" E; 21 Apr. 2022; A.D. Tran *et al.* leg.; TAD2208; ZVNU • 1 ♂, 1 ♀ (apterous); same collection data as for preceding; NHMW.

**Description**

**Apterous female**

MEASUREMENTS. Body length 11.25–11.88 (holotype 11.38), width 2.67–2.97 (holotype 2.43), head width 1.46, interocular width 0.62, eye length (dorsal view) 0.68; relative lengths of antennal segments I–IV: 4.20 : 1.17 : 1.26 : 0.92; pronotum: length 0.82, width 1.57; mesonotum: length 2.72, width 2.43; metanotum: length 0.92, width 2.55; abdomen length (ventral view) 4.95; abdominal sternum VII: length 1.58, width 1.26; abdominal mediotergite I: length 0.36, width 1.12; relative lengths of leg

segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.40 : 3.60 : 2.15 : 0.90, middle leg: 11.88 : 6.40 : 3.28 : 0.41, hind leg: 11.88 : 4.75 : 0.12 : 0.17.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum completely black, without yellow markings (Figs 3B, 18A). Connexivum dorsally blackish. Venter of female mainly light yellow, except mesosternum and mesopleuron black antero-laterally (Fig. 18B). Metasternum and abdominal venter light yellow.

**ABDOMEN.** Abdomen relatively long, caudal part moderately curved dorsad (Figs 5B, 18C). Connexiva erect on abdominal segments I–VI, parallel to each other above mediotergites, reflexed over terminal terga (Figs 5B, 17A, 18C). Abdominal mediotergite I not swollen, with sparse silvery pubescence laterally (Fig. 3B). Abdominal segment VII elongate, in lateral view nearly as long as three preceding abdominal segments, completely enclosing genital segments; ventral length of sternum VII nearly as long as two preceding sterna. Abdominal connexiva convergent towards abdominal apex (Figs 17B, 18A, D). Posterior margin of abdominal segment VII with five processes, including an elongate, tapering process terminating each connexivum, a pair of blunt processes laterally, and a semicircular median process ventrally (Fig. 18D–F).

#### **Macropterous female**

Similar to apterous female in general structure and coloration with following exceptions: pronotal lobe covering most of mesonotum; posterior margin of pronotal lobe broadly rounded and slightly lighter colored (dark-yellowish).

**MEASUREMENTS.** Body length 10.81, width 2.53, head width 1.44, interocular width 0.59, eye length (dorsal view) 0.65; relative lengths of antennal segments I–IV: 4.10 : 1.08 : 1.19 : 0.94; pronotum: length 3.23, width 2.38; mesonotum width 2.53; metanotum: length 0.67, width 2.59; length of fore wing: 7.65; abdomen length (ventral view) 4.70; abdominal sternum VII: length 1.50, width 1.17; abdominal mediotergite I: length 0.35, width 1.08; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.20 : 3.40 : 2.03 : 0.90, middle leg: 11.88 : 6.19 : 3.20 : 0.44, hind leg: 11.88 : 4.95 : 0.14 : 0.21.

#### **Apterous male**

**MEASUREMENTS.** Body length 7.70–8.00, width 2.08–2.22, head width 1.33, interocular width 0.54, eye length (dorsal view) 0.59; relative lengths of antennal segments I–IV: 3.78 : 1.10 : 1.26 : 0.92; pronotum: length 0.72, width 1.35; mesonotum: length 2.25, width 1.94; metanotum: length 0.73, width 1.98; abdomen length (ventral view) 3.30; abdominal sternum VII: length 0.36, width 1.12; abdominal mediotergite I: length 0.25, width 0.72; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.13 : 3.15 : 1.26 : 0.72, middle leg: 11.38 : 5.56 : 2.75 : 0.41, hind leg: 11.44 : 3.93 : 0.13 : 0.16.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum and mesonotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum completely black, without yellow markings (Figs 4B, 17C, 18G). Connexivum dorsally blackish. Mesosternum blackish with thin yellow median stripe on anterior two-thirds and light yellow posterior third (Fig. 18H). Metasternum and abdominal venter light yellow.

**LEG.** Middle trochanter with 4–5 small spines on distal part; middle femur with small spines scattered along its length, not forming a distinct row (Fig. 18I).

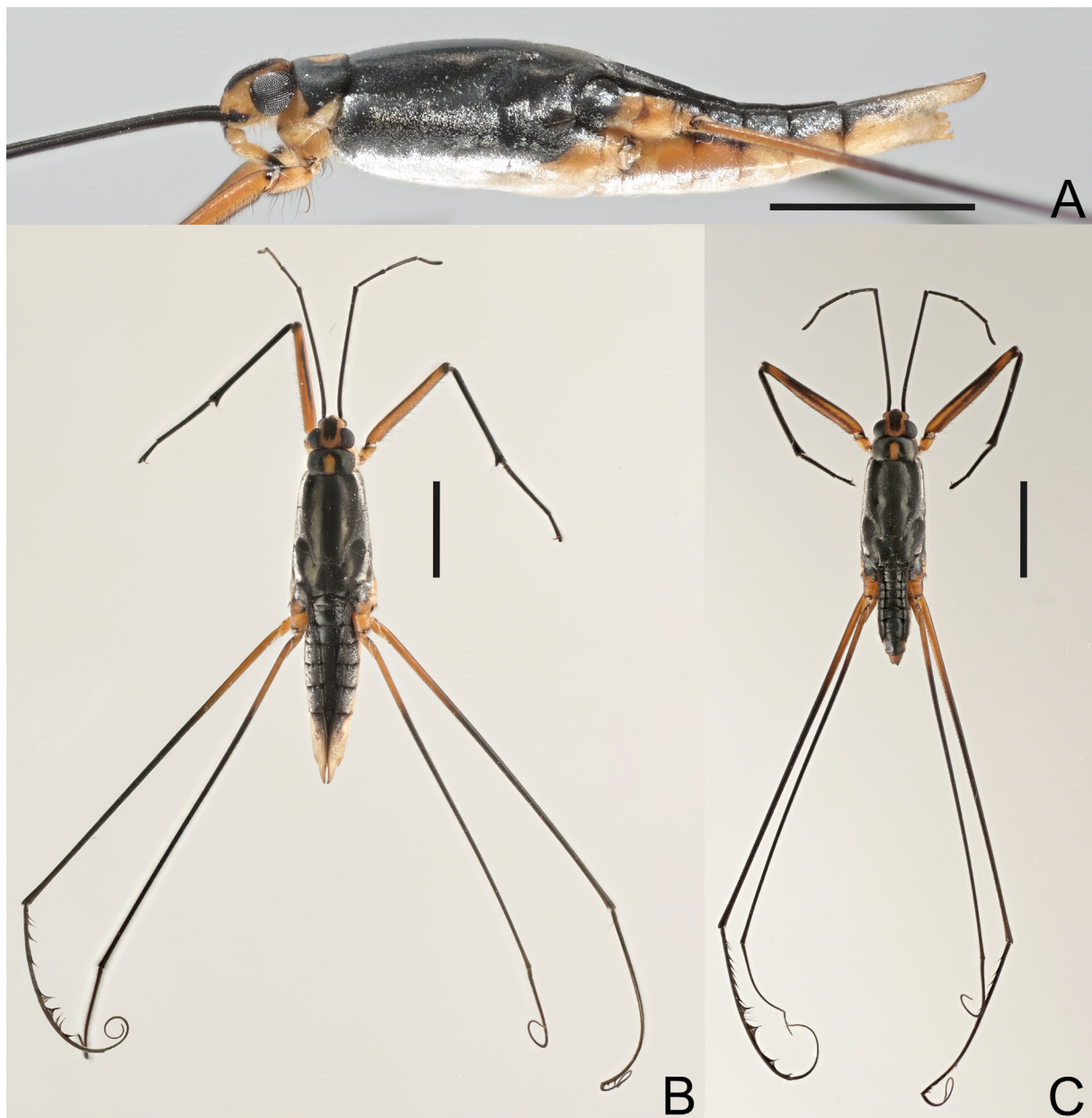
**GENITALIA.** Abdominal segment VIII slightly dorso-ventrally depressed. Genitalia slightly directed ventrad. Pygophore elongate, apical end subovate. Proctiger laterally with broadly rounded lobes

(Figs 6B, 18J). Paramere relatively stout, curved at basal fourth, distal part tapering towards the slightly curved and rounded apex (Figs 8B, 18K).

**Macropterous male**

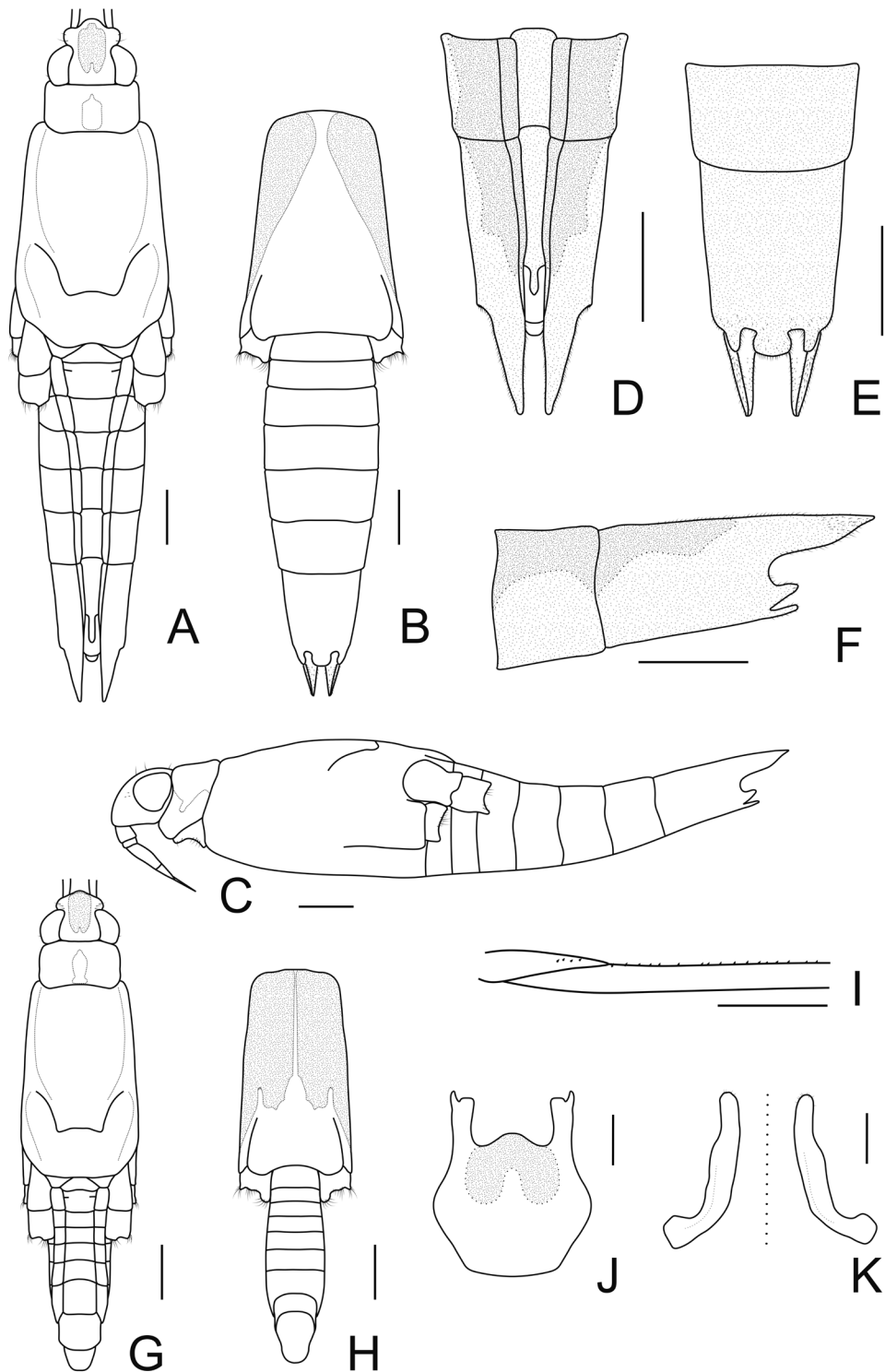
Similar to apterous male in general structure; pronotal lobe similar to that of macropterous female.

MEASUREMENTS. Body length 8.90–9.35 (including wings), width 2.20–2.34, head width 1.32, interocular width 0.52, eye length (dorsal view) 0.63; relative lengths of antennal segments I–IV: 3.80 : 1.07 : 1.24 : 0.92; pronotum: length 2.91, width 2.08; mesonotum width 2.13; metanotum: length 0.61, width 2.01; length



**Fig. 17.** Photographs of *Rhyacobates elongatus* sp. nov. A–B. Holotype, apterous female (ZVNU). A. Lateral view. B. Habitus, dorsal view. C. Habitus of paratype, apterous male (ZVNU), dorsal view. Scale bar = 3 mm.





**Fig. 18.** Morphological features of *Rhyacobates elongatus* sp. nov. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, dorsal view. **E.** Abdominal end of female, ventral view. **F.** Abdominal end of female, lateral view. **G.** Body of male, dorsal view. **H.** Body of male, excluding head and prothorax, ventral view. **I.** Basal part of right middle leg of male, ventral view. **J.** Proctiger of male, dorsal view. **K.** Left paramere, lateral aspect, two different views. Scale bars: A–I = 1 mm; J–K = 0.2 mm.

of fore wing: 6.40; abdomen length (ventral view) 3.20; abdominal sternum VII: length 0.50, width 1.12; abdominal mediotergite I: length 0.29, width 0.67; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 4.00:3.06:1.19:0.68, middle leg: 11.00:5.50:2.78:0.41, hind leg: 10.94:3.83:0.11:0.15.

### Distribution

Vietnam: Hà Tĩnh.

### Comparative notes

*Rhyacobates elongatus* sp. nov. is probably a sister species of *R. bui* sp. nov.; see comparative notes under *R. bui*.

### *Rhyacobates turgidus* sp. nov.

[urn:lsid:zoobank.org:act:A61745D8-0A50-4E9C-89CA-B557C637ED2E](https://zoobank.org/urn:lsid:zoobank.org:act:A61745D8-0A50-4E9C-89CA-B557C637ED2E)

Figs 3C–D, 4C, 5C, 6C, 8C, 19–20

### Diagnosis

Body length of apterous females 7.82–8.50, of apterous males 5.90–6.31. In both sexes, abdominal mediotergite I distinctly swollen and large, about as long as the three subsequent abdominal terga together (Figs 3C–D, 4C, 20A–B, H). Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3C, 19A, 20A); abdominal mediotergite I with a median brownish-yellow stripe; abdominal terga II–VI distinctly short (Figs 3C–D, 20A–B); abdominal mediotergite II medially hidden beneath the abdominal mediotergite I but not laterally (Figs 3C, 20A); laterosternites of connexivum VII expanded dorsad, folded mesad, but not meeting in middle of abdominal dorsum; posterior margin of sternum VII with a short and pointed median process (Fig. 20E–G). Male: middle trochanter with one spine; middle femur with scattered small spines, not arranged in distinct row (Fig. 20J); length of middle tibia ca 1.4 times length of hind tibia; proctiger with angular lobes laterally (Figs 6C, 20K); paramere relatively slender, strongly curved at basal third, distal part tapering towards hook-shaped apex (Figs 8C, 20L).

### Etymology

The species epithet is derived from the Latin adjective ‘turgidus’, meaning ‘swollen’ and refers to the extremely large abdominal mediotergite I.

### Material examined

#### Holotype (Fig. 19A)

CHINA • ♀ (apterous); Sichuan Province, Lu-zhou City, He-jiang County, Tian-tang-ba; 106°15′09.5″ N, 28°35′3.6″ E; 741 m a.s.l.; 9 Aug. 2016; Chen-guang Zheng leg.; NKUM.

#### Paratypes (Fig. 19B)

CHINA • 3 ♂♂, 3 ♀♀ (apterous), 1 ♀ (dealated macropterous); same collection data as for holotype; NKUM • 3 ♀♀ (apterous); Chongqing City, Si-mian Mountain; 28°36′30.4″ N, 106°22′19.2″ E; 895 m a.s.l.; 10 Aug. 2016; Yan-fei Li leg.; NKUM • 1 ♂, 4 ♀♀ (apterous); Sichuan Province, Lu-zhou City, Xu-yong County, Hua-gao-xi National Nature Reserve; 28°16′19.4″ N, 105°32′27.6″ E; 741 m a.s.l.; 15 Aug. 2013; Yang Liu and Zhen Ye leg.; NKUM.

**Description****Apterous female**

MEASUREMENTS. Body length 7.82–8.50 (holotype 8.20), width 3.01–3.60 (holotype 3.48), head width 1.48, interocular width 0.71, eye length (dorsal view) 0.43; relative lengths of antennal segments I–IV: 3.89:1.02:1.18:0.92; pronotum: length 0.81, width 1.65; mesonotum: length 3.78, width 3.25; metanotum: length 0.84, width 2.84; abdomen length (ventral view) 2.94; abdominal sternum VII: length 1.56, width 1.05; abdominal mediotergite I: length 0.86, width 1.71; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 3.94:3.38:1.93:0.88, middle leg: 11.12:6.88:4.25:0.45, hind leg: 11.35:5.41:0.16:0.24.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3C, 19A, 20A). Connexivum dorsally brownish-yellow. Abdominal mediotergite I with a median yellow stripe. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 20C). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively short, almost straight (Fig. 5C, 20D). Connexiva erect on abdominal segments I–VI, parallel to each other above mediotergites, reflexed over terminal mediotergites (Fig. 20A–B). Abdominal mediotergite I distinctly swollen, nearly as long as three subsequent abdominal terga together, sparsely covered with silvery pubescence on each side; abdominal terga II–VI distinctly short in length (Figs 3C–D, 20A–B). Abdominal mediotergite II medially hidden beneath abdominal mediotergite I, but laterally exposed (Figs 3C–D, 20A). Abdominal segment VII elongate, nearly as long as two preceding abdominal segments together, length of ventral margin distinctly longer than that of dorsal margin in lateral view (Figs 5C, 20D); laterosternites of connexivum VII expanded dorsad, folded mesad, not meeting in middle of abdominal dorsum (Fig. 20E). Abdominal sternum VII tapering caudad, posterior margin with a short and pointed median process (Fig. 20E–F).

**Dealated macropterous female**

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish (Figs 3D, 20B).

MEASUREMENTS. Body length 7.81, width 2.90, head width 1.45, interocular width 0.66, eye length (dorsal view) 0.53; pronotum: length 2.97, width 2.41; mesonotum width 2.90; metanotum: length 0.67, width 2.51; abdominal sternum VII: length 1.05, width 1.49; abdominal mediotergite I: length 0.67, width 1.19.

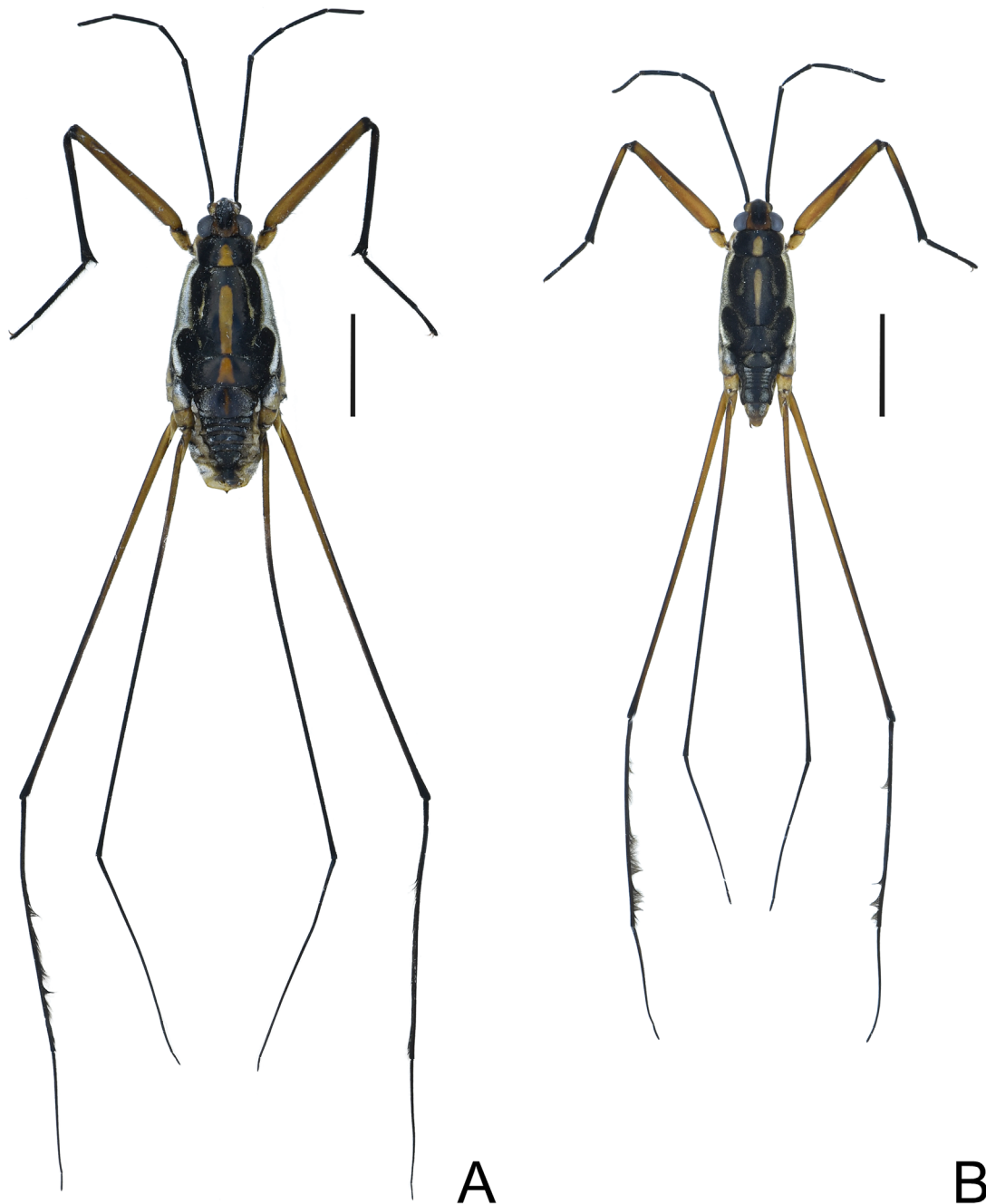
**Apterous male**

MEASUREMENTS. Body length 5.90–6.31, width 2.14–2.20, head width 1.32, interocular width 0.60, eye length (dorsal view) 0.42; relative lengths of antennal segments I–IV: 3.28:0.92:1.03:0.87; pronotum: length 0.71, width 1.41; mesonotum: length 1.30, width 2.14; metanotum: length 0.71, width 1.82; abdomen length (ventral view) 1.98; abdominal sternum VII: length 0.46, width 0.83; abdominal mediotergite I: length 0.46, width 0.85; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 3.33:2.88:1.02:0.63, middle leg: 8.72:5.41:2.66:0.43, hind leg: 8.95:3.78:0.16:0.23.

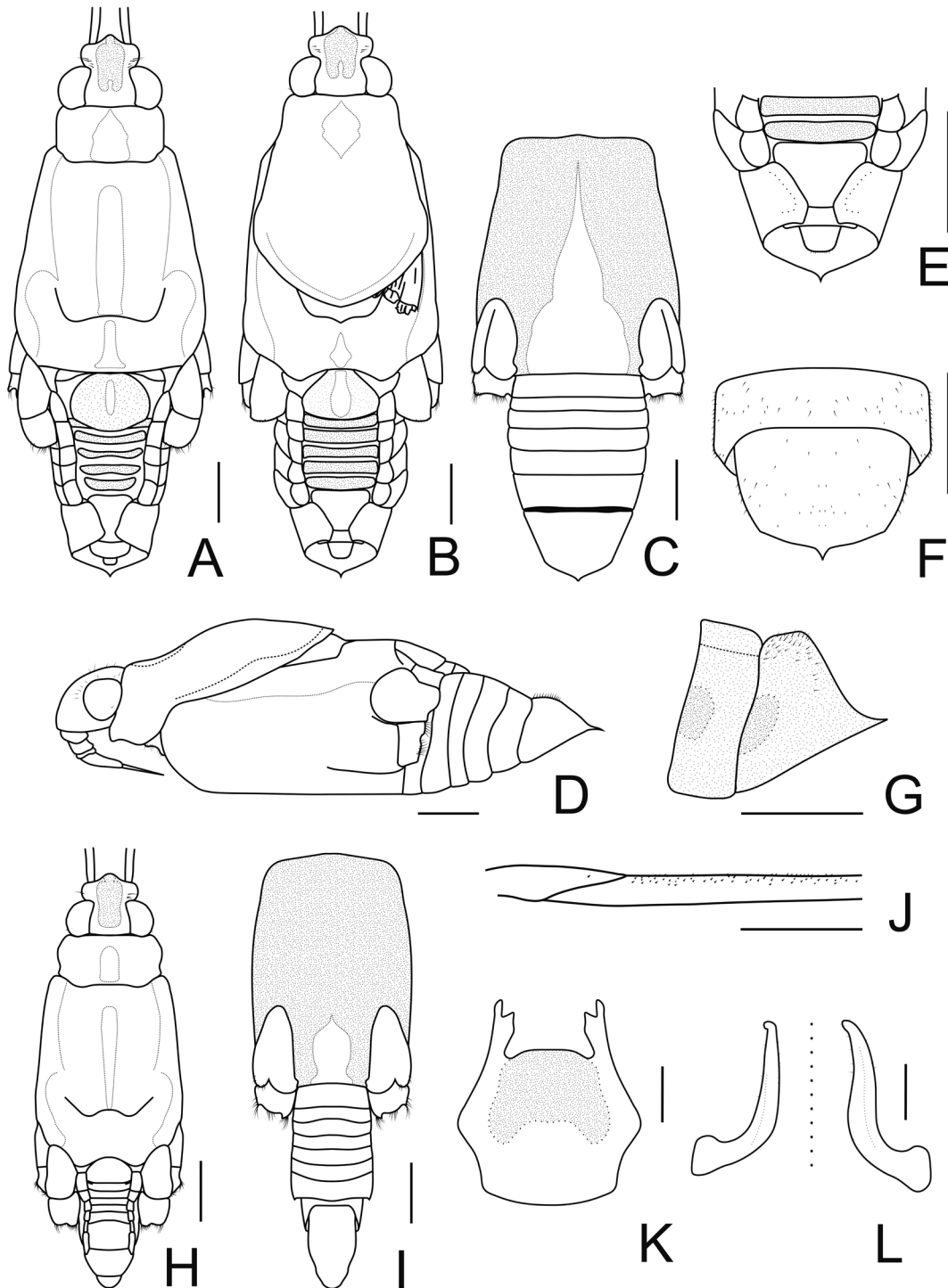
COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly black, without yellow markings (Figs 4C, 19B, 20H). Connexivum dorsally blackish (Figs 4C,

19B). Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 20I). Abdominal venter dark-yellow.

ABDOMEN. Abdomen relatively short. Abdominal mediotergite I extremely swollen (Figs 4C, 20H), nearly as long as three subsequent abdominal terga together.



**Fig. 19.** Habitus of *Rhyacobates turgidus* sp. nov., dorsal view. **A.** Holotype, apterous female (NKUM). **B.** Paratype, apterous male (NKUM). Scale bar = 3 mm.



**Fig. 20.** Morphological features of *Rhyacobates turgidus* sp. nov. **A–B.** Body of female, apterous form (A) and dealated macropterous form (B), dorsal view. **C.** Body of female, excluding head and prothorax, ventral view. **D.** Body of female, dealated macropterous form, lateral view. **E.** Abdominal end of female, dorsal view. **F.** Abdominal end of female, ventral view. **G.** Abdominal end of female, lateral view. **H.** Body of male, dorsal view. **I.** Body of male, excluding head and prothorax, ventral view. **J.** Basal part of right middle leg of male, ventral view. **K.** Proctiger of male, dorsal view. **L.** Left paramere, lateral aspect, two different views. Scale bars: A–J = 1 mm; K–L = 0.2 mm.

LEG. Middle trochanter with one spine; middle femur with scattered small spines, not arranged in distinct row (Fig. 20J).

GENITALIA. Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger with angular lobes laterally (Figs 6C, 20K). Paramere relatively slender, strongly curved at basal third, distal part tapering towards hook-shaped apex (Figs 8C, 20L).

### Distribution

China: Chongqing, Sichuan.

### Comparative notes

*Rhyacobates turgidus* sp. nov. is closely related to *R. recurvus* and *R. constrictus*. These three species possess a robust body and similar outline of abdominal segment VII (Fig. 3C, I, N). *Rhyacobates turgidus* can be distinguished from *R. constrictus* by median yellowish stripes on the mesonotum, metanotum and abdominal mediotergite I (Figs 3C, 20A), which are absent in *R. constrictus*. *Rhyacobates turgidus* can be distinguished from *R. recurvus* by the following characteristics: (1) in lateral view, *R. turgidus* has a nearly straight abdomen (Fig. 5C, 20D), whereas *R. recurvus* has its abdomen curved dorsad (Figs 5M, 31C); (2) *R. turgidus* has an extremely swollen abdominal mediotergite I, which is nearly as long as the three subsequent abdominal tergites, and distinctly short abdominal terga II–VI (Figs 3C–D, 20A–B), whereas abdominal terga I–VI of *R. recurvus* are relatively normal-sized (Figs 3N, 31A).

### *Rhyacobates abdominalis* Andersen & Chen, 1995

Figs 2A, 3E, 4D, 5D, 6D, 8D, 21–22

*Rhyacobates abdominalis* Andersen & Chen, 1995: 58–59, figs 12–15 (original description).

*Rhyacobates abdominalis* – Tran & Yang 2006: 19 (record Vietnam). — Tran & Nguyen 2016: 512 (with remarks).

### Diagnosis

Body length of apterous females 8.47–9.40, of apterous males 6.20–7.42. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3E, 21A, 22A); abdominal segment VII dorsally with an angular process terminating each connexivum (Figs 5D, 22C), laterally with a pair of indistinct blunt processes, posterior margin of sternum VII with a pointed median process (Fig. 22D–E). Male: middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 22I); length of middle tibia ca 1.4 times length of hind tibia; proctiger with angular lobes laterally (Figs 6D, 22J); paramere strongly curved at basal third, distal part slender and tapering towards hook-shaped apex (Figs 8D, 22K).

### Material examined

#### Holotype (Fig. 21A–B)

CHINA • ♀ (apterous); Guangdong Province, Ru-yuan County, Lao-Peng Stream; 1100 m a.s.l.; 14 Aug. 1990; Ping-ping Chen leg.; NKUM.

#### Paratype (Fig. 21C–D)

CHINA • 1 ♂ (apterous); same collection data as for holotype; NKUM.

**Non-type specimens**

CHINA – **Anhui Province** • 5 ♂♂, 6 ♀♀ (apterous); Chi-zhou City, Qing-yang County, Jiu-Hua Mountain; 30°28'43.2" N, 117°49'25.9" E; 20 Jul. 1994; Ping-ping Chen leg.; NKUM. – **Guangdong Province** • 1 ♂, 1 ♀ (apterous); Ru-yuan City, Nan-ling, Xiao-huang-shan; Jul. 2015; Zhen Ye leg.; NKUM. – **Fujian Province** • 1 ♂, 1 ♀ (apterous); Wu-yi-shan City, Tong-mu County, Gua-dun; 10 Aug. 2011; Zhen Ye leg.; NKUM. – **Hubei Province** • 2 ♂♂, 2 ♀♀ (apterous); Shi-yan City, Huang-bai-xi Village; 32°5'27.7" N, 109°43'1.5" E; 600 m a.s.l.; 10 Jul. 2017; Zhen Ye leg.; NKUM. – **Jiangxi Province** • 7 ♂♂, 11 ♀♀ (apterous); Gan-zhou City, Jiu-lian Mountain; 24°24'59.1" N, 114°24'53.3" E; 500 m a.s.l.; 20 Aug. 2020; Yan-fei Li leg.; NKUM • 1 ♂, 1 ♀ (apterous); Lushan, flowing stream; Oct. 2008; C.M. Yang leg.; ZRC. – **Zhejiang Province** • 23 ♂♂, 13 ♀♀ (apterous); Hang-zhou City, Tian-mu Mountain; 30°21'55.3" N, 119°25'53.7" E; 800 m a.s.l.; 20 Aug. 1999; Qiang Xie leg.; NKUM • 12 ♂♂, 10 ♀♀ (apterous); same collection data as for preceding; 400–600 m a.s.l.; 8 Aug. 2007; Geng-ping Zhu leg.; NKUM • 12 ♂♂, 10 ♀♀ (apterous); same collection data as for preceding; 400–600 m a.s.l.; 8 Aug. 2007; Geng-ping Zhu leg.; NKUM • 8 ♂♂, 10 ♀♀ (apterous); same collection data as for preceding; 1326 m a.s.l.; 1 Aug. 2011; Zhen Ye, Wu-hao Yang and Wen-bo Yi leg.; NKUM • 2 ♂♂, 1 ♀ (apterous); Hang-zhou City, Shun-xi; 30°3'20.7" N, 118°56'21.3" E; 2 Jul. 2007; Zhong-hua Fan leg.; NKUM • 7 ♂♂, 3 ♀♀ (apterous); Jiang-shan City, Lao-fo-yan Village; 28°21'42.6" N, 118°41'22.1" E; 570 m a.s.l.; 8 Aug. 2016; Min Li and Xue-shuang Ma leg.; NKUM • 4 ♂♂, 3 ♀♀ (apterous); Li-shui City, Jiu-long Mountain; 28°21'42.6" N, 118°41'22.1" E; 570 m a.s.l.; 8 Aug. 2016; Min Li and Xue-shuang Ma leg.; NKUM.

VIETNAM • 1 ♀ (apterous); Lào Cai Province, Sa Pa, Cát Cát, Ho stream (feeder stream of Mường Hoa stream); 22°19'32.9" N 103°49'52.9" E; 27 Oct. 2020; A.D. Tran leg.; TAD20-23; ZVNU.

GPS data of previous records: see Tran & Yang (2006).

**Supplemental description****Apterous female**

MEASUREMENTS. Body length 8.47–9.40, width 2.90–3.30, head width 1.66, interocular width 0.71, eye length (dorsal view) 0.65; relative lengths of antennal segments I–IV: 4.50:1.26:1.46:1.02; pronotum: length 0.91, width 1.84; mesonotum: length 2.71, width 3.69; metanotum: length 1.01, width 3.29; abdomen length (ventral view) 3.99; abdominal sternum VII: length 1.69, width 1.72; abdominal mediotergite I: length 0.38, width 1.19; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 4.69:4.03:2.31:1.04, middle leg: 12.86:7.84:4.71:0.43, hind leg: 13.02:6.71:0.21:0.24.

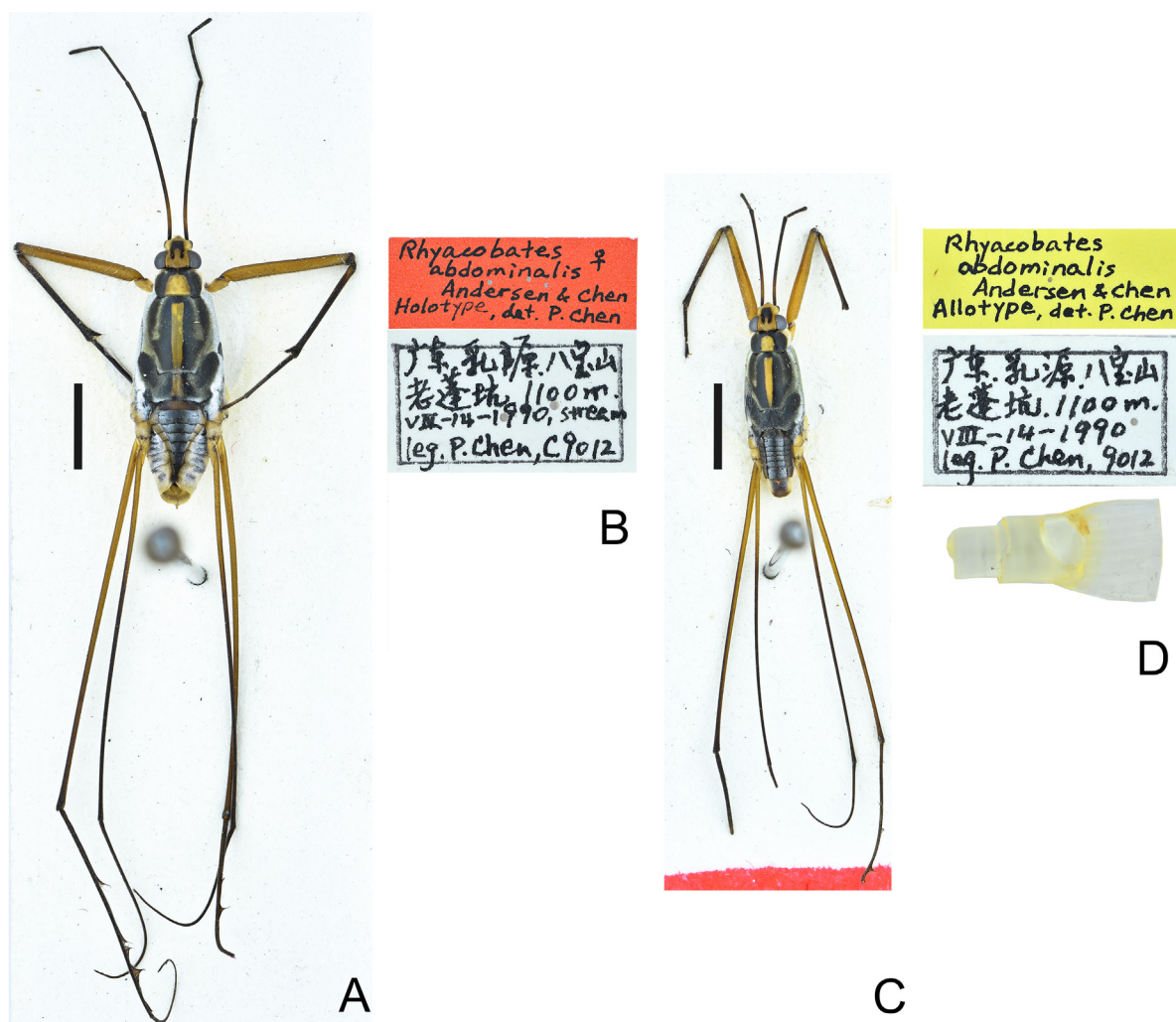
COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3E, 22A). Connexivum dorsally brownish-yellow. Abdominal mediotergite I completely yellow or with a yellow marking, covered with silver pubescence (Fig. 3E). Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 22B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively short, curved dorsad towards end (Figs 5D, 22C). Connexiva erect on abdominal segments I–VII, meeting above terminal mediotergites (Fig. 22A). Abdominal segment VII elongate, nearly as long as two preceding abdominal segments together (Figs 5D, 22C), completely enclosing genital segments (Fig. 22D). Abdominal segment VII dorsally with an angular process terminating each connexivum (Fig. 22E), laterally with a pair of indistinct blunt process, ventrally with a pointed median process on posterior margin (Fig. 22D–E).

### Apterous male

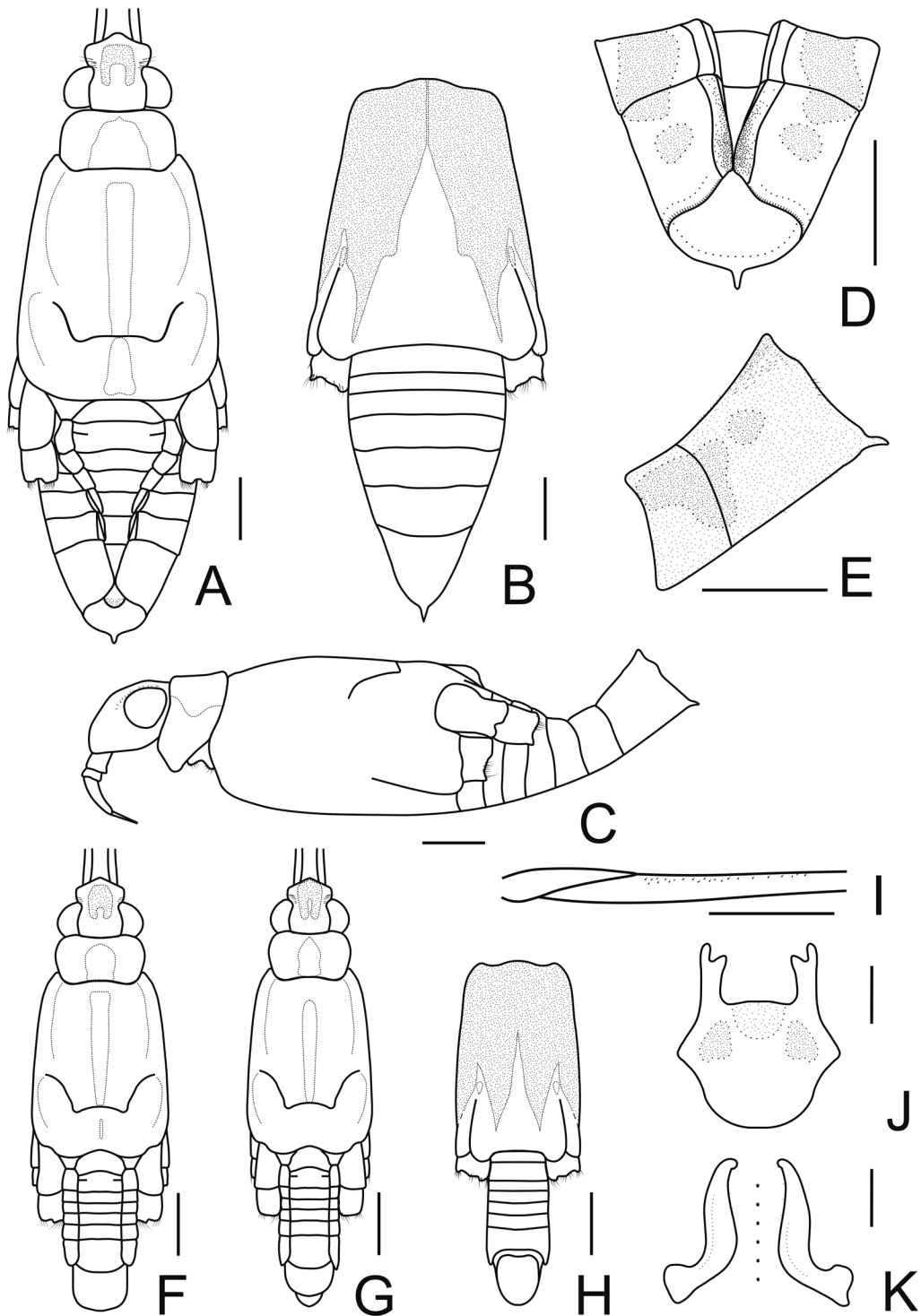
MEASUREMENTS. Body length 6.20–7.40, width 1.90–2.20, head width 1.36, interocular width 0.58, eye length (dorsal view) 0.54; relative lengths of antennal segments I–IV: 3.41:1.01:1.14:0.89; pronotum: length 0.73, width 1.42; mesonotum: length 2.09, width 2.32; metanotum: length 0.65, width 2.12; abdomen length (ventral view) 2.76; abdominal sternum VII: length 0.52, width 1.14; abdominal mediotergite I: length 0.36, width 0.83; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 3.74:3.11:1.10:0.53, middle leg: 11.11:6.38:3.19:0.33, hind leg: 11.18:4.44:0.17:0.18.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum with two color forms: one (i.e., paratype) with a very thin yellow median stripe (Figs 21C, 22F), the other without yellow markings (Figs 4D, 22G). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, which is narrower than that of female (Fig. 22H). Abdominal venter light yellow.



**Fig. 21.** Photographs of *Rhyacobates abdominalis* Andersen & Chen, 1995 and relevant labels. A–B. Holotype, apterous female (NKUM). A. Habitus, dorsal view. B. Labels. C–D. Paratype, apterous male (NKUM). C. Habitus, dorsal view. D. Labels. Scale bar: A, C = 3 mm.





**Fig. 22.** Morphological features of *Rhyacobates abdominalis* Andersen & Chen, 1995. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, dorsal view. **E.** Abdominal end of female, lateral view. **F–G.** Body of male, dorsal view. **H.** Body of male, excluding head and prothorax, ventral view. **I.** Basal part of right middle leg of male, ventral view. **J.** Proctiger of male, dorsal view. **K.** Left paramere, lateral aspect, two different views. Scale bars: A–I = 1 mm; J–K = 0.2 mm.

LEG. Middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 22I).

GENITALIA. Abdominal segment VIII ventro-laterally depressed. Pygophore large, ovate. Proctiger with angular lobes laterally (Figs 6D, 22J). Paramere strongly curved at basal third, distal part slender and tapering towards hook-shaped apex (Figs 8D, 22K).

### Distribution

China: Anhui, Fujian, Hubei, Jiangxi, Zhejiang (first records); Guangdong (Andersen & Chen 1995). Vietnam: Lào Cai (Tran & Yang 2006).

### Comparative notes

*Rhyacobates abdominalis* is closely related to *R. chinensis*, both having the hind margin of abdominal segment VII in the female with five processes. However, *R. abdominalis* can be distinguished from *R. chinensis* by having a shorter connexival process of abdominal segment VII (Figs 22E, 25G–I). In addition, the pair of lateral processes is inconspicuous or vestigial in *R. abdominalis* (Fig. 22E), but elongate and pointed in *R. chinensis* (Fig. 25G–I).

*Rhyacobates anderseni* Tran & Yang, 2006  
Figs 3F, 4E, 5E, 6E, 8E, 23

*Rhyacobates anderseni* Tran & Yang, 2006: 14–16, figs 7–16, 27 (original description).

*Rhyacobates anderseni* – Tran & Nguyen 2016: 513 (with remarks).

### Diagnosis

Body length of females 6.79–7.30, of males 6.00–6.20. Both sexes: mesonotum mainly black with a median brownish-yellow stripe (broader in female, narrower in male); metanotum chiefly blackish, without yellow markings (Figs 3F, 23A). Female: hind margin of metanotum with a pointed median process extending over abdominal tergum I (Fig. 23C–D); pronotum mainly black with a median brownish-yellow spot; posterior margin of abdominal segment VII with four processes, dorsally with a long process terminating each connexivum (Fig. 23F–G), laterally with a pair of pointed processes (Fig. 23F, H), ventrally almost truncate, without median process (Fig. 23H). Male: middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 23K); length of middle tibia ca 1.8–1.9 times length of hind tibia; proctiger with rounded lobes laterally (Figs 6E, 23L); paramere relatively stout and evenly curved, middle part thickened, distal part tapering towards rounded apex (Figs 8E, 23M).

### Material examined

#### Type specimens

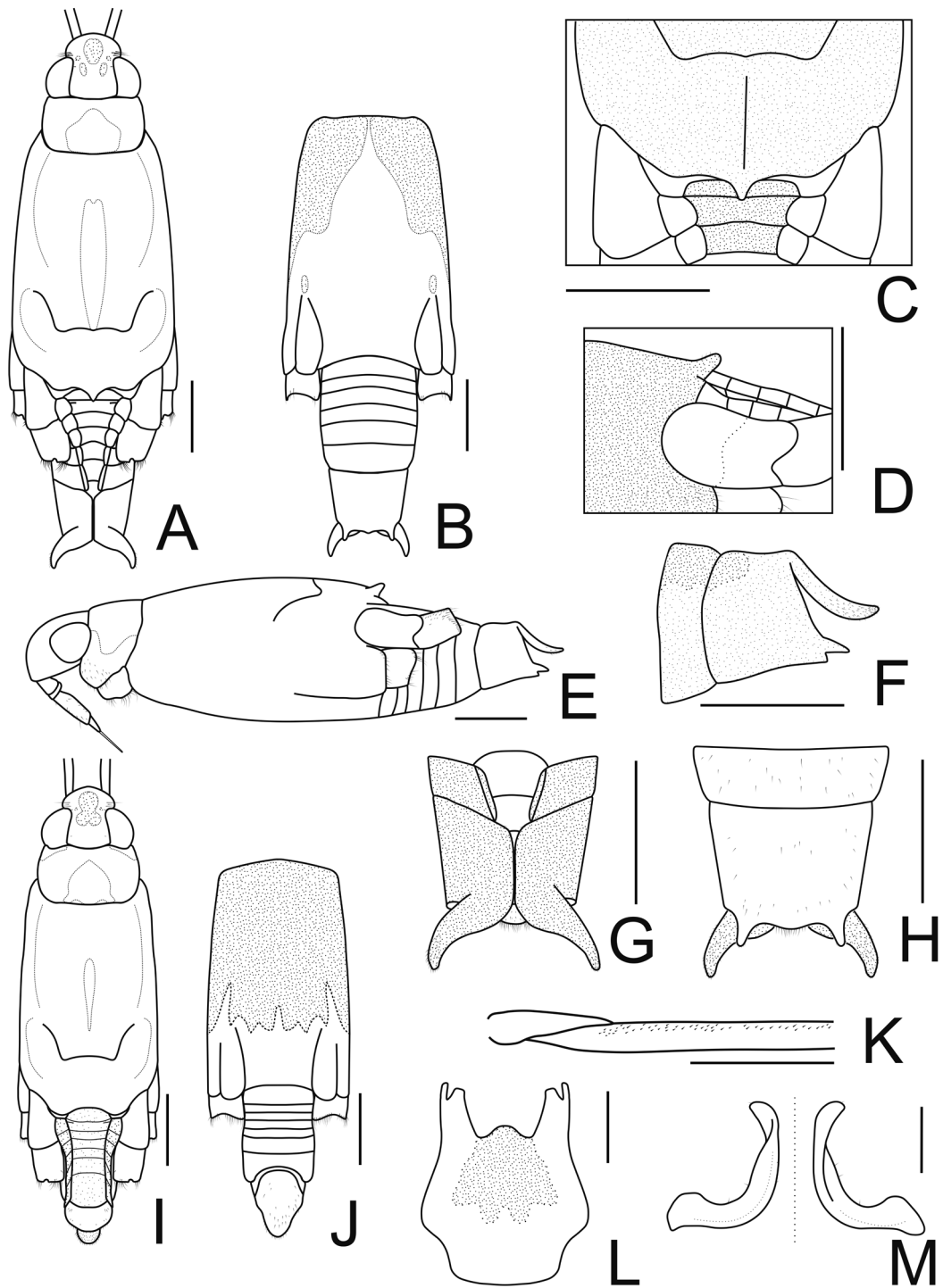
See Tran & Yang (2006).

#### Non-type specimens

CHINA • 5 ♂♂, 3 ♀♀ (apterous); Yunnan Province, Jing-hong City, Cai-yang River; 22°33'4.1" N, 101°5'14.6" E; 879 m a.s.l.; 30 Jul. 2016; Zhen Ye leg.; NKUM.

VIETNAM • 1 ♂ (apterous), 1 ♂ (macropterous); Hà Tĩnh Province, Vũ Quang National Park, Khe Nam Châm stream, site #1, upstream; 18°17'31.5" N, 105°21'18.7" E; 21 Apr. 2022; A.D. Tran *et al.* leg.; TAD2208; ZVNU • 1 ♀ (macropterous); same collection data as for preceding; NKUM.

GPS data of previous records: see Tran & Yang (2006).



**Fig. 23.** Morphological features of *Rhyacobates anderseni* Tran & Yang, 2006. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Metathorax of female, dorsal view. **D.** Metathorax of female, lateral view. **E.** Body of female, lateral view. **F.** Abdominal end of female, lateral view. **G.** Abdominal end of female, dorsal view. **H.** Abdominal end of female, ventral view. **I.** Body of male, dorsal view. **J.** Body of male, excluding head and prothorax, ventral view. **K.** Basal part of right middle leg of male, ventral view. **L.** Proctiger of male, dorsal view. **M.** Left paramere, lateral aspect, two different views. Scale bars: A–K = 1 mm; L–M = 0.2 mm.

## Supplemental description

### Apterous female

MEASUREMENTS. Body length 6.79–7.30, width 2.00–2.60, head width 1.32, interocular width 0.58, eye length (dorsal view) 0.59; relative lengths of antennal segments I–IV: 3 : 0.86 : 1.21 : 0.74; pronotum: length 0.73, width 1.47; mesonotum: length 2.36, width 2.54; metanotum: length 0.88, width 1.98; abdomen length (ventral view) 2.88; abdominal sternum VII: length 1.23, width 1.18; abdominal mediotergite I: length 0.15, width 0.96; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.03 : 2.35 : 1.17 : 0.83, middle leg: 8.75 : 5.35 : 2.63 : 0.45, hind leg: 8.85 : 3.08 : 0.15 : 0.21.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 3F, 23A). Connexivum dorsally blackish. Venter of female chiefly blackish with a median yellowish spot (Fig. 23B). Abdominal venter light yellow.

ABDOMEN. Hind margin of metanotum produced as a median protuberance over abdominal tergum I (Fig. 23C–D). Abdomen relatively short, nearly straight, moderately curved dorsad posteriorly (Figs 5E, 23E). Connexivum on abdominal segments I–VI dorsally blackish, forming a straight line in dorsal view (Figs 3F, 23A). Abdominal segment VII elongate, nearly as long as three preceding abdominal segments together (Fig. 23E), completely enclosing genital segments (Figs 3F, 23G). Posterior margin of abdominal segment VII with four processes, dorsally with a long, slender process terminating each connexivum (Fig. 23G), laterally with a pair of pointed processes (Fig. 23F, H), ventrally almost truncate, without a median process (Fig. 23H).

### Apterous male

MEASUREMENTS. Body length 6.00–6.20, width 1.70–1.90, head width 1.21, interocular width 0.55, eye length (dorsal view) 0.53; relative lengths of antennal segments I–IV: 2.84 : 0.89 : 1.14 : 0.78; pronotum: length 0.68, width 1.31; mesonotum: length 2.13, width 1.85; metanotum: length 0.64, width 1.65; abdomen length (ventral view) 1.94; abdominal sternum VII: length 0.38, width 0.59; abdominal mediotergite I: length 0.19, width 0.68; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.04 : 2.44 : 0.89 : 0.54, middle leg: 8.80 : 4.86 : 2.38 : 0.36, hind leg: 8.75 : 2.62 : 0.11 : 0.15.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 4E, 23I). Connexivum dorsally blackish. Metasternum anteriorly blackish and posteriorly light yellow (Fig. 23J). Abdominal venter anteriorly blackish and posteriorly light yellow or completely light yellow.

LEG. Middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 23K).

GENITALIA. Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger with rounded lobes laterally (Figs 6E, 23L). Paramere relatively stout and evenly curved, middle part thickened, distal part tapering towards rounded apex (Figs 8E, 23M).

## Distribution

China: Yunnan; Vietnam: Hà Tĩnh (Tran & Yang 2006).

## Comparative notes

*Rhyacobates anderseni* is distinct from all congeners in having a median process on the posterior margin of the metanotum in the female (Fig. 23D), which is present in three other ptilomerine genera,

i.e., *Andersenius*, *Pleciobates* and *Jucundus* Distant, 1910. However, this species matches all other characteristics of *Rhyacobates* defined by Andersen & Chen (1995), as discussed by Tran & Yang (2006: 16). Future phylogenetic studies using molecular data may help to resolve the taxonomic position of this species.

***Rhyacobates angustus* Tran & Nguyen, 2016**  
Figs 3G, 5F, 6F, 24

*Rhyacobates angustus* Tran & Nguyen, 2016: 502–503, figs 1–10 (original description).

**Diagnosis**

Body length of apterous female 11.30 (holotype), of apterous males 7.70–8.10. Color (Figs 3G, 24B): dorsum of head yellow with a median longitudinal dark marking on anterior three quarters; thorax of female with a broad median yellow marking on pronotum (about one third of pronotal width), a relatively broad median yellow stripe on posterior four-fifths of mesonotum, and a median yellow marking on metanotum; thorax of male with a narrow median yellow marking on pronotum, a narrow yellow median stripe on posterior four-fifths of mesonotum, and without yellow markings on metanotum. Female: ventral length of pregenital abdomen about two-thirds body length; connexivum of abdominal segments I–VI widened; abdominal segment VII elongate, dorso-ventrally depressed, with a pair of broad, subtriangular connexival processes (Figs 5F, 24A); posterior margin of sternum VII convex and widened. Male: middle trochanter without spines; small spines at basal fifth of middle femur not arranged in distinct row and those at distal four-fifths arranged in distinct row (Fig. 24C); length of middle tibia ca 1.6 times length of hind tibia; abdomen relatively short, posterior segments slightly curved ventrad; pygophore simple, with rounded apical margin; proctiger with rounded lobes laterally (Fig. 6F); paramere relatively slender, curved at basal third, slightly thicker at middle part, and apex narrow and directed mesad.

**Material examined**

**Type specimens** (Fig. 24)  
See Tran & Nguyen (2016).

**Distribution**

Vietnam: Lào Cai (Tran & Nguyen 2016).

**Comparative notes**

*Rhyacobates angustus* resembles *R. zetteli*, as discussed by Tran & Nguyen (2016: 503, 507–508). It is also similar to *R. bui* sp. nov. and *R. elongatus* sp. nov.; see comparative notes under *R. bui*.

***Rhyacobates chinensis* Hungerford & Matsuda, 1959**  
Figs 2B, 3H, 4F, 5G, 6G, 8F, 11–13, 25

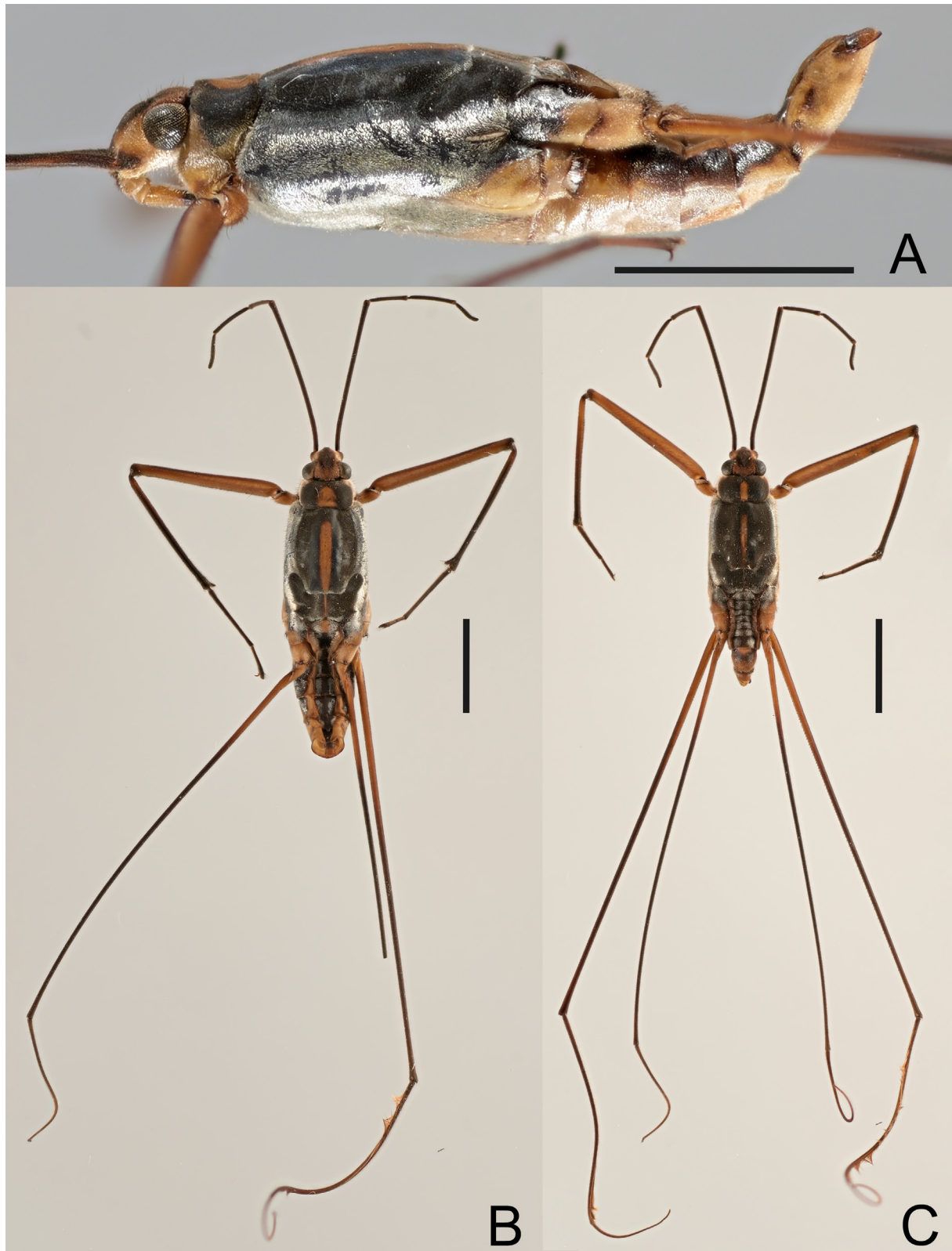
*Rhyacobates chinensis* Hungerford & Matsuda, 1959: 69 (original description).

*Rhyacobates esakii* Miyamoto & Lee, 1963: 43 (synonymized with *Rhyacobates chinensis*).

*Rhyacobates chinensis* – Andersen & Chen 1995: 57, figs 6–11 (with remarks).

**Diagnosis**

Body length of apterous females 8.01–9.45, of apterous males 6.20–6.81. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3H, 25A); posterior margin of abdominal segment VII with five processes,



**Fig. 24.** Photographs of *Rhyacobates angustus* Tran & Nguyen, 2016. **A–B.** Holotype, apterous female (ZVNU). **A.** Body, lateral view. **B.** Habitus, dorsal view. **C.** Allotype, apterous male (ZVNU), habitus, dorsal view. Scale bar = 3 mm.

including a short, angular process terminating each connexivum, a pair of pointed processes laterally, which are as long as or longer than connexival process, ventrally with a pointed, median process (Figs 5G, 25G–I). Male: middle trochanter with 3–6 spines; middle femur with spines but not in distinct row (Fig. 25L); length of middle tibia ca 1.5–1.7 times length of hind tibia; proctiger with angular lobes laterally (Figs 6G, 25M); paramere relatively slender and sinuate, basal and middle parts thickened, distal part tapering towards hook-shaped apex (Figs 8F, 25N).

## Material examined

### Non-type specimens

CHINA—**Chongqing City** • 13 ♂♂, 15 ♀♀ (apterous); Si-mian Mountain; 28°36'30.4" N, 106°22'19.2" E; 895 m a.s.l.; 10 Aug. 2016; Yan-fei Li leg.; NKUM. — **Hebei Province** • 10 ♂♂, 11 ♀♀ (apterous); Cheng-de City, Wei-chang County, Yu-dao-kou; 42°13'8.7" N, 117°1'33.6" E; 1200 m a.s.l.; 30 Aug. 2016; Ya-hui Zhen leg.; NKUM • 4 ♂♂, 26 ♀♀ (apterous); Cheng-de City, Xing-long County, Wu-ling Mountain; 29 Aug. 1973; Sheng-li Liu leg.; NKUM. — **Henan Province** • 15 ♂♂, 31 ♀♀ (apterous); Xin-xiang City, Hui County, Bo-bi Village; 35°34'47.2" N, 113°35'47.6" E; 1200 m a.s.l.; 21 Jul. 2016; Ye Zhen leg.; NKUM. — **Hubei Province** • 2 ♂♂, 2 ♀♀ (apterous); Shi-yan City, Zhu-xi Village; 32°16'36.1" N, 109°41'59.7" E; 600 m a.s.l.; 11 Aug. 2015; Zhen Ye leg.; NKUM • 8 ♂♂, 12 ♀♀ (apterous); Jin-chun County, Wen-quan Bridge; 30°14'35.2" N, 115°43'5.2" E; 56 m a.s.l.; 12 Jul. 2022; Zhao-qi Leng leg.; NKUM • 11 ♂♂, 10 ♀♀ (apterous); Sui-zhou City, Hei-long-tan; 31°47'21.1" N, 114°5'16.1" E; 225 m a.s.l.; 14 Jul. 2022; Zhao-qi Leng, Chen Liu and Zi-he Li leg.; NKUM • 27 ♂♂, 29 ♀♀ (apterous); Huang-gang City, Ying-shan County, Tao-hua-chong; 30°58'5.2" N, 116°1'29.3" E; 719 m a.s.l.; 13 Jul. 2022; Zhao-qi Leng and Zhen Ye leg.; NKUM. — **Hunan Province** • 5 ♂♂, 5 ♀♀ (apterous); Zhang-jia-jie City, Jin-bian-xi; 14 Oct. 1985; Huan-guang Zou leg.; NKUM. — **Liaoning Province** • 12 ♂♂, 13 ♀♀ (apterous); Dan-dong City, Kuan-dian County; 41°0'5.7" N, 125°11'26.1" E; 222 m a.s.l.; 6 Jul. 2016; Juan-juan Yuan leg.; NKUM. — **Neimenggu Province** • 7 ♂♂, 4 ♀♀ (apterous); Xi-lin-guo-le League, Zhong-li-fang; Aug. 1974; Zhong-ming Jiang leg.; NKUM. — **Shaanxi Province** • 1 ♂, 1 ♀ (apterous); Chang-zhi City, Tai-hang Mountain; 35°53'52.3" N, 113°28'57.9" E; 1070 m a.s.l.; 9 Aug. 2018; Hua-xi Liu and Xue Dong leg.; NKUM • 8 ♂♂, 9 ♀♀ (apterous); Hua County, Gao-tang Village; 34°24'23.3" N, 109°39'1.6" E; 1070 m a.s.l.; 7 Jul. 2014; Huan-huan Yang leg.; NKUM. — **Sichuan Province** • 2 ♂♂, 3 ♀♀ (apterous); Guang-yuan City, Shui-mo-gou; 32°48'3.4" N, 106°3'33.7" E; 1002 m a.s.l.; 19 Jul. 2016; Yan-chen Li leg.; NKUM • 6 ♂♂, 7 ♀♀ (dealated macropterous); Guang-yuan City, Shui-mo-gou; 32°48'3.4" N, 106°3'33.7" E; 1002 m a.s.l.; 19 Jul. 2016; Yan-chen Li leg.; NKUM • 2 ♂♂, 3 ♀♀ (apterous); Wan-yuan City, Yu-quan Mountain; 32°9'35.6" N, 108°8'19.4" E; 580 m a.s.l.; 25 Aug. 2017; Chen-guang Zheng leg.; NKUM. — **Tian-jin City** • 2 ♀♀ (apterous); Ji-zhou District, Xia-ying Village; 29 Jul. 1985; Liu leg.; NKUM.

## Supplemental description

### Apterous female

MEASUREMENTS. Body length 8.01–9.45, width 2.60–3.20, head width 1.42, interocular width 0.74, eye length (dorsal view) 0.65; relative lengths of antennal segments I–IV: 4.31 : 1.04 : 1.18 : 0.86; pronotum: length 0.74, width 1.66; mesonotum: length 2.42, width 3.03; metanotum: length 0.62, width 2.75; abdomen length (ventral view) 4.69; abdominal sternum VII: length 1.82, width 1.75; abdominal mediotergite I: length 0.54, width 1.36; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.36 : 3.84 : 1.96 : 0.88, middle leg: 12.51 : 6.85 : 3.32 : 0.48, hind leg: 14.21 : 5.45 : 0.15 : 0.25.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3H, 25A). Connexivum dorsally brownish-yellow. Abdominal tergum I completely yellow or with a median yellow marking. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 25B). Abdominal venter light yellow.

**ABDOMEN.** Abdomen relatively short, curved dorsad towards end at different angles. Connexiva convergent along dorsal midline of abdominal segments IV–VI, meeting erectly above terminal mediotergites (Fig. 25A). Abdominal segment VII elongate, nearly as long as three preceding abdominal segments together (Fig. 25E). Posterior margin of abdominal segment VII with five processes, dorsally with a short, angular process terminating each connexivum, laterally with a pair of pointed processes, as long as or longer than connexival process, ventrally with a pointed median process (Fig. 25C–D). Processes of abdominal segment VII variable among populations (Fig. 25G–I).

#### **Dealated macropterous female**

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum (Fig. 25F); posterior margin broadly rounded and brownish; abdominal segment VII wider than that of apterous form.

**MEASUREMENTS.** Body length 9.19, width 3.48, head width 1.89, interocular width 0.86, eye length (dorsal view) 0.67; relative lengths of antennal segments I–IV: 4.38 : 1.64 : 1.62 : 1.03; pronotum: length 3.43, width 2.89; mesonotum width 3.48; metanotum: length 0.73, width 3.06; abdomen length (ventral view) 4.04; abdominal sternum VII: length 1.89, width 2.03; abdominal mediotergite I: length 0.49, width 1.31; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.44 : 4.08 : 2.26 : 0.92, middle leg: 13.11 : 7.72 : 3.88 : 0.61, hind leg: 13.49 : 5.88 : 0.19 : 0.25.

#### **Apterous male**

**MEASUREMENTS.** Body length 6.20–6.81, width 1.80–2.10, head width 1.36, interocular width 0.76, eye length (dorsal view) 0.54; relative lengths of antennal segments I–IV: 3.94 : 1.01 : 1.04 : 0.94; pronotum: length 0.74, width 1.58; mesonotum: length 2.19, width 2.18; metanotum: length 0.68, width 2.03; abdomen length (ventral view) 2.53; abdominal sternum VII: length 0.45, width 1.08; abdominal mediotergite I: length 0.34, width 0.79; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.84 : 3.28 : 1.16 : 0.58, middle leg: 10.90 : 6.11 : 2.63 : 0.41, hind leg: 11.57 : 3.52 : 0.14 : 0.20.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 4F, 25J). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, narrower than that of female (Fig. 25K). Abdominal venter light yellow.

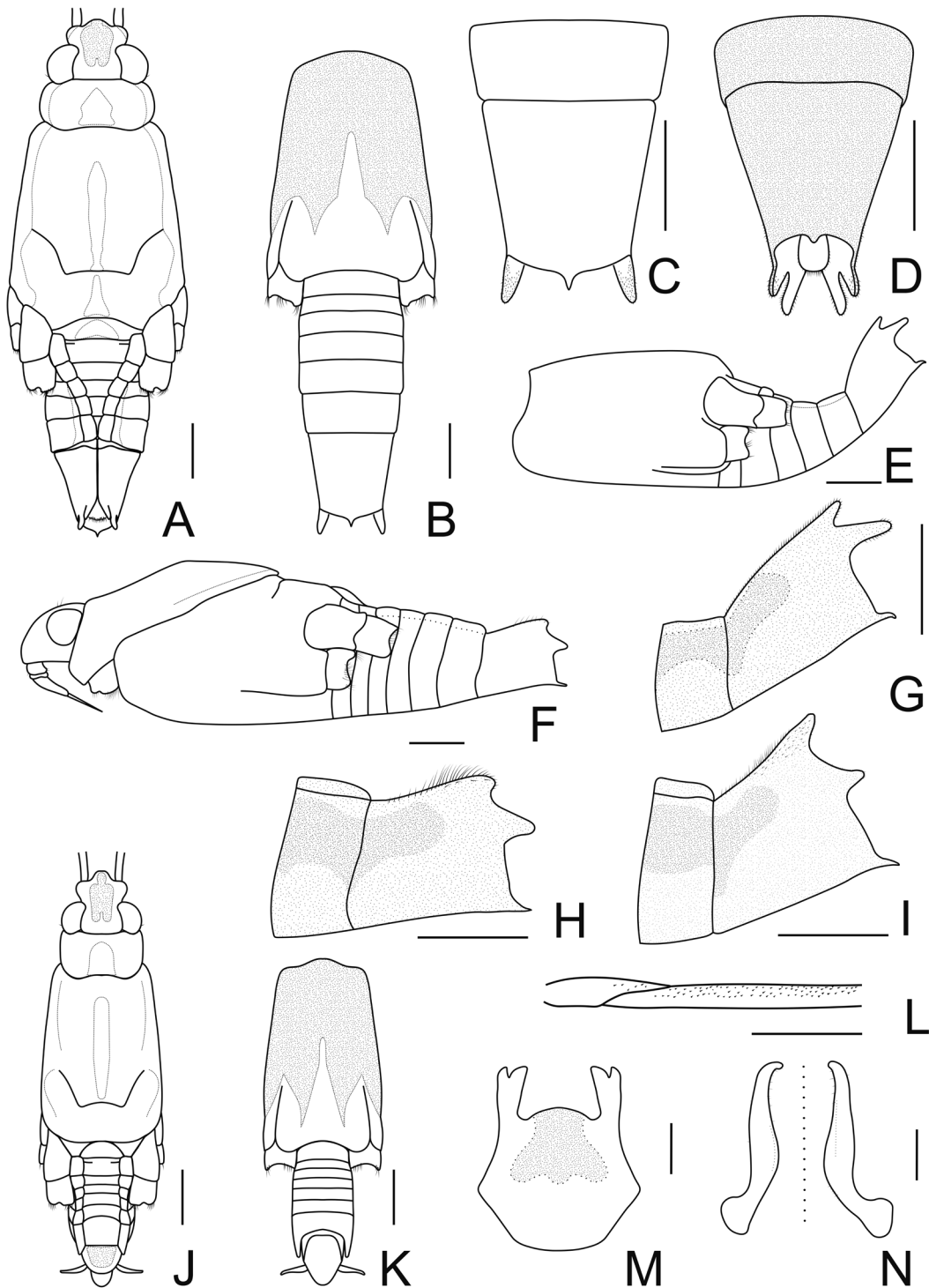
**LEG.** Middle trochanter with 3–6 spines on distal part; middle femur with spines but not in distinct row (Fig. 25L).

**GENITALIA.** Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger with angular lobes laterally (Figs 6G, 25M). Paramere relatively slender and sinuate, middle part thickened, distal part tapering towards hook-shaped apex (Figs 8F, 25N).

#### **Dealated macropterous male**

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish.





**Fig. 25.** Morphological features of *Rhyacobates chinensis* Hungerford & Matsuda, 1959. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C–D.** Abdominal end of female, ventral view. **E–F.** Body of female, apterous form (E, excluding head and prothorax) and dealated macropterous form (F), lateral view. **G–I.** Abdominal end of female, lateral view. **J.** Body of male, dorsal view. **K.** Body of female, excluding head and prothorax, ventral view. **L.** Basal part of right middle leg of male, ventral view. **M.** Proctiger of male, dorsal view. **N.** Left paramere, lateral aspect, two different views. Scale bars: A–L = 1 mm; M–N = 0.2 mm.

MEASUREMENTS. Body length 7.48, width 2.64, head width 1.46, interocular width 0.76, eye length (dorsal view) 0.59; relative lengths of antennal segments I–IV: 3.86 : 1.12 : 1.16 : 0.90; pronotum: length 2.84, width 2.42; mesonotum width 2.64; metanotum: length 0.59, width 2.35; abdomen length (ventral view) 2.84; abdominal sternum VII: length 0.55, width 1.25; abdominal mediotergite I: length 0.29, width 0.89; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.06 : 3.47 : 1.06 : 0.67, middle leg: 11.69 : 6.16 : 2.76 : 0.44, hind leg: 11.81 : 4.16 : 0.15 : 0.21.

### Distribution

China: Chongqing, Liaoning, Shaanxi, Shanxi, Sichuan (first records); Hebei, Henan, Hubei, Hunan, Inner Mongolia, Tianjin; Korea: Nam Te Cheon (Andersen & Chen 1995).

### Comparative notes

*Rhyacobates chinensis* is most similar to *R. abdominalis*; see comparative notes under *R. abdominalis*.

### *Rhyacobates constrictus* Tran & Nguyen, 2016 Figs 3I, 5H, 6H, 26

*Rhyacobates constrictus* Tran & Nguyen, 2016: 508–512, figs 24–39 (original description).

### Diagnosis

Body length of apterous females 8.70–9.40, of apterous males 6.90–7.10. Color (Figs 3I, 5H, 26): dorsum of head mainly yellow, with a median, longitudinal brown marking on anterior three-quarters; pronotum with a median yellow marking (in males, median marking narrower); mesonotum and metanotum entirely black, without yellow markings. Female: abdomen relatively short; ventral length of pregenital abdomen about 0.4 times body length (Figs 3I, 26B); abdominal apex curved dorsad; mediotergite I swollen; connexivum of segments I–V narrow, of segment VI wider; abdominal segment VII tapering towards apex (Figs 5H, 26A); laterosternites of connexivum VII expanded dorsad and curved mesad; posterior margin of sternum VII with narrow median process. Male: middle trochanter without spines; small spines on middle femur scattered, not arranged in distinct row; length of middle tibia ca 1.5 times length of hind tibia; abdomen relatively short; pygophore simple, with rounded apical margin; proctiger with broadly angular lobe on each lateral side (Fig. 6H); paramere curved at basal fourth, strongly thickened at middle part, then tapering towards apex, distal part with scattered short setae.

### Material examined

**Type specimens** (Fig. 26)

See Tran & Nguyen (2016).

### Distribution

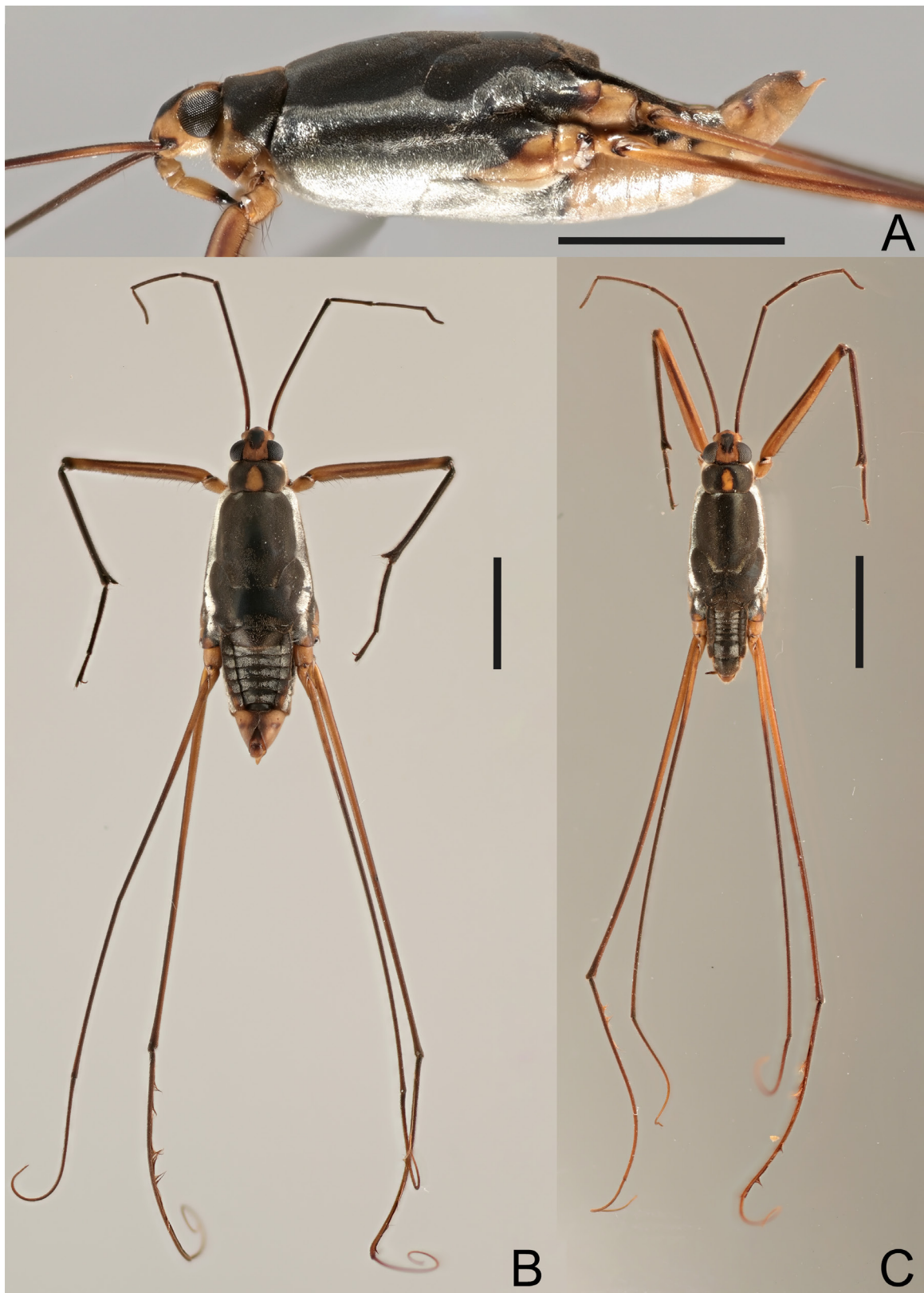
Vietnam: Phú Thọ (Tran & Nguyen 2016).

### Comparative notes

Tran & Nguyen (2016: 512) provided comparative notes between *R. constrictus*, *R. abdominalis* and *R. recurvus*, which all have a median process on the posterior margin of mediosternite VII of the female. Also see further comparative notes under *R. bui* sp. nov. and *R. turgidus* sp. nov.

### *Rhyacobates edentatus* Andersen & Chen, 1995 Figs 3J, 4G, 5I, 6I, 8G, 27–28

*Rhyacobates edentatus* Andersen & Chen, 1995: 63–64, figs 33–36 (original description).



**Fig. 26.** Photographs of *Rhyacobates constrictus* Tran & Nguyen, 2016. **A–B.** Holotype, apterous female (ZVNU). **A.** Body, lateral view. **B.** Habitus, dorsal view. **C.** Allotype, apterous male (ZVNU), habitus, dorsal view. Scale bar = 3 mm.

## Diagnosis

Body length of apterous females 7.21–9.64, of apterous males 5.70–6.62. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3J, 28A); posterior part of abdomen curved dorsad to oblique position, both sides of abdominal segment VII dorsally folded mesad, almost meeting each other over mediotergite (Fig. 28D–F), posterior margin of sternum VII truncate or with obtuse angle (Fig. 28E). Male: middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 28I); length of middle tibia ca 1.9–2.0 times length of hind tibia; proctiger with angular lobes laterally (Figs 6I, 28J); paramere relatively slender, curved at basal third, distal part tapering towards hook-shaped apex (Figs 8G, 28K).

## Material examined

### Holotype (Fig. 27A–B)

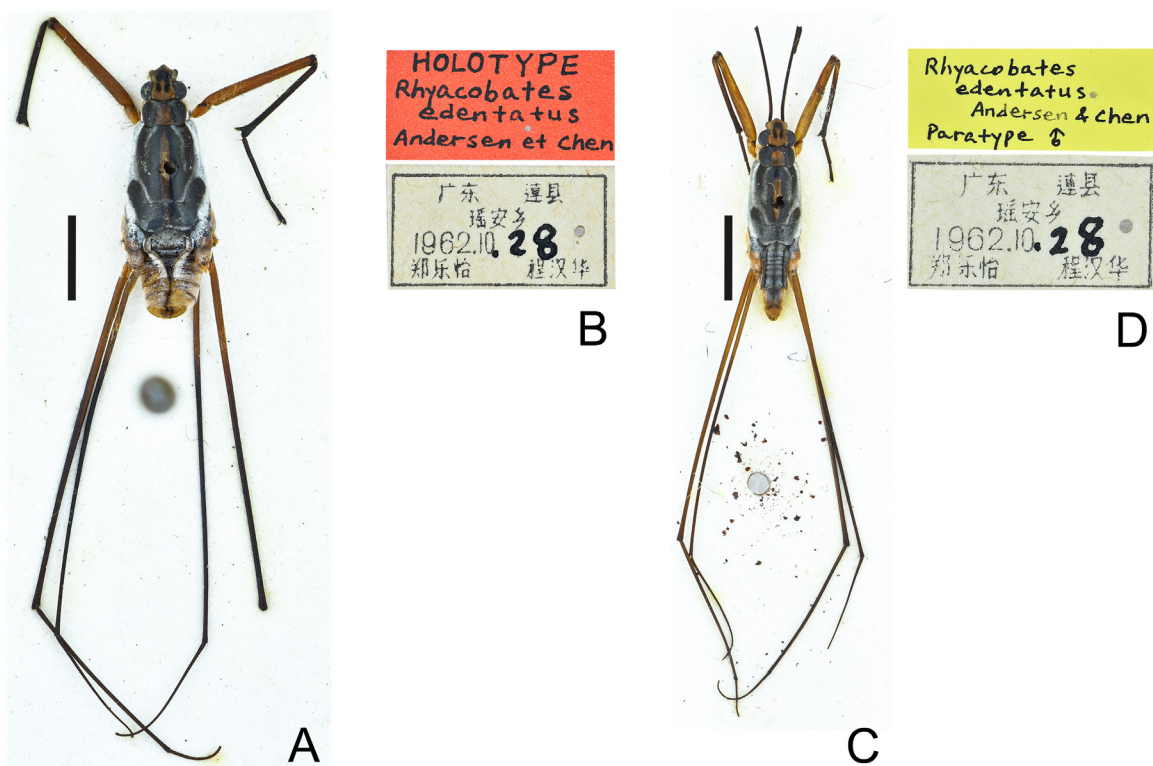
CHINA • ♀ (apterous); Guangdong Province, Lian County, Yao-an Village; 30 Jul. 1962; Le-yi Zheng and Han-hua Cheng leg.; NKUM.

### Paratypes (Fig. 27C–D)

CHINA • 3 ♂♂, 1 ♀ (apterous); same collection data as for holotype; NKUM.

### Non-type specimens

CHINA – **Chongqing City** • 7 ♂♂, 8 ♀♀ (apterous); Nan-chuan Region, Jin-fo Mountain; 29°3'25.6" N, 107°5'55.1" E; 598 m a.s.l.; 19 Jul. 2022; Qiao Mu *et al.* leg.; NKUM. – **Guangdong Province** • 13 ♂♂,



**Fig. 27.** Photographs of *Rhyacobates edentatus* Andersen & Chen, 1995 and relevant labels. A–B. Holotype, apterous female (NKUM). A. Habitus, dorsal view. B. Labels. C–D. Paratype, apterous male (NKUM). C. Habitus, dorsal view. D. Labels. Scale bar: A, C = 3 mm.

10 ♀♀ (apterous); Qing-yuan City, Guang-dong-di-yi Mountain; 24°47'42.1" N, 112°54'47.5" E; 696 m a.s.l.; 21 Jul. 2019; Si-ying Fu leg.; NKUM • 1 ♂, 2 ♀♀ (apterous); Shao-guan City, Nan-ling; 24°54'58.4" N, 113°2'47.6" E; 513 m a.s.l.; 5 Jun. 2016; Ya-hui Zhen leg.; NKUM. – **Guangxi Province** • 1 ♂, 1 ♀ (apterous); Gui-lin City, Long-sheng County, Hua-ping National Nature Reserve; 25°41'11.5" N, 109°56'59.1" E; 540–800 m a.s.l.; 18 Jul. 2009; Zhong-hua Fan leg.; NKUM • 2 ♂♂, 3 ♀♀ (apterous); Laibin City, Jin-xiu County, Da-yao Mountain; 24°8'40.2" N, 110°4'49.1" E; 565 m a.s.l.; 25 Jul. 2019; Zhen Ye leg.; NKUM. – **Guizhou Province** • 1 ♀ (apterous); Zun-yi City, Kuan-kuo-shui National Nature Reserve; 28°5'9.4" N, 107°14'47.5" E; Jul. 2012; Tong-yin Xie leg.; NKUM. – **Fujian Province** • 1 ♂, 2 ♀♀ (apterous); Nan-ping City, Wu-yi Mountain; 27°38'53.1" N, 117°58'20.1" E; 18 Jul. 2018; Si-ying Fu, Kun Jiang and Xin Yang leg.; NKUM. – **Hubei Province** • 64 ♂♂, 55 ♀♀ (apterous); Huang-gang City, Ying-shan County, Jiu-gong Mountain; 29°22'08.6" N, 114°34'36.5" E; 700 m a.s.l.; 3 Aug. 2010; Wen-jun Bu *et al.* leg.; NKUM • 13 ♂♂, 16 ♀♀ (apterous); Huang-gang City, Ying-shan County, Jiu-gong Mountain; 29°23'59.7" N, 114°39'24.5" E; 130 m a.s.l.; 11 Jul. 2022; Zhao-qi Leng and Zhen Ye leg.; NKUM. – **Hunan Province** • 4 ♂♂, 5 ♀♀ (apterous); Shao-yang City, Dong-kou County, Luo-xi; 27°2'19.4" N, 110°13'48.6" E; 500 m a.s.l.; 27 Jul. 2016; Yan-chen Li and Chen-guang Zheng leg.; NKUM. – **Jiangxi Province** • 2 ♂♂, 2 ♀♀ (apterous); Lu-shan City, Gu-ling County; 9 Aug. 1934; O. Piel leg.; IZAS. – **Sichuan Province** • 4 ♂♂, 3 ♀♀ (apterous); Lu-zhou City, Huang-jing; 28°14'57.3" N, 105°44'39.5" E; 886 m a.s.l.; 7 Aug. 2016; Chen-guang Zheng leg.; NKUM • 1 ♀ (apterous); Le-shan City, Mu-chuan County, Hei-xiong Valley; 28°52'26.8" N, 103°57'31.1" E; 1090 m a.s.l.; 2 Aug. 2017; Chen-guang Zheng leg.; NKUM.

### Supplemental description

#### Apterous female

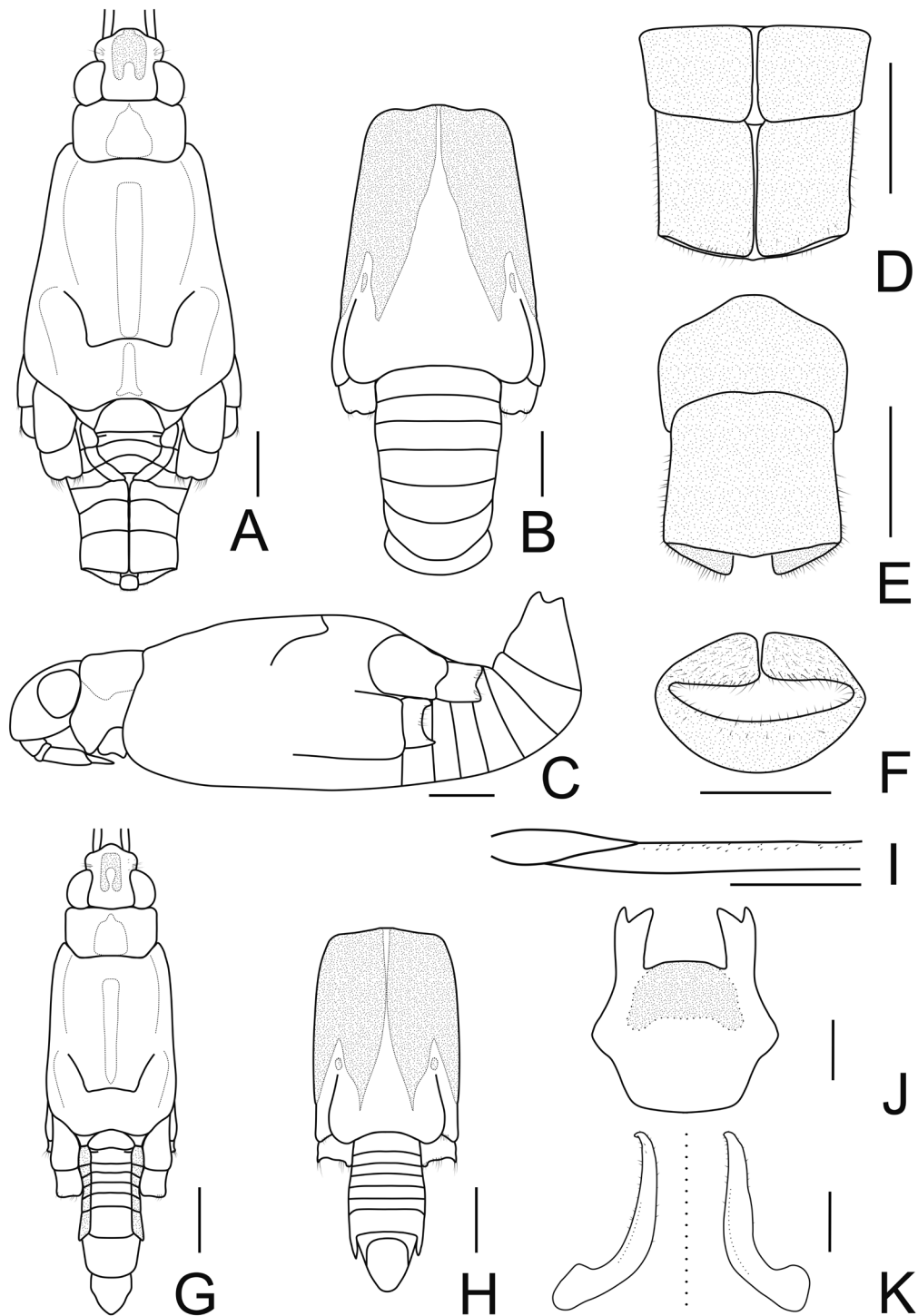
MEASUREMENTS. Body length 7.21–9.64, width 3.03–3.53, head width 1.63, interocular width 0.66, eye length (dorsal view) 0.62; relative lengths of antennal segments I–IV: 4.18:1.31:1.35:1.05; pronotum: length 0.81, width 1.71; mesonotum: length 2.57, width 3.30; metanotum: length 0.86, width 3.09; abdomen length (ventral view) 2.70; abdominal sternum VII: length 0.84, width 1.48; abdominal mediotergite I: length 0.49, width 1.29; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 4.17:3.66:2.17:0.95, middle leg: 12.27:7.72:4.48:0.48, hind leg: 12.78:6.41:0.21:0.27.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3J, 28A). Connexivum dorsally brownish-yellow. Abdominal tergum I yellow or with a yellow marking. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 28B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively short, with posterior part curved dorsad to oblique position (Figs 5I, 28C). Connexiva erect anteriorly, reflexed above terminal mediotergites (Figs 3J, 28A), or never converging. Abdominal segment VII elongate (Fig. 28C), nearly as long as two preceding abdominal segments together ventrally, completely enclosing genital segments (Fig. 28D). Both sides of abdominal segment VII folded mesad on dorsal side, almost meeting each other over mediotergite (Fig. 28D–F), posterior margin of sternum VII truncate or with obtuse angle (Fig. 28E).

#### Apterous male

MEASUREMENTS. Body length 5.70–6.60, width 1.70–1.90, head width 1.26, interocular width 0.50, eye length (dorsal view) 0.49; relative lengths of antennal segments I–IV: 2.90:0.95:1.01:0.75; pronotum: length 0.65, width 1.35; mesonotum: length 1.85, width 1.94; metanotum: length 0.55, width 1.78; abdomen length (ventral view) 2.21; abdominal sternum VII: length 0.42, width 0.91; abdominal mediotergite I: length 0.29, width 0.66; relative lengths of leg segments (femur:tibia:tarsal



**Fig. 28.** Morphological features of *Rhyacobates edentatus* Andersen & Chen, 1995. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, dorsal view. **E.** Abdominal end of female, ventral view. **F.** Abdominal end of female, caudal view. **G.** Body of male, dorsal view. **H.** Body of male, excluding head and prothorax, ventral view. **I.** Basal part of right middle leg of male, ventral view. **J.** Proctiger of male, dorsal view. **K.** Left paramere, lateral aspect, two different views. Scale bars: A–I = 1 mm; J–K = 0.2 mm.

segment I:tarsal segment II): fore leg: 3.12:2.41:0.89:0.58, middle leg: 8.77:7.09:3.31:0.34, hind leg: 9.48:3.50:0.14:0.19.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 4G, 28G). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, narrower than that of female (Fig. 28H). Abdominal venter light yellow.

**LEG.** Middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 28I).

**GENITALIA.** Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger with angular lobes laterally (Figs 6I, 28J). Paramere relatively slender, curved at basal third, distal part tapering towards hook-shaped apex (Figs 8G, 28K).

### **Distribution**

China: Fujian, Guizhou, Hunan, Hubei, Sichuan, Yunnan (first records); Guangdong, Guangxi (Andersen & Chen 1995).

### **Comparative notes**

*Rhyacobates edentatus* can be distinguished from the other species of *Rhyacobates* by the combination of following features of the female: the posterior part of the abdomen is curved dorsad to an oblique position, both sides of abdominal segment VII are dorsally folded mesad, almost meeting each other over the mediotergite (Fig. 28D–F), and the posterior margin of sternum VII is obtusely angled or truncate, and without posterior processes (Fig. 28E).

### ***Rhyacobates gongvo* Tran & Yang, 2006** Figs 3K, 4H, 5J, 7A

*Rhyacobates gongvo* Tran & Yang, 2006: 16–19, figs 17–25, 28 (original description).

*Rhyacobates gongvo* – Tran & Nguyen 2016: 513, figs 41–42 (with remarks).

### **Diagnosis**

Body length of apterous females 7.80–8.30, of apterous males 6.20–6.50. Color (Figs 3K, 4H): head yellow with black markings; pronotum: of female with a large subtriangular yellow marking, of male with subovate yellow spot; in apterous form, mesonotum with yellow median stripe; metanotum: of female completely black, without yellow markings, of male chiefly black, usually with very thin yellow median stripe. Female: abdomen elongate and straight (Fig. 5J); ventral length of pregenital abdomen about 0.4 times body length; posterior part of abdominal segment VII slightly depressed dorso-ventrally; connexival processes of segment VII long, straight, flat (Fig. 3K); sternum VII not totally enclosing genital segments, posterior margin straight, without process (Fig. 3K). Male: length of middle tibia ca 2.1 times length of hind tibia; pygophore simple; proctiger with angular lobes laterally (Fig. 7A); paramere slender, strongly curved at basal third, then tapering towards narrow apex.

### **Material examined**

#### **Type specimens**

See Tran & Yang (2006).

### Non-type specimens

VIETNAM • 1 ♂, 1 ♀ (apterous); Lào Cai Province, Sa Pa, Cát Cát, Ho stream (feeder stream of Mườ̄ng Hoa stream); 22°19'32.9" N, 103°49'52.9" E; 27 Oct. 2020; A.D. Tran leg.; TAD20-23; ZVNU • 1 ♀ (apterous); same collection data as for preceding; NKUM.

GPS data of previous records: see Tran & Yang (2006), Tran & Nguyen (2016).

### Distribution

Vietnam: Lào Cai (Tran & Yang 2006; Tran & Nguyen 2016).

### Comparative notes

This species is most similar to *R. malaisei*, which was discussed by Tran & Yang (2006: 18–19). Here, we provide further comparative notes between the two species. *Rhyacobates gongvo* and *R. malaisei* share the following characteristics of the female: (1) the metanotum is completely black, without yellow markings (Fig. 3K, M); (2) the abdomen is relatively straight and elongate; (3) the connexiva of abdominal segments I–VI are blackish, forming straight lines in dorsal view (Fig. 3K, M); (4) abdominal segment VII has a pair of pointed or angular lateral processes (Figs 3K, 5J, L, 30G); and (5) the posterior margin of sternum VII is truncate or slightly sunken, without a median process (Fig. 30F). The key differences between these two species are as follows: in the female of *R. gongvo*, the connexiva of abdominal segment VII do not meet each other over the dorsum (Fig. 3K), whereas in the female of *R. malaisei*, the connexiva of abdominal segment VII are more developed, curved mesad and meeting over the middle of the abdominal dorsum (Figs 3M, 30D–E). In the male of *R. gongvo*, the lateral lobes of the proctiger are angular (Fig. 7A), whereas in *R. malaisei*, each lateral lobe of the proctiger has an angular process directed ventrad (Figs 7C, 30K).

### *Rhyacobates lundbladi* (Hungerford, 1957)

Figs 2C, 3L, 4I, 5K, 7B, 8H, 29

*Esakobates lundbladi* Hungerford, 1957: 33–36 (original description).

*Rhyacobates lundbladi* – Hungerford & Matsuda 1959: 69–72. — Matsuda 1960: 273–276, figs 659, 661, 665, 667, 669–672, 677, 679–680. — Andersen & Chen 1995: 61–62, figs 26–27 (with remarks).

### Diagnosis

Body length of apterous females 11.62–12.21, of apterous males 8.02–8.41. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3L, 29A); yellowish subtriangular marking on metanotum similar to the marking on pronotum (Figs 3L, 29A); posterior margin of abdominal mediotergite VII with a short median process (Fig. 29A, D); abdominal segment VII with four distinct processes, including two lobe-like processes on each connexival corner, consisting of one broader, posteriorly directed outer process and a narrower inner process (Fig. 29D–F); posterior margin of sternum VII with a small, rounded median process (Fig. 29E). Male: middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 29J); length of middle tibia ca 1.5–1.6 times length of hind tibia; proctiger relatively large, with angular lobes laterally (Figs 7B, 29K); paramere relatively slender and sinuate, middle part thickened, distal part tapering towards narrowly rounded apex (Figs 8H, 29L).

### Material examined

#### Non-type specimens

CHINA – **Hunan Province** • 10 ♂♂, 7 ♀♀ (apterous); Shao-yang City, Dong-kou County, Luo-xi; 27°2'19.4" N, 110°13'48.6" E; 500 m a.s.l.; 27 Jul. 2016; Yan-chen Li and Chen-guang Zheng leg.;



NKUM. – **Jiangxi Province** • 1 ♀ (apterous); Lu-shan City, Gu-ling County; 16 Jul. 1935; O. Piel leg.; IZAS • 1 ♂ (dealated macropterous); Lu-shan City, Gu-ling County; 16 Jul. 1935; O. Piel leg.; IZAS.

### Supplemental description

#### Apterous female

MEASUREMENTS. Body length 11.62–12.21, width 2.60–3.08, head width 1.67, interocular width 0.81, eye length (dorsal view) 0.66; relative lengths of antennal segments I–IV: 5.11:1.24:1.67:1.10; pronotum: length 0.91, width 1.78; mesonotum: length 2.94, width 3.34; metanotum: length 0.81, width 3.08; abdomen length (ventral view) 5.68; abdominal sternum VII: length 1.95, width 1.53; abdominal mediotergite I: length 0.52, width 1.41; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 5.28:4.51:3.05:1.10, middle leg: 13.71:7.95:3.68:0.51, hind leg: 14.10:6.73:0.17:0.21.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3L, 29A). Yellowish subtriangular marking on metanotum similar with the one on pronotum. Connexivum dorsally brownish-yellow. Abdominal tergum I with a median yellow marking. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 29B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively long, slightly curved dorsad towards end (Fig. 29C). Connexiva erect on abdominal segments I–VI, subparallel to each other above mediotergites, reflexed over terminal mediotergites, nearly meeting each other above mediotergite VII (Fig. 29D). Posterior margin of abdominal mediotergite VII with a short median process. Abdominal segment VII elongate, moderately curved dorsad towards end or nearly straight, about as long as two preceding abdominal segments together (Figs 5K, 29C). Posterior margin of abdominal segment VII with four distinct processes, including two lobe-like processes on each connexival corner (Fig. 29D–F), one broader, posteriorly-directed outer lobe and the other narrower pointed inner lobe, ventrally with a small, median process (Fig. 29E).

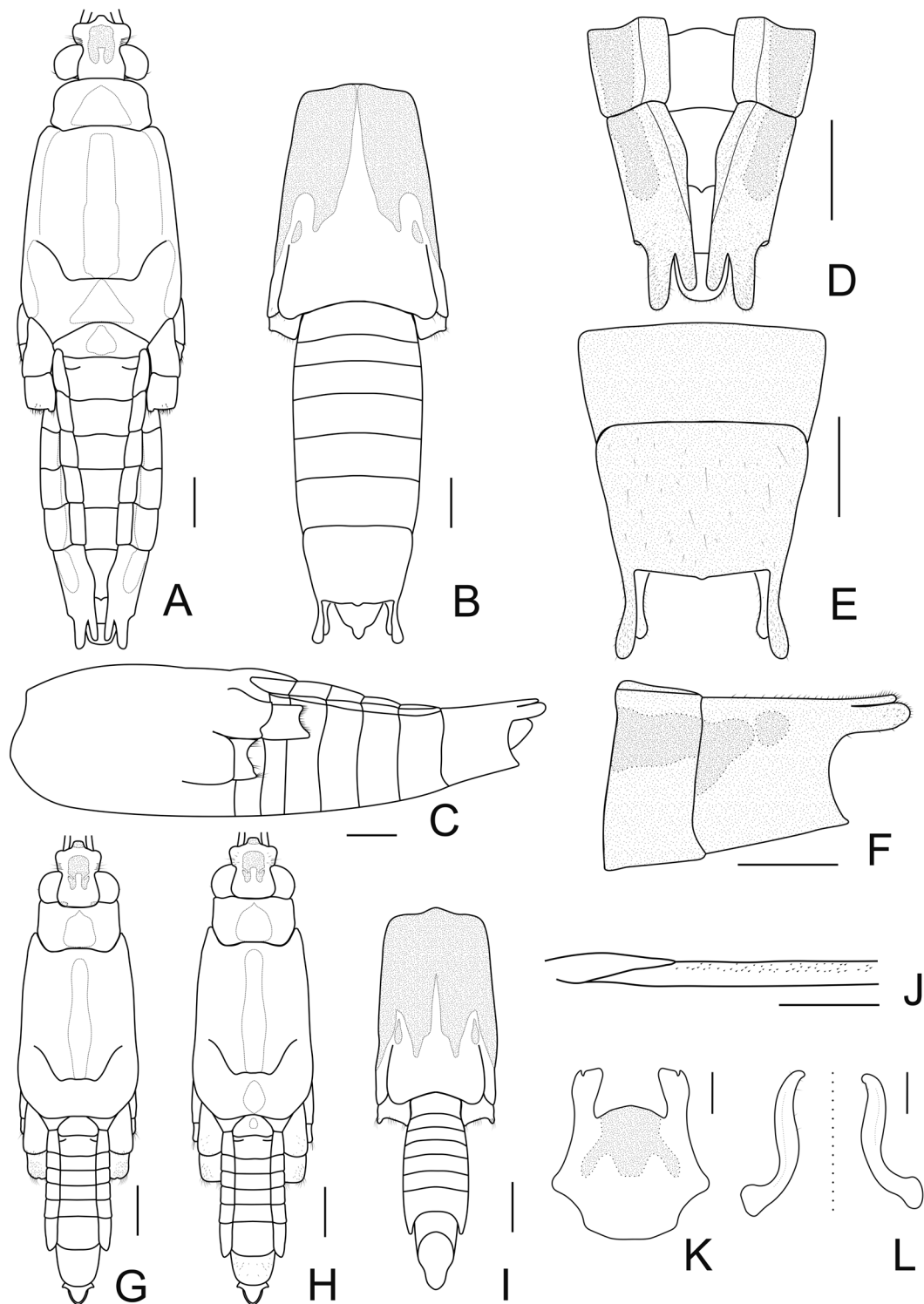
#### Apterous male

MEASUREMENTS. Body length 8.02–8.41, width 2.00–2.60, head width 1.54, interocular width 0.83, eye length (dorsal view) 0.60; relative lengths of antennal segments I–IV: 4.12:1.02:1.35:0.94; pronotum: length 0.75, width 1.66; mesonotum: length 2.33, width 2.41; metanotum: length 0.61, width 2.06; abdomen length (ventral view) 3.08; abdominal sternum VII: length 0.59, width 1.22; abdominal mediotergite I: length 0.40, width 0.87; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 4.15:3.41:1.38:0.70, middle leg: 11.32:6.44:2.63:0.43, hind leg: 10.71:4.08:0.14:0.20.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum with two color forms: one without (Fig. 29G) and the other with (Figs 4I, 29H) yellow marking on metanotum and abdominal tergum I. Individuals of the two types were found mixed in the same population. Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, narrower than that of female (Fig. 29I). Abdominal venter light yellow.

LEG. Middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 29J).

GENITALIA. Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger relatively large, with angular lobes laterally (Figs 7B, 29K). Paramere relatively slender and sinuate, middle part thickened, distal part tapering towards narrowly rounded apex (Figs 8H, 29L).



**Fig. 29.** Morphological features of *Rhyacobates lundbladi* (Hungerford, 1957). **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, dorsal view. **E.** Abdominal end of female, ventral view. **F.** Abdominal end of female, lateral view. **G–H.** Body of male, dorsal view. **I.** Body of male, excluding head and prothorax, ventral view. **J.** Basal part of right middle leg of male, ventral view. **K.** Proctiger of male, dorsal view. **L.** Left paramere, lateral aspect, two different views. Scale bars: A–J = 1 mm; K–L = 0.2 mm.

**Distribution**

China: Hunan (first record); Zhejiang (Andersen & Chen 1995).

**Comparative notes**

*Rhyacobates lundbladi* is closely related to *R. svenhedini* due to their large body sizes, the bilobate processes on the connexival corners of abdominal segment VII and the median process on posterior margin of abdominal mediotergite VII (Figs 3L, P, 29D, 34D). However, *R. lundbladi* differs from *R. svenhedini* by the combination of following characteristics of the female: (1) in *R. lundbladi*, the subtriangular yellowish marking on metanotum is wide, with larger apex angle (Figs 3L, 29D), whereas in *R. svenhedini*, the subtriangular yellowish marking on metanotum is relatively thin, with sharp apex angle (Figs 3P, 34D); (2) in *R. lundbladi* the inner processes on the connexivum of abdominal segment VII are elongate (Fig. 29D), whereas that in *R. svenhedini* is very small (Fig. 34D).

***Rhyacobates malaisei* Andersen & Chen, 1995**  
Figs 3M, 4J, 5L, 7C, 8I, 30

*Rhyacobates malaisei* Andersen & Chen, 1995: 59–61, figs 18–61 (original description).

**Diagnosis**

Body length of apterous females 7.00–9.82, of apterous males 6.00–6.81. Female: pronotum mainly black with a median subtriangular brownish-yellow spot; mesonotum mainly black with a median brownish-yellow stripe; metanotum completely black, without median yellow stripe; connexiva erect on abdominal segments I–VI, parallel to each other above mediotergites, curved mesad over mediotergite VII (Fig. 30A), meeting in middle of abdominal dorsum (Fig. 30D) or overlapping each other (Fig. 30E); abdominal segment VII dorsally with a long process terminating each connexivum (Fig. 30F), posterior margin of the long process with dense setae; abdominal segment VII laterally with a pair of small, pointed processes (Fig. 30G); posterior margin of sternum VII truncate or slightly sunken, without median process (Fig. 30F). Male: median black spot of head posteriorly bifurcate and extending to the hind margin of head; pronotum mainly black with a median subtriangular brownish-yellow spot; middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 30J); length of middle tibia ca 2.0–2.1 times length of hind tibia; proctiger widened, with angular lateral lobes produced into small process directing postero-ventrad (Figs 7C, 30K); paramere relatively slender and evenly curved, apex slightly spatulate (Figs 8I, 30L).

**Material examined****Non-type specimens**

CHINA – **Yunnan Province** • 1 ♂, 4 ♀♀ (apterous); An-ning City, Qing-long County; 25°0'58.1" N, 102°19'35.2" E; 790 m a.s.l.; 28 Jun. 2016; Hua-xi Liu leg.; NKUM • 7 ♂♂, 8 ♀♀ (apterous); Da-li City; Yang-bi County; 25°42'25.3" N, 99°56'49.8" E; 1500 m a.s.l.; 20 Aug. 2006; Xu Zhang leg.; NKUM • 2 ♂♂ (apterous); Kun-ming City; Mu-yang River; 23°4'4.7" N, 113°12'15.0" E; 2041 m a.s.l.; 3 Oct. 2022; Xun Hao leg.; NKUM.

**Supplemental description****Apterous female**

MEASUREMENTS. Body length 7.00–9.82, width 2.10–2.88, head width 1.48, interocular width 0.75, eye length (dorsal view) 0.53; relative lengths of antennal segments I–IV: 3.88:1.03:1.35:0.91; pronotum: length 0.80, width 1.68; mesonotum: length 2.53, width 2.88; metanotum: length 0.78, width 2.44; abdomen length (ventral view) 4.83; abdominal sternum VII: length 1.96, width 1.51; abdominal mediotergite I: length 0.46, width 1.38; relative lengths of leg segments (femur : tibia : tarsal

segment I : tarsal segment II): fore leg: 3.85 : 3.15 : 1.52 : 0.85, middle leg: 10.85 : 5.91 : 2.53 : 0.34, hind leg: 10.91 : 3.47 : 0.19 : 0.20.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median subtriangular brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly black, without yellow markings (Figs 3M, 30A). Connexivum dorsally blackish. Venter of female chiefly blackish with a median yellowish spot (Fig. 30B). Abdominal venter light yellow.

**ABDOMEN.** Abdomen elongate, nearly straight, moderately curved dorsad towards end (Fig. 30C). Connexiva erect on abdominal segments I–VI, parallel to each other above mediotergites, reflexed over abdominal mediotergite VII (Fig. 30A), meeting in middle of abdominal dorsum (Fig. 30D) or overlapping each other (Fig. 30E). Abdominal segment VII elongate, nearly as long as two preceding abdominal segments together ventrally (Figs 5L, 30C), completely enclosing genital segments (Fig. 30D–E). Abdominal segment VII dorsally with a long process terminating each connexivum (Fig. 30F), posterior margin of the long process with dense setae. Abdominal segment VII laterally with a pair of small, pointed processes (Fig. 30G), posterior margin of sternum VII truncate or slightly sunken, without median process (Fig. 30F).

#### **Apterous male**

**MEASUREMENTS.** Body length 6.00–6.81, width 1.70–1.98, head width 1.21, interocular width 0.54, eye length (dorsal view) 0.48; relative lengths of antennal segments I–IV: 3.58 : 0.89 : 1.23 : 0.72; pronotum: length 0.69, width 1.32; mesonotum: length 1.91, width 1.98; metanotum: length 0.42, width 1.73; abdomen length (ventral view) 2.57; abdominal sternum VII: length 0.43, width 0.66; abdominal mediotergite I: length 0.25, width 0.62; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.54 : 3.01 : 1.03 : 0.54, middle leg: 10.11 : 5.03 : 2.75 : 0.31, hind leg: 10.56 : 2.56 : 0.13 : 0.16.

**COLORATION.** Median black spot of head posteriorly bifurcate and extending to the hind margin of head. Pronotum mainly black with a median brownish-yellow spot, which is subtriangular-shaped. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly black, without yellow markings (Figs 4J, 30H). Connexivum dorsally blackish. Mesosternum mainly blackish with a median brownish small spot (Fig. 30I). Abdominal venter dark-brownish.

**ABDOMEN.** Abdominal mediotergite I not swollen, fully covered with silvery pubescence.

**LEG.** Middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 30J).

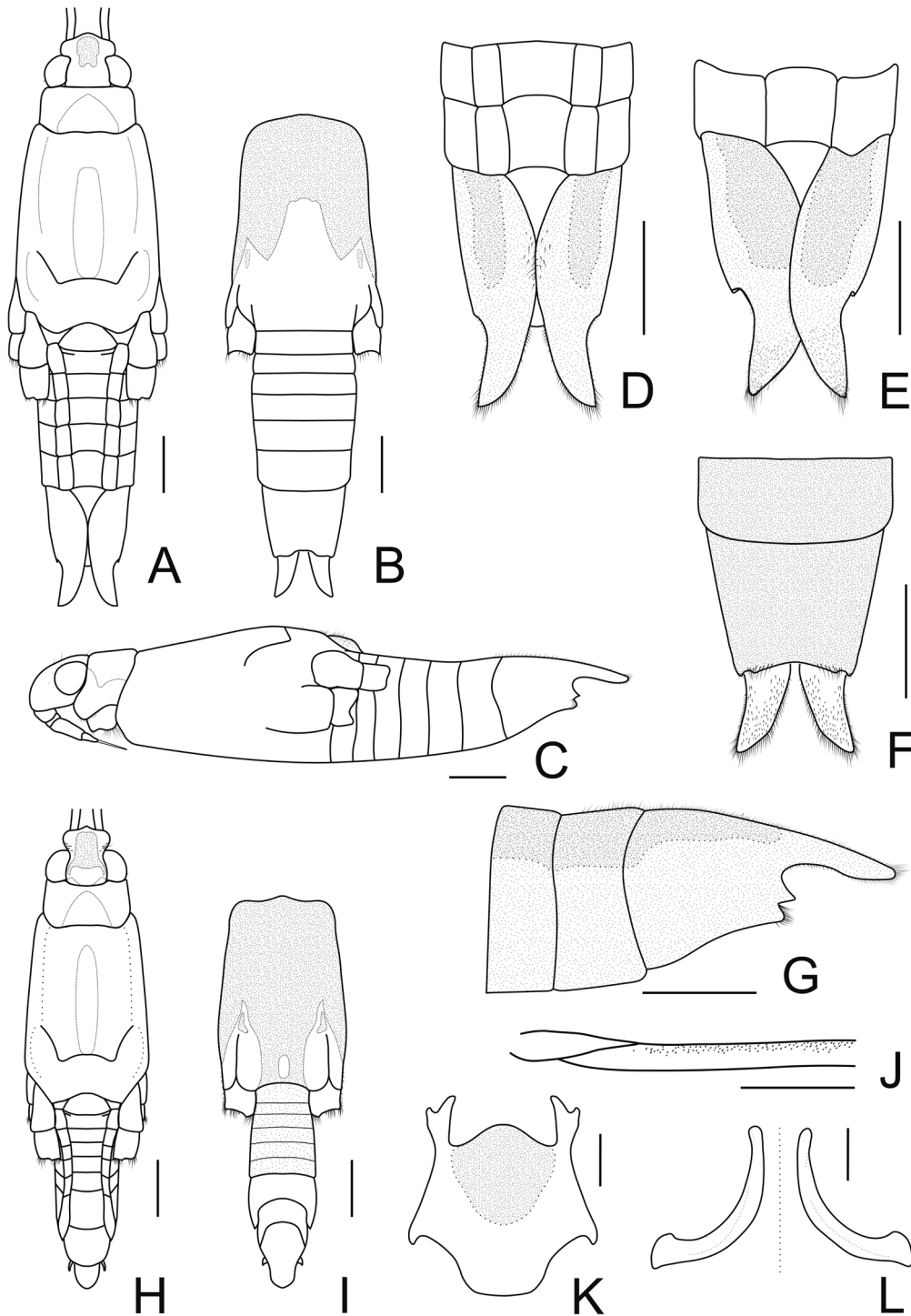
**GENITALIA.** Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger widened, with angular lateral lobes produced into small process directed postero-ventrad (Figs 7C, 30K). Paramere relatively slender and evenly curved, apex slightly spatulate (Figs 8I, 30L).

#### **Distribution**

China: Yunnan; Thailand: Chiang Mai; Myanmar: Bumgahtuang-Hpungan (Andersen & Chen 1995).

#### **Comparative notes**

*Rhyacobates malaisei* is most similar to *R. gongvo*; see comparative notes under *R. gongvo*.



**Fig. 30.** Morphological features of *Rhyacobates malaisei* Andersen & Chen, 1995. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D–E.** Abdominal end of female, dorsal view. **F.** Abdominal end of female, ventral view. **G.** Abdominal end of female, lateral view. **H.** Body of male, dorsal view. **I.** Body of male, excluding head and prothorax, ventral view. **J.** Basal part of right middle leg of male, ventral view. **K.** Proctiger of male, dorsal view. **L.** Left paramere, lateral aspect, two different views. Scale bars: A–J = 1 mm; K–L = 0.2 mm.

*Rhyacobates recurvus* Andersen & Chen, 1995  
Figs 3N, 4K, 5M, 7D, 8J, 14, 31

*Rhyacobates recurvus* Andersen & Chen, 1995: 59, figs 16–17 (original description).

**Diagnosis**

Body length of apterous females 7.06–8.71, of apterous males 5.42–5.91. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3N, 31A); abdomen relatively short, with posterior part distinctly curved dorsad to oblique or nearly vertical position (Figs 8J, 31C); abdominal mediosternite VII tapering caudad, posterior margin with a median process; apex of the process pointed and hook-shaped (Fig. 31D, F). Male: middle trochanter with one spine; middle femur with scattered small spines, not arranged in distinct row (Fig. 31I); length of middle tibia ca 1.6 times length of hind tibia; proctiger laterally with rounded lobes (Figs 7D, 31J); paramere relatively slender, strongly curved at basal fourth, middle part thickened, distal part tapering towards narrowly rounded apex (Figs 8J, 31J).

**Material examined**

**Non-type specimens**

CHINA – **Hubei Province** • 7 ♂♂, 5 ♀♀ (apterous); Huang-gang City, Ying-shan County, Jiu-gong Mountain; 29°3'25.6" N, 107°5'55.1" E; 130 m a.s.l.; 11 Jul. 2022; Zhao-qi Leng and Zhen Ye leg.; NKUM. – **Jiangxi Province** • 1 ♂, 2 ♀♀ (apterous); Nan-chang City; 2 Jun. 1919; IZAS. – **Zhejiang Province** • 3 ♀♀ (apterous); Jin-hua City, Pan-an County, Da-pan Mountain; 28°58'30.1" N, 120°31'36.4" E; 29 Jul. 2015; Wen-bo Yi leg.; NKUM.

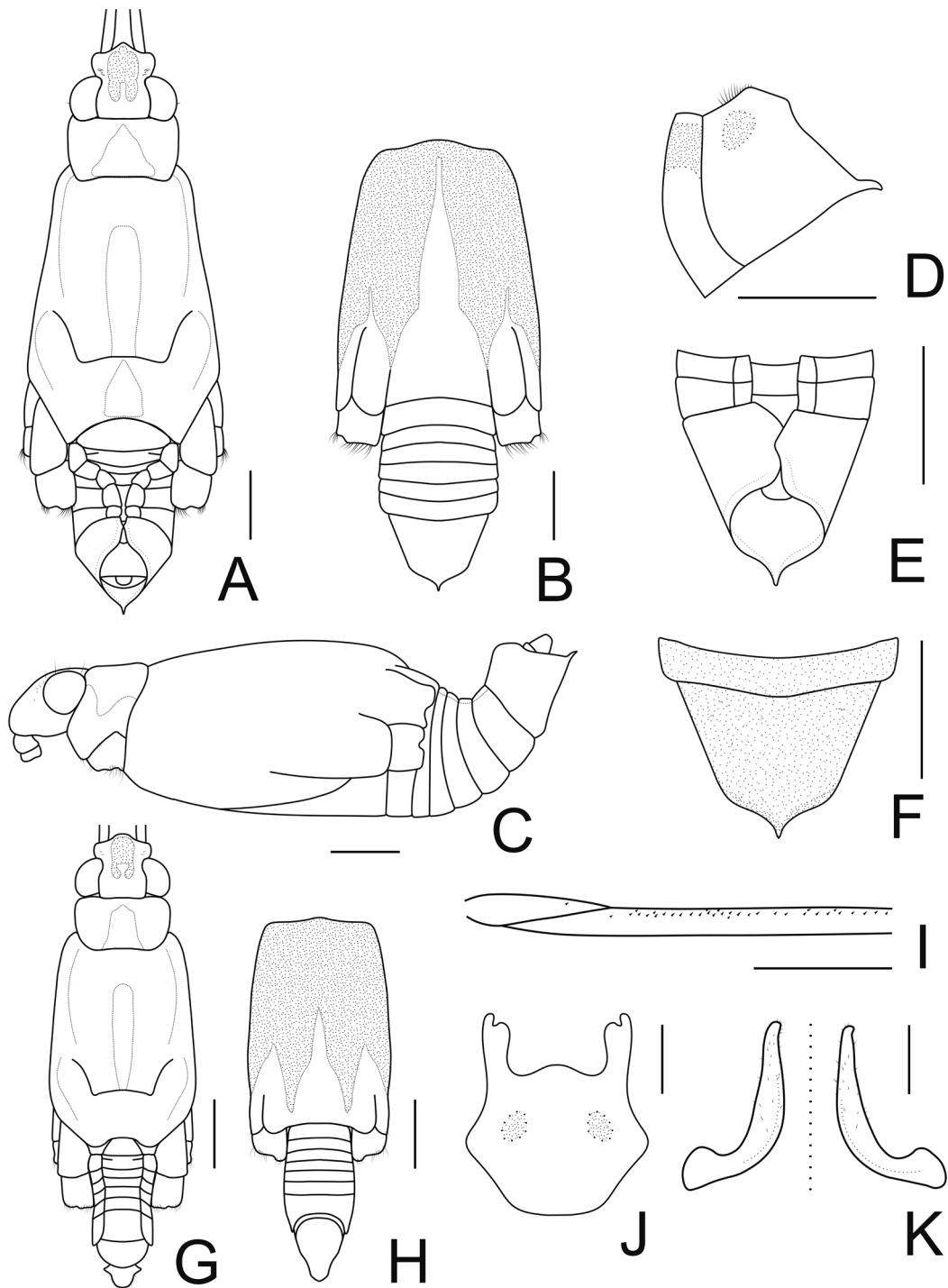
**Supplemental description**

**Apterous female**

MEASUREMENTS. Body length 7.06–8.71, width 2.63–2.90, head width 1.42, interocular width 0.53, eye length (dorsal view) 0.60; relative lengths of antennal segments I–IV: 3.95 : 1.05 : 0.93 : 0.78; pronotum: length 0.74, width 1.52; mesonotum: length 2.44, width 2.63; metanotum: length 0.69, width 2.34; abdomen length (ventral view) 1.96; abdominal sternum VII: length 0.90, width 1.12; abdominal mediotergite I: length 0.28, width 1.09; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.10 : 3.65 : 1.67 : 0.83, middle leg: 12.02 : 6.95 : 2.91 : 0.38, hind leg: 12.35 : 5.05 : 0.16 : 0.18.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 3N, 31A). Abdominal tergum I with yellowish spots on each side or completely yellow. Connexivum dorsally brownish-yellow. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 31B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively short, with posterior part distinctly curved dorsad to oblique or nearly vertical position (Figs 5M, 31C). Connexiva erect on abdominal segments I–II, converging along dorsal midline of segments III–VI, reflexed above terminal terga (Fig. 31A). Abdominal segment VII elongate, ventral margin longer than dorsal margin in lateral view (Figs 5M, 31C), nearly as long as three preceding abdominal segments together, not completely enclosing genital segments (Fig. 31D); laterosternites of connexivum VII expanded dorsad, folded mesad (Fig. 31A), meeting in middle of abdominal dorsum or overlapping each other (Fig. 31E). Abdominal sternum VII tapering caudad, posterior margin with a median process; apex of the process pointed and hook-shaped (Fig. 31D, F).



**Fig. 31.** Morphological features of *Rhyacobates recurvus* Andersen & Chen, 1995. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, lateral view. **E.** Abdominal end of female, dorsal view. **F.** Abdominal end of female, ventral view. **G.** Body of male, dorsal view. **H.** Body of male, excluding head and prothorax, ventral view. **I.** Basal part of right middle leg of male, ventral view. **J.** Proctiger of male, dorsal view. **K.** Left paramere, lateral aspect, two different views. Scale bars: A–I = 1 mm; J–K = 0.2 mm.

### **Apterous male**

MEASUREMENTS. Body length 5.42–5.91, width 1.73–2.01, head width 1.23, interocular width 0.41, eye length (dorsal view) 0.49; relative lengths of antennal segments I–IV: 2.93:0.93:0.97:0.73; pronotum: length 0.64, width 1.27; mesonotum: length 1.78, width 1.83; metanotum: length 0.63, width 1.73; abdomen length (ventral view) 1.91; abdominal sternum VII: length 0.42, width 0.79; abdominal mediotergite I: length 0.21, width 0.56; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 3.08:2.64:0.88:0.54, middle leg: 9.64:4.87:2.17:0.32, hind leg: 10.06:3.10:0.13:0.16.

COLORATION. Median black spot of head posteriorly bifurcate. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 4K, 31G). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, narrower than that of female (Fig. 31H). Abdominal venter light yellow.

LEG. Middle trochanter with one spine; middle femur with scattered small spines, not arranged in distinct row (Fig. 31I).

GENITALIA. Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger with rounded lobes laterally (Figs 7D, 31J). Paramere relatively slender, strongly curved at basal fourth, middle part thickened, distal part tapering towards narrowly rounded apex (Figs 8J, 31J).

### **Distribution**

China: Hubei, Zhejiang (first records); Jiangxi (Andersen & Chen 1995).

### **Comparative notes**

*Rhyacobates recurvus* is most similar to *R. turgidus* sp. nov.; see comparative notes under *R. turgidus*.

### **Remarks**

Andersen & Chen (1995) described this species based on a single female specimen from Jiangxi, China. In this study, we have collected both males and females from Hubei and Zhejiang, China; thus, we can provide a description of the apterous male and additional distribution information.

*Rhyacobates scorpio* Andersen & Chen, 1995  
Figs 2D, 3O, 4L, 5N, 7E, 8K, 32–33

*Rhyacobates scorpio* Andersen & Chen, 1995: 62–63, figs 1, 28–32 (original description).

### **Diagnosis**

Body length of apterous females 9.22–11.95, of apterous males 8.01–8.10. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 2D, 3O, 32A, 33A); abdominal segments I–VI straight, with long, blackish setae on mesal margins of the connexivum; abdominal segment VII elongate, abruptly bent dorsad at an angle of about 90° (Figs 5N, 33C), dorsally with an angular process terminating each connexivum (Fig. 33D–F), posterior margin of sternum VII angularly produced in the middle (Fig. 33G). Male: middle trochanter with 3–5 spines; middle femur with spines but not in distinct row (Fig. 33J); length of middle tibia ca 1.2–1.4 times length of hind tibia; proctiger relatively large, with broadly rounded lobes laterally (Figs 7E, 33K); paramere relatively slender, strongly curved at basal fourth, distal part tapering towards hook-shaped apex (Figs 8K, 33L).



## Material examined

### Holotype (Fig. 32A–C)

CHINA • ♀ (apterous); Sichuan Province, Song Ch'i Hsien; Jul. 1938; D.C. Graham leg.; USNM.

### Paratypes (Fig. 32D–G)

CHINA – Sichuan Province • 2 ♂♂, 1 ♀ (apterous); E-mei Mountain, Jie-yin Temple; 14 Jul. 1957; Le-yi Zheng leg.; NKUM • 1 ♀ (apterous); Song Ch'i, Kuanhsien; Aug. 1938; D.C. Graham leg.; USNM • 1 ♀ (apterous); Wenchuan City; Aug. 1938; D.C. Graham leg.; USNM.

### Non-type specimens

CHINA – Sichuan Province • 1 ♂, 1 ♀ (apterous); E-mei-shan City, E-mei Mountain, Qingyin Attic; 29°34'29.7" N, 103°24'38.3" E; 19 Aug. 2013; Zhen Ye leg.; NKUM • 5 ♂♂, 11 ♀♀ (apterous); Le-shan City, Mu-chuan County, Hei-xiong Valley; 28°52'26.8" N, 103°57'31.1" E; 1090 m a.s.l.; 2 Aug. 2017; Chen-guang Zheng leg.; NKUM • 2 ♂♂, 10 ♀♀ (apterous); Ya-an City, Bi-xia Mountain; 30°4'8.9" N, 102°59'34.6" E; 30 Jul. 2016; Chen-guang Zheng leg.; NKUM.

## Supplemental description

### Apterous female

MEASUREMENTS. Body length 9.22–11.95, width 3.31–3.81, head width 1.83, interocular width 0.84, eye length (dorsal view) 0.78; relative lengths of antennal segments I–IV: 4.85 : 1.51 : 1.83 : 1.29; pronotum: length 1.02, width 2.08; mesonotum: length 2.97, width 3.81; metanotum: length 1.25, width 3.28; abdomen length (ventral view) 5.06; abdominal sternum VII: length 1.53, width 1.58; abdominal mediotergite I: length 0.63, width 1.63; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 5.15 : 4.59 : 2.23 : 1.32, middle leg: 14.15 : 8.52 : 5.32 : 0.59, hind leg: 14.31 : 7.92 : 0.21 : 0.28.

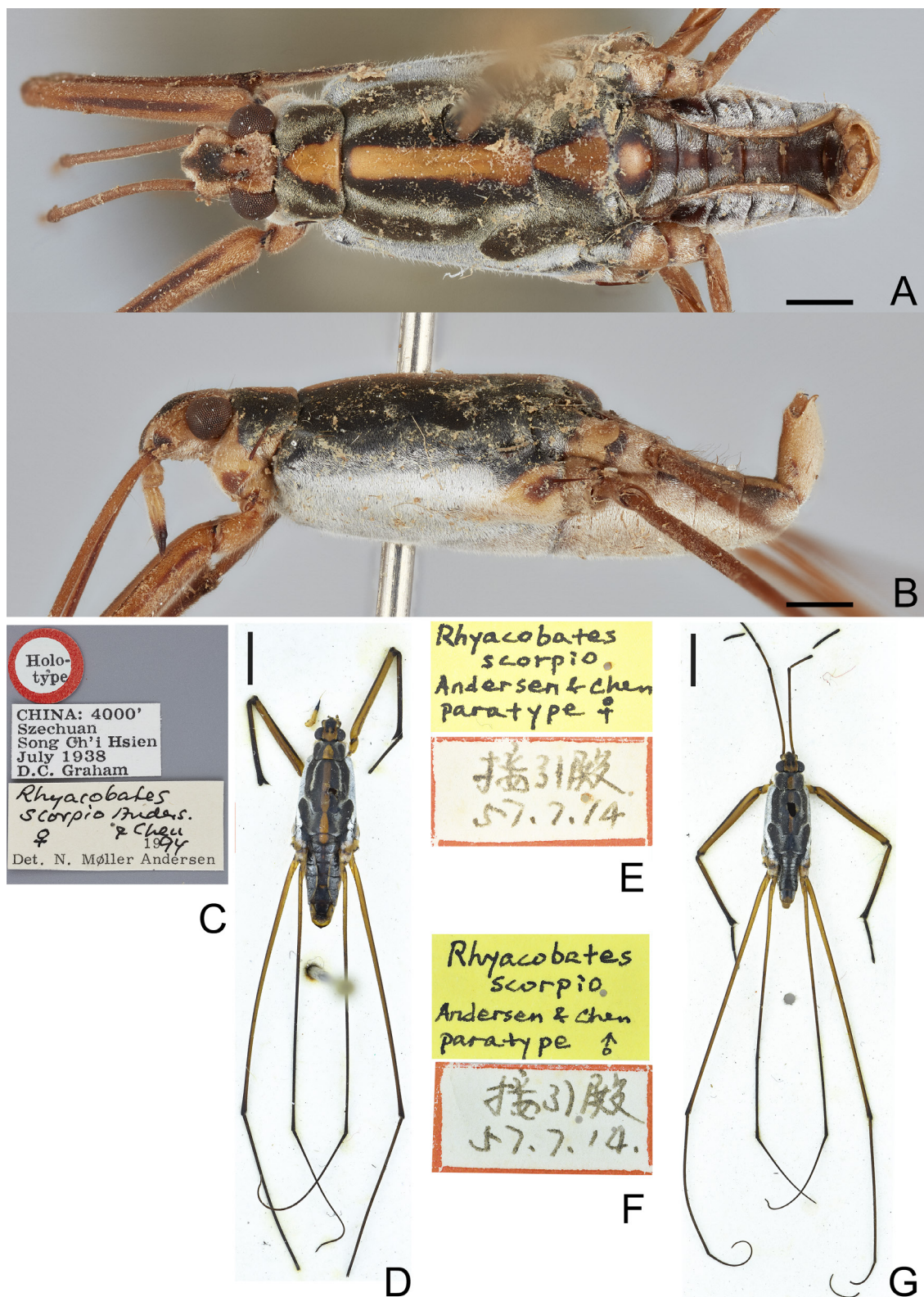
COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Figs 2D, 3O, 32A, 33A). Connexivum dorsally brownish-yellow. Abdominal tergum I with a median yellow marking. Mesosternum chiefly blackish with two median yellowish spots, divided by a blackish line (Fig. 33B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively short, gradually tapering towards apex (Fig. 33C). Connexiva on abdominal segments I–VI erect, not meeting each other above mediotergites, reflexed upon abdominal mediotergite VII (Fig. 33A). Abdominal segment VII elongate, completely enclosing genital segments, nearly as long as two preceding abdominal segments together, abruptly turning dorsad at a maximum angle of about 90°, dorsally with an angular process terminating each connexivum (Fig. 33D–F), posterior margin of sternum VII angularly produced in the middle (Fig. 33G).

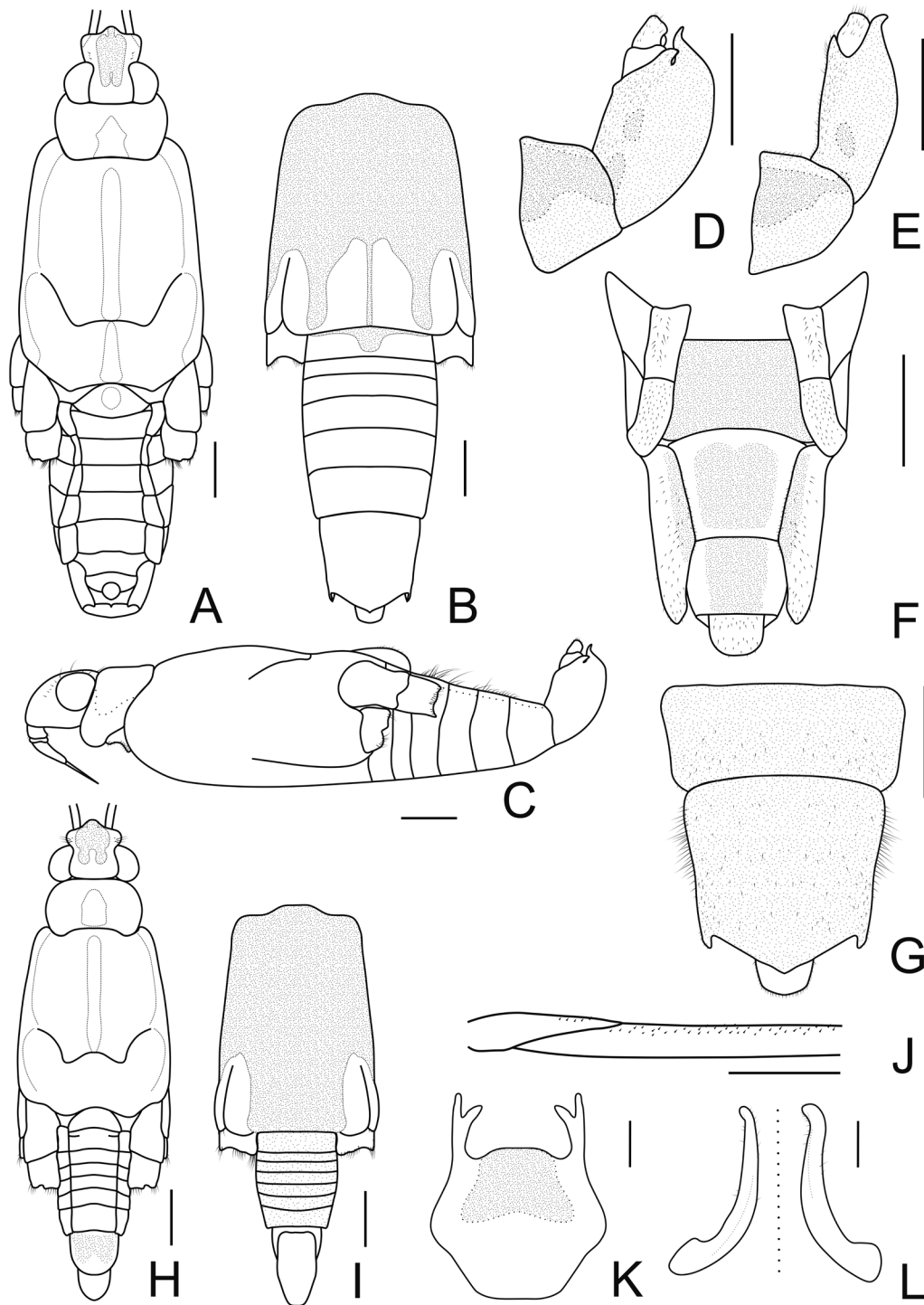
### Dealated macropterous female

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish; abdominal segment VII only weakly turned dorsad.

MEASUREMENTS. Body length 11.31, width 3.58, head width 1.64, interocular width 0.84, eye length (dorsal view) 0.73; relative lengths of antennal segments I–IV: 4.63 : 1.34 : 1.62 : 1.22; pronotum: length 4.61, width 2.81; mesonotum width 3.58; metanotum: length 0.85, width 3.23; abdomen length (ventral view) 4.68; abdominal sternum VII: length 2.15, width 1.63; abdominal mediotergite I: length 0.66, width 1.17; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.68 : 4.28 : 1.98 : 1.15, middle leg: 12.70 : 7.26 : 3.76 : 0.58, hind leg: 13.56 : 6.78 : 0.18 : 0.29.



**Fig. 32.** Photographs of *Rhyacobates scorpio* Andersen & Chen, 1995 and relevant labels. **A–C.** Holotype, apterous female (USNM). **A.** Dorsal view. **B.** Lateral view. **C.** Labels. **D–E.** Paratype, apterous female (NKUM). **D.** Habitus, dorsal view. **E.** Labels. **F–G.** Paratype, apterous male (NKUM). **F.** Labels. **G.** Habitus, dorsal view. Scale bars: A–B = 1 mm; D, G = 3 mm.



**Fig. 33.** Morphological features of *Rhyacobates scorpio* Andersen & Chen, 1995. **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D–E.** Abdominal end of female, lateral view. **F.** Abdominal end of female, dorsal view. **G.** Abdominal end of female, ventral view. **H.** Body of male, dorsal view. **I.** Body of male, excluding head and prothorax, ventral view. **J.** Basal part of right middle leg of male, ventral view. **K.** Proctiger of male, dorsal view. **L.** Left paramere, lateral aspect, two different views. Scale bars: A–J = 1 mm; K–L = 0.2 mm.

### **Apterous male**

MEASUREMENTS. Body length 8.01–8.10, width 1.60–2.81, head width 1.66, interocular width 0.83, eye length (dorsal view) 0.64; relative lengths of antennal segments I–IV: 4.62:1.48:1.70:1.18; pronotum: length 0.91, width 1.83; mesonotum: length 2.38, width 2.81; metanotum: length 0.91, width 2.41; abdomen length (ventral view) 3.72; abdominal sternum VII: length 0.54, width 1.34; abdominal mediotergite I: length 0.41, width 1.06; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 5.16:4.40:1.44:0.70, middle leg: 13.02:7.44:3.78:0.59, hind leg: 13.35:6.13:0.19:0.29.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 4L, 33H). Connexivum dorsally blackish. Mesosternum chiefly blackish with median brownish spots or totally blackish (Fig. 33I). Abdominal venter dark-yellow.

LEG. Middle trochanter with 3–5 spines on distal part; middle femur with spines but not in distinct row (Fig. 33J).

GENITALIA. Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger relatively large, with broadly rounded lobes laterally (Figs 7E, 33K). Paramere relatively long and slender, strongly curved at basal fourth, distal part tapering towards hook-shaped apex (Figs 8K, 33L).

### **Dealated macropterous male**

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish.

MEASUREMENTS. Body length 8.35, width 2.78, head width 1.57, interocular width 0.78, eye length (dorsal view) 0.61; relative lengths of antennal segments I–IV: 4.52:1.43:1.61:1.18; pronotum: length 3.20, width 2.51; mesonotum width 2.78; metanotum width 2.46; abdomen length (ventral view) 2.90; abdominal sternum VII: length 0.51, width 1.33; abdominal mediotergite I: length 0.44, width 1.09; relative lengths of leg segments (femur:tibia:tarsal segment I:tarsal segment II): fore leg: 4.85:4.05:1.38:0.95, middle leg: 13.01:7.55:3.98:0.54, hind leg: 13.45:6.19:0.15:0.23.

### **Distribution**

China: Sichuan (Andersen & Chen 1995).

### **Comparative notes**

The female of *R. scorio* can be distinguished from that of all other species of *Rhyacobates* by the unique shape of its abdomen (Figs 5N, 33C): abdominal segments I–VI are straight, with long, blackish setae on the lateral margins of the connexivum; abdominal segment VII is elongate, and abruptly turns dorsad at a maximum angle of about 90°, dorsally with an angular process terminating each connexivum (Fig. 33D–F), ventrally with a median process (Fig. 33G).

### *Rhyacobates svenhedini* (Lundblad, 1934)

Figs 2E, 3P, 4M–N, 5O, 7F, 8L, 34

*Esakobates svenhedini* Lundblad, 1934: 23–25, pl. 2 fig. 10 (original description).

*Rhyacobates svenhedini* – Hungerford & Matsuda 1959: 69–72. — Matsuda 1960: 273–276. — Andersen & Chen 1995: 61, figs 24–25 (with remarks).

**Diagnosis**

Body length of apterous females 10.30–11.59, of apterous males 7.21–7.90. Female: pronotum mainly black with a median brownish-yellow spot, mesonotum with a median brownish-yellow stripe, metanotum medially with a subtriangular yellow marking and with a sharp apex angle (Figs 2E, 3P, 34A); posterior margin of abdominal mediotergite VII with a short median process; posterior margin of abdominal segment VII with four distinct processes dorsally, including two lobe-like processes on each connexival corner (Fig. 34D–F): one long, posteriorly directed outer process and a smaller, shorter, pointed inner process (in some individuals, the inner process is very small or indistinct); posterior margin of sternum VII with a small angular median process (Fig. 34E). Male: middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 34J); length of middle tibia ca 1.3 times length of hind tibia; proctiger relatively large, with angular lobes laterally (Figs 7F, 34K); paramere strongly curved at basal third, distal part slender, with hook-shaped apex (Figs 8L, 34L).

**Material examined****Non-type specimens**

CHINA—**Sichuan Province** • 31 ♂♂, 52 ♀♀ (apterous); Guang-yuan City, Qing-chuan County, Tang-jia-he; 32°31'25.1" N, 104°49'23.7" E; 1077 m a.s.l.; 16 Jul. 2016; Chen-guang Zheng leg.; NKUM • 2 ♂♂ (macropterous); Guang-yuan City, Qing-chuan County, Tang-jia-he; 32°31'25.1" N, 104°49'23.7" E; 1077 m a.s.l.; 16 Jul. 2016; Chen-guang Zheng leg.; NKUM.

**Supplemental description****Apterous female**

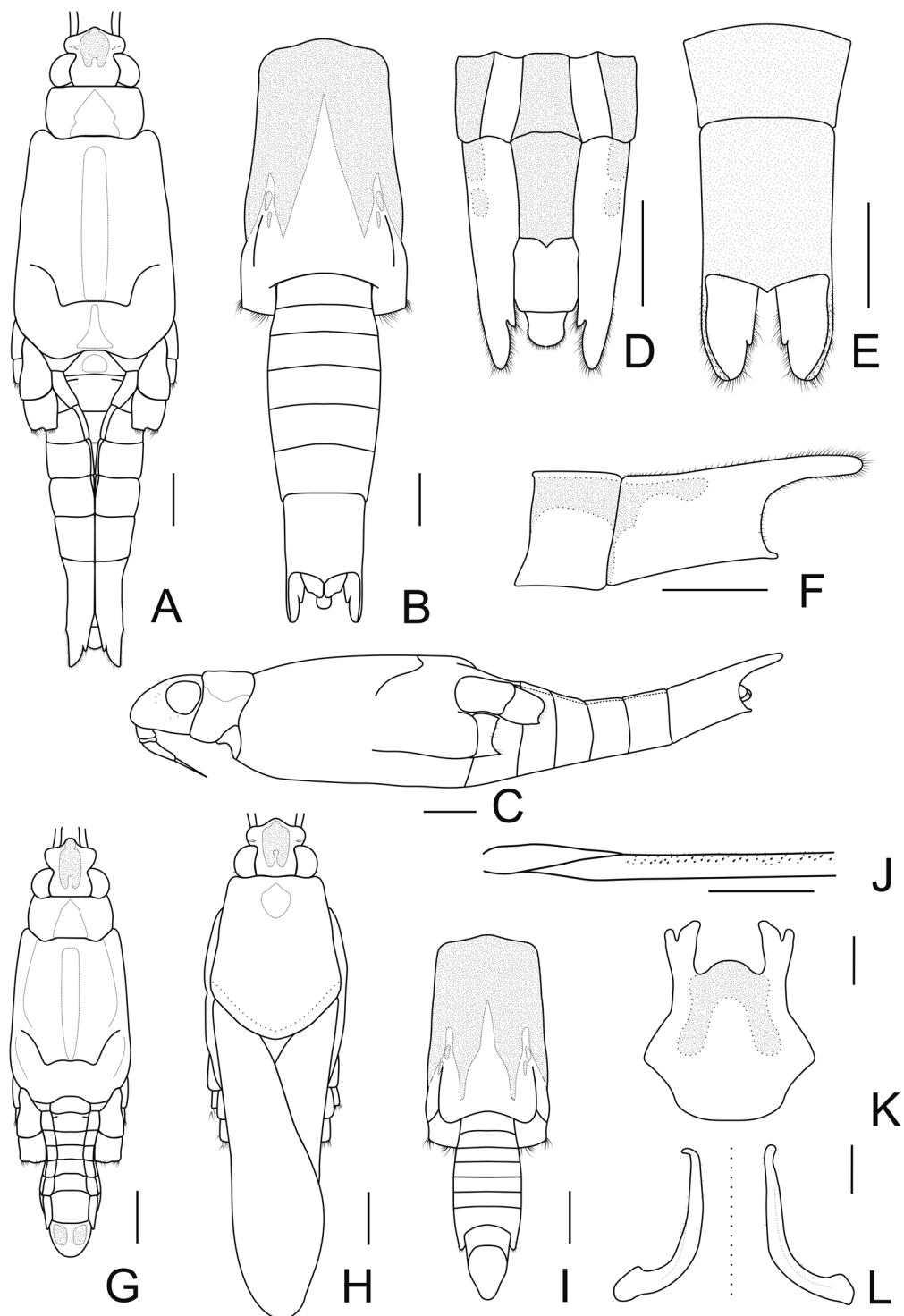
MEASUREMENTS. Body length 10.30–11.59, width 2.70–3.22, head width 1.56, interocular width 0.76, eye length (dorsal view) 0.61; relative lengths of antennal segments I–IV: 5.02 : 1.22 : 1.34 : 1.23; pronotum: length 0.91, width 1.94; mesonotum: length 2.59, width 3.16; metanotum: length 0.82, width 2.68; abdomen length (ventral view) 6.80; abdominal sternum VII: length 2.03, width 1.41; abdominal mediotergite I: length 0.54, width 1.36; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 5.19 : 4.63 : 2.48 : 1.04, middle leg: 13.91 : 7.10 : 3.32 : 0.51, hind leg: 13.61 : 5.56 : 0.15 : 0.24.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe, metanotum medially with a subtriangular yellow marking and with a sharp apex angle (Figs 2E, 3P, 34A). Connexivum dorsally brownish-yellow. Abdominal tergum I with a median yellow marking. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 34B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively long, caudal part moderately curved dorsad (Fig. 34C). Connexival margin of abdominal segments I–II erect, of III–VII reflexed (Fig. 34A), meeting each other above terminal mediotergites (Fig. 34A, D). Posterior margin of abdominal mediotergite VII with a short median process. Abdominal segment VII elongate, about as long as two preceding abdominal segments together (Figs 5O, 34C). Posterior margin of abdominal segment VII with four distinct processes, including two lobe-like processes on each connexival corner (Fig. 34D–F): one long, posteriorly-directed outer process and a smaller pointed inner process (in some individuals, the inner process very small or indistinct), posterior margin of sternum VII with a small median process (Fig. 34E).

**Apterous male**

MEASUREMENTS. Body length 7.21–7.90, width 1.70–2.22, head width 1.36, interocular width 0.72, eye length (dorsal view) 0.51; relative lengths of antennal segments I–IV: 3.42 : 1.08 : 1.23 : 0.93; pronotum: length 0.69, width 1.45; mesonotum: length 2.22, width 2.22; metanotum: length 0.66, width 2.09; abdomen length (ventral view) 3.53; abdominal sternum VII: length 0.54, width 1.04; abdominal mediotergite I:



**Fig. 34.** Morphological features of *Rhyacobates svenhedini* (Lundblad, 1934). **A.** Body of female, dorsal view. **B.** Body of female, excluding head and prothorax, ventral view. **C.** Body of female, lateral view. **D.** Abdominal end of female, dorsal view. **E.** Abdominal end of female, ventral view. **F.** Abdominal end of female, lateral view. **G–H.** Body of male, apterous form (G) and macropterous form (H), dorsal view. **I.** Body of male, excluding head and prothorax, ventral view. **J.** Basal part of right middle leg of male, ventral view. **K.** Proctiger of male, dorsal view. **L.** Left paramere, lateral aspect, two different views. Scale bars: A–J = 1 mm; K–L = 0.2 mm.

length 0.27, width 0.98; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.44 : 3.84 : 1.29 : 0.78, middle leg: 12.90 : 6.85 : 2.83 : 0.51, hind leg: 13.3 : 4.23 : 0.21 : 0.15.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Figs 4M, 34G). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, narrower than that of female (Fig. 34I). Abdominal venter light yellow.

**LEG.** Middle trochanter without spines; middle femur with scattered small spines, not arranged in distinct row (Fig. 34J).

**GENITALIA.** Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger relatively large, with angular lobes laterally (Figs 7F, 34K). Paramere strongly curved at basal third, distal part slender, with hook-shaped apex (Figs 8L, 34L).

#### **Macropterous male**

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish (Figs 4N, 34H).

**MEASUREMENTS.** Body length 7.35, width 2.11, head width 1.30, interocular width 0.62, eye length (dorsal view) 0.51; relative lengths of antennal segments I–IV: 3.88 : 1.05 : 1.18 : 0.99; pronotum: length 2.71, width 2.14; mesonotum width 2.11; metanotum width 1.80; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.96 : 3.04 : 1.23 : 0.61, middle leg: 11.36 : 6.31 : 3.05 : 0.75, hind leg: 11.67 : 4.99 : 0.25 : 0.21.

#### **Distribution**

China: Fujian, Sichuan (Andersen & Chen 1995).

#### **Comparative notes**

*Rhyacobates svenhedini* is most similar to *R. lundbladi*; see comparative notes under *R. lundbladi*.

***Rhyacobates takahashii* Esaki, 1923**  
Figs 2F, 3Q, 4O, 5P, 7G, 8M, 35

*Rhyacobates takahashii* Esaki, 1923: 388, pl. 1 (original description).

*Rhyacobates takahashii* – Esaki 1925: 60. — Matsuda 1960: 273–276, figs 656–658, 660, 663, 674–676, 678. — Andersen & Chen 1995: 55, figs 2–5 (with remarks).

#### **Diagnosis**

Body length of apterous females 8.60–10.88, of apterous males 6.20–7.32. Female: pronotum mainly black with a median brownish-yellow spot; mesonotum and metanotum mainly black with a median brownish-yellow stripe (Fig. 35A); posterior margin of abdominal mediotergite VII with a short median process (Fig. 35E); posterior margin of abdominal segment VII with three processes, including a relatively slender, angular process terminating each connexivum, and a pointed median process ventrally (Fig. 35F–G). Male: middle trochanter with one spine; middle femur with scattered small spines, not arranged in distinct row (Fig. 35L); length of middle tibia ca 1.5–1.8 times length of hind tibia; proctiger with angular lobes laterally (Figs 7G, 35M); paramere relatively slender, strongly curved at basal fourth, distal part tapering towards hook-shaped apex (Figs 8M, 35N).

## Material examined

### Non-type specimens

CHINA – **Guangxi Province** • 5 ♂♂, 2 ♀♀ (apterous); Lai-bin City, Jin-xiu County; 23°55'51.6" N, 110°10'46.6" E; 524 m a.s.l.; 26 Jul. 2019; Ze-zhong Jin leg.; NKUM. – **Taiwan Island** • 1 ♂ (apterous); Taitung, Xinwulixi, Xinwuli bridge; 2 Dec. 2001; H.H. Tan, K. Lim and Y.M. Ju leg.; THH0199; ZRC • 1 ♀ (apterous); Taipei County, Wulai, Fusan; 24°46.973' N, 121°30.106' E; 336 m a.s.l.; 6 Apr. 2004; A.D. Tran leg.; TAD0402; ZRC • 3 ♂♂, 7 ♀♀ (apterous); Pingtung County, Henchun, Wangsha stream; 22°02.351' N, 120°45.852' E; 39 m a.s.l.; 8 Apr. 2004; A.D. Tran leg.; TAD0406; ZRC • 4 ♂♂, 2 ♀♀ (apterous), 2 ♂♂, 1 ♀ (macropterous); Yilan County, Yuanshan, Dahu stream; 24°45.218' N, 121°39.777' E; 147 m a.s.l.; 12 Apr. 2004; A.D. Tran leg.; TAD0412; ZRC • 7 ♂♂, 9 ♀♀ (dealated macropterous); Taizhong City, Ba-xian Mountain; 24°17'55.1" N, 120°45'41.5" E; 5 Jun. 2011; Qiang Xie leg.; NKUM.

## Supplemental description

### Apterous female

MEASUREMENTS. Body length 8.60–10.88, width 2.59–2.90, head width 1.84, interocular width 0.85, eye length (dorsal view) 0.68; relative lengths of antennal segments I–IV: 4.10 : 1.05 : 1.22 : 0.81; pronotum: length 0.90, width 1.84; mesonotum: length 3.05, width 2.94; metanotum: length 0.92, width 2.65; abdomen length (ventral view) 4.66; abdominal sternum VII: length 1.87, width 1.29; abdominal mediotergite I: length 0.35, width 1.11; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.46 : 3.62 : 2.01 : 0.90, middle leg: 12.40 : 6.86 : 2.98 : 0.38, hind leg: 12.73 : 4.57 : 0.11 : 0.14.

COLORATION. Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum and metanotum mainly black with a median brownish-yellow stripe (Fig. 35A). Abdominal tergum I with a median yellow marking. Connexivum dorsally brownish-yellow. Mesosternum chiefly blackish with a median subtriangular yellowish spot (Fig. 35B). Abdominal venter light yellow.

ABDOMEN. Abdomen relatively short, curved dorsad towards end (Fig. 35D) or nearly straight. Connexiva erect on abdominal segments I–II, converging along dorsal midline of IV–VI segments, meeting erectly above terminal mediotergites (Fig. 35A). Abdominal segment VII elongate, nearly as long as three preceding abdominal segments together (Figs 5P, 35D). Posterior margin of abdominal mediotergite VII with a short median process (Fig. 35E). Posterior margin of abdominal segment VII with three processes, dorsally above terminating each connexivum with a relatively slender process directing ventrad, ventrally with a pointed median process (Fig. 35E–G).

### Dealated macropterous female

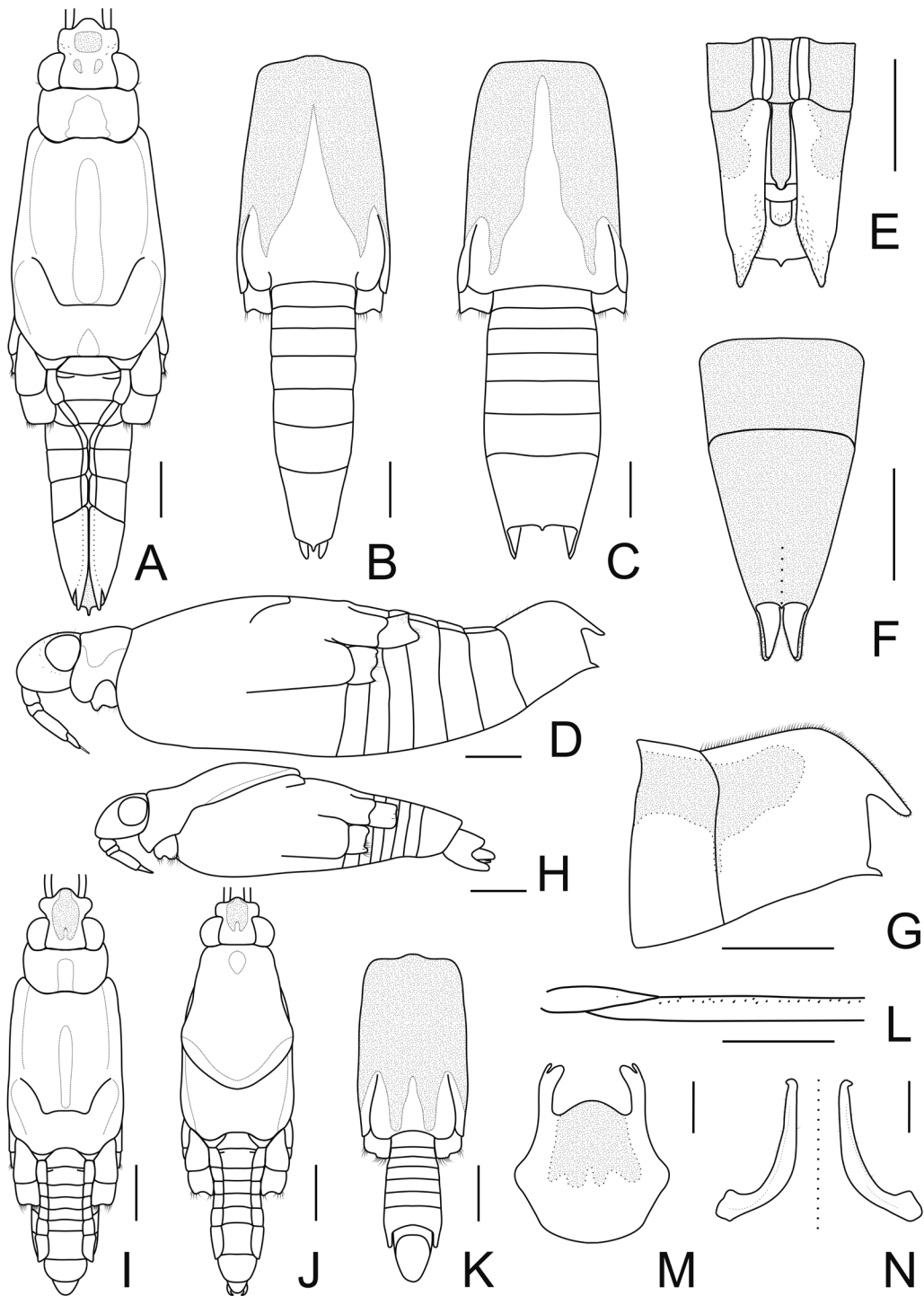
Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish (Fig. 3Q).

MEASUREMENTS. Body length 10.01, width 2.86, head width 1.51, interocular width 0.60, eye length (dorsal view) 0.58; relative lengths of antennal segments I–IV: 3.98 : 1.08 : 1.22 : 0.98; pronotum: length 3.12, width 2.41; mesonotum width 2.86; metanotum: length 0.73, width 2.62; abdomen length (ventral view) 4.80; abdominal sternum VII: length 1.46, width 1.79; abdominal mediotergite I: length 0.39, width 1.15; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 4.68 : 3.85 : 1.91 : 0.97, middle leg: 12.47 : 6.77 : 3.32 : 0.33, hind leg: 13.31 : 5.13 : 0.17 : 0.23.

### Apterous male

MEASUREMENTS. Body length 6.20–7.32, width 1.80–2.09, head width 1.43, interocular width 0.59, eye length (dorsal view) 0.60; relative lengths of antennal segments I–IV: 3.58 : 1.04 : 1.07 : 0.84; pronotum:





**Fig. 35.** Morphological features of *Rhyacobates takahashii* Esaki, 1923. **A.** Body of female, dorsal view. **B–C.** Body of female, excluding head and prothorax, ventral view. **D.** Body of female, lateral view. **E.** Abdominal end of female, dorsal view. **F.** Abdominal end of female, ventral view. Abdominal end of female, lateral view. **H.** Body of male, dealated macropterous form, lateral view. **I–J.** Body of male, apterous form (I) and dealated macropterous form (J), dorsal view. **K.** Body of male, excluding head and prothorax, ventral view. **L.** Basal part of right middle leg of male, ventral view. **M.** Proctiger of male, dorsal view. **N.** Left paramere, lateral aspect, two different views. Scale bars: A–L = 1 mm; M–N = 0.2 mm.

length 0.76, width 1.55; mesonotum: length 2.16, width 2.09; metanotum: length 0.69, width 1.88; abdomen length (ventral view) 2.69; abdominal sternum VII: length 0.53, width 1.22; abdominal mediotergite I: length 0.34, width 0.70; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.49 : 2.91 : 1.06 : 0.62, middle leg: 10.02 : 5.11 : 2.17 : 0.35, hind leg: 10.04 : 2.79 : 0.11 : 0.13.

**COLORATION.** Median black spot of head posteriorly bifurcate. Pronotum mainly black with a median brownish-yellow spot. Mesonotum mainly black with a median brownish-yellow stripe. Metanotum chiefly blackish, without yellow markings (Fig. 35I). Connexivum dorsally blackish. Mesosternum chiefly blackish with a median subtriangular yellowish spot, narrower than that of female (Fig. 35K). Abdominal venter light yellow.

**LEG.** Middle trochanter with one spine; middle femur with scattered small spines, not arranged in distinct row (Fig. 35L).

**GENITALIA.** Abdominal segment VIII ventro-laterally impressed. Pygophore large, ovate. Proctiger with rounded lobes laterally (Figs 7G, 35I). Paramere relatively slender, strongly curved at basal fourth, distal part tapering towards hook-shaped apex (Figs 8M, 35J).

#### **Dealated macropterous male**

Similar to apterous female in general structure and coloration with following exceptions: thorax with a pronotal lobe, anterior part with a subrhombic yellow marking, posterior part elongate, covering most of mesonotum; posterior margin broadly rounded and brownish (Figs 5P, 35J).

**MEASUREMENTS.** Body length 6.39, width 1.85, head width 1.22, interocular width 0.47, eye length (dorsal view) 0.49; relative lengths of antennal segments I–IV: 3.24 : 0.93 : 0.90 : 0.79; pronotum: length 2.40, width 1.81; mesonotum width 1.85; metanotum: length 0.49, width 1.68; abdomen length (ventral view) 2.29; abdominal sternum VII: length 0.53, width 0.97; abdominal mediotergite I: length 0.25, width 0.69; relative lengths of leg segments (femur : tibia : tarsal segment I : tarsal segment II): fore leg: 3.66 : 3.11 : 1.34 : 0.60, middle leg: 10.48 : 5.32 : 2.26 : 0.33, hind leg: 11.02 : 3.56 : 0.13 : 0.18.

#### **Distribution**

China: Guangxi (first record); Taiwan (Andersen & Chen 1995).

#### **Comparative notes**

The female of *R. takahashii* can be distinguished from all other species of *Rhyacobates* by the combination of following characters: in the females, the posterior margin of abdominal segment VII has three processes, including an erect, elongate and angular process terminating each connexivum, which is directed ventrad, and a pointed, slender median process ventrally (Fig. 35F–G).

#### ***Rhyacobates zetteli* Tran & Nguyen, 2016**

Figs 3R, 5Q, 7H

*Rhyacobates zetteli* Tran & Nguyen, 2016: 505–508, figs 11–23 (original description).

#### **Diagnosis**

Body length of apterous females 9.80–10.60, of apterous males 7.30–7.70. Color (Fig. 3R): dorsum of head mainly yellow with small black markings; pronotum mainly yellow with narrow black marking on anterior margin and sometimes laterally; mesonotum with broad median marking from anterior to posterior margin (median marking broader in females than in males); metanotum with laterally expanded yellow marking (more extensive in females). Female: abdomen elongate and straight; ventral length

of pregenital abdomen about half of body length (Fig. 5Q); connexivum of segments I–VI narrow; connexival corners of segment VI with small processes; abdominal segment VII tapering towards apex; mediotergite VII with small median process on posterior margin; sternum VII with bilobate posterior margin, connexival corners with small blunt processes which bend mesad. Male: middle trochanter with 6–7 spines; middle femur with spines but not in distinct row; length of middle tibia about equal to length of hind tibia; pygophore simple, with straight apical margin; proctiger with subtrapezoidal lobes laterally (Fig. 7H); paramere relatively long and slender, curved at basal third, distal part tapering towards narrowly rounded apex.

### Material examined

#### Type specimens

See Tran & Nguyen (2016).

#### Non-type specimens

VIETNAM • 3 ♀♀ (apterous); Lào Cai Province, Sa Pa, Núi Xê area, Vàng stream and its feeders; 22°20'54.4" N, 103°46'12.0" E; 25 Oct. 2020; A.D. Tran *et al.* leg.; TAD20-19; ZVNU • 1 ♀ (apterous); same collection data as for preceding; NKUM.

GPS data of previous records: see Tran & Nguyen (2016).

### Distribution

Vietnam: Lào Cai (Tran & Nguyen 2016).

### Comparative notes

*Rhyacobates zetteli* is most similar to *R. angustus*, as discussed by Tran & Nguyen (2016: 503, 507–508). Also see comparative notes under *R. bui* sp. nov.

### Revised key to species of *Rhyacobates* Esaki, 1923

Note: The males of *Rhyacobates* spp. do not exhibit many reliable characters for species identification. In most species, the shape of the proctiger, especially its lateral lobes, and the shape of the paramere, preferably to be used in combination, are the only characters for species identification. However, species identification of *Rhyacobates* are more reliable when associated female specimens are present in the samples.

1. Both sexes: both mesonotum and metanotum completely black, without median yellow marking (Figs 3A–B, 4A–B) ..... 2
  - Both sexes: mesonotum with median yellow marking (Figs 3C–R, 4C–M, O) ..... 4
2. Female: body relatively robust, width 3.1–3.2, ratio of body width: length > 0.36; abdominal mediotergite I swollen, nearly as long as two posterior terga together (Fig. 3I); posterior margin of abdominal mediotergite VII without median process; posterior margin of abdominal segment VII dorsally without process, ventrally with a narrow median process (Fig. 5H). Male: middle trochanter without spines; lateral lobes of proctiger distinctly angular (Fig. 6H); paramere strongly thickened at middle, with scattered short setae on distal part ..... *R. constrictus* Tran & Nguyen, 2016
  - Female: body relatively slender, width 2.3–3.0, ratio of body width: length < 0.29; abdominal mediotergite I not swollen, nearly as long as mediotergite II; posterior margin of abdominal mediotergite VII with a median process; posterior margin of abdominal segment VII dorsally with a pair of processes, ventrally with a semicircular median process (Figs 16E, 18E). Male: middle trochanter with 3–5 spines (Figs 16J, 17I); lateral lobes of proctiger subtrapezoid or broadly rounded (Fig. 6A–B); paramere not thickened at middle, distal part without setae (Fig. 8A–B) ..... 3

3. Female: body length 8.8–9.3, connexival process of abdominal segment VII short, with relatively blunt apex (Fig. 16D). Male: body length 6.5–6.9; lateral lobes of proctiger subtrapezoid (Fig. 6A); apical part of paramere relatively slender, distinctly curved (Figs 8A, 16L) ..... ***R. bui*** sp. nov.  
 – Female: body length 11.2–11.9, connexival process of abdominal segment VII long, with pointed apex (Fig. 18D). Male: body length 7.7–8.0; lateral lobes of proctiger broadly rounded (Fig. 6B); apical part of paramere relatively stout, not distinctly curved (Figs 8B, 18K) .....  
 ..... ***R. elongatus*** sp. nov.
4. Female: metanotum completely black, without yellow markings (Fig. 3F, K, M). Male: length of middle tibia ca 1.8–2.1 times length of hind tibia ..... 5  
 – Female: metanotum with median yellow stripe. Male: length of middle tibia usually less than 1.8 times length of hind tibia (except in *R. edentatus*: 1.9–2.0, and *R. takahashii*: 1.5–1.8) ..... 7
5. Female: posterior margin of metanotum with a pointed median process (Fig. 23C–D); abdomen short, ventral length ca 0.2 times body length; posterior margin of abdominal segment VII with long connexival processes and laterally with a pair of pointed processes (Fig. 23F, H). Male: ventral length of abdomen ca 0.3 times body length; lateral lobes of proctiger rounded; paramere stout, with middle part thickened (Figs 8E, 23M) ..... ***R. anderseni*** Tran & Yang, 2006  
 – Female: posterior margin of metanotum without process; abdomen longer, ventral length ca 0.5 times body length; posterior margin of abdominal segment VII with long connexival processes and laterally with a pair of short angular processes or without distinct process (Figs 5J, L, 30F–G). Male: ventral length of abdomen ca 0.4–0.5 times body length; lateral lobes of proctiger angular; paramere slender ..... 6
6. Female: abdominal segment VII with connexiva reaching or overlapping each other on dorsum, thus covering most of mediotergites VII and VIII; posterior margin of segment VII with a pair of pointed lateral processes (Figs 3M, 30G). Male: metanotum chiefly black, without yellow markings; proctiger laterally with angular lobes produced into distinct process directed postero-ventrad (Figs 7C, 30K) ..... ***R. malaisei*** Andersen & Chen, 1995  
 – Female: abdominal segment VII with connexiva not reaching each other on dorsum, thus mediotergites VII and VIII exposed; posterior margin of segment VII without distinct lateral processes (Fig. 3K). Male: metanotum with a very thin yellow median stripe; lateral lobes of proctiger angular but without distinct process (Fig. 7A) ..... ***R. gongvo*** Tran & Yang, 2006
7. Female: abdominal segment VII without any posterior processes; connexiva of segments IV–VII meeting each other along midline of dorsum; posterior margin of sternum VII relatively obtuse, without distinct process (Fig. 28D–E). Male: length of middle tibia ca 1.9–2.0 times length of hind tibia ..... ***R. edentatus*** Andersen & Chen, 1995  
 – Female: abdominal segment VII with posterior processes; connexiva converging and partly meeting each other at segment VII or not meeting each other; posterior margin of sternum VII ventrally with distinct process or presenting an arc shape (*R. angustus*). Male: length of middle tibia  $\leq$  1.8 times length of hind tibia ..... 8
8. Both sexes: pronotum chiefly yellowish, mesonotum with a broad yellowish median marking; metanotum with laterally expanded yellow marking (Fig. 3R). Female: abdominal segment VI with small but distinct connexival processes; segment VII also with a pair small connexival processes, ventral margin bilobate. Male: lateral lobes of proctiger subtrapezoidal (Fig. 7H) .....  
 ..... ***R. zetteli*** Tran & Nguyen, 2016

- Both sexes: pronotum, mesonotum, metanotum chiefly black, with a narrower median marking. Female: abdominal segment VI without connexival processes; ventral margin of segment VII not bilobate. Male: lateral lobes of proctiger rounded or angular ..... 9
9. Female: abdominal segment VII without connexival processes (Figs 20E, G, 31E–F); abdominal mediotergite I elongate, not shorter than two subsequent terga together. Male: body length 5.4–6.3 ..... 10
- Female: abdominal segment VII with connexival processes; abdominal mediotergite I not elongate, nearly as long as mediotergite II. Male: body length 6.2–8.4 ..... 11
10. Both sexes: abdominal mediotergite I swollen and large, nearly as long as three subsequent terga together (Fig. 20A, H). Female: abdominal mediotergite II medially hidden beneath mediotergite I except laterally; abdominal terga II–V extremely short; abdominal segment VII as in Fig. 20E–G. Male: body length 5.9–6.3 ..... *R. turgidus* sp. nov.
- Both sexes: abdominal mediotergite I shorter than two subsequent abdominal mediotergites together (Fig. 31A, G). Female: abdominal mediotergite II not covered by mediotergite I; terga II–V normal sized, not shortened (Fig. 31A); abdominal segment VII as in Fig. 31D–F. Male: body length 5.4–5.9 ..... *R. recurvus* Andersen & Chen, 1995
11. Female: posterior margin of abdominal sternum VII with an acute median process. Male: body length 6.2–7.4 ..... 12
- Female: posterior margin of abdominal sternum VII with an obtuse median process or presenting an arc shape. Male: body length 7.5–8.4 ..... 14
12. Female: posterior margin of abdominal mediotergite VII with a short median process (Fig. 35E); connexival processes of abdominal segment VII long and directed postero-ventrad (Fig. 35E–G). Male: lateral lobes of proctiger rounded (Figs 7G, 35M); paramere strongly curved at basal fourth as in Figs 8M, 35N, relatively straight on apical half ..... *R. takahashii* Esaki, 1923
- Female: posterior margin of abdominal mediotergite VII without median process; connexival processes of abdominal segment VII short, angular, directing upwards (Figs. 22E, 25G–I). Male: lateral lobes of proctiger angular; paramere more curved on apical half ..... 13
13. Female: posterior margin of abdominal segment VII laterally with a pair of rounded process (Fig. 22D–E). Male: middle trochanter without spines; paramere strongly curved at basal third, as in Figs 8D, 22K ..... *R. abdominalis* Andersen & Chen, 1995
- Female: posterior margin of abdominal segment VII with laterally with a pair of long, pointed processes (Fig. 25E–J). Male: middle trochanter with 3–6 spines; paramere sinuate, as in Figs 8F, 25N ..... *R. chinensis* Hungerford & Matsuda, 1959
14. Female: connexival processes of abdominal segment VII distinctly bilobate; posterior margin of abdominal mediotergite VII with a short median process. Male: posterior lobes of proctiger angular (Fig. 7B, F) ..... 15
- Female: connexival processes of abdominal segment VII angular, not bilobate; posterior margin of abdominal mediotergite VII without median process. Male: posterior lobes of proctiger rounded (Fig. 7E) ..... 16
15. Female: subtriangular yellowish marking on metanotum wide, with larger apex angle; inner lobe of bilobate connexival processes of abdominal segment VII elongate (Fig. 29D, F). Male: paramere sinuate (Figs 8H, 29L) ..... *R. lundbladi* (Hungerford, 1957)

- Female: subtriangular yellowish marking on metanotum relatively thin, with sharp apex angle; inner lobe of bilobate connexival processes of abdominal segment VII very short (Fig. 34D–E). Male: paramere strongly curved at basal third, with hook-shaped apex (Figs 8L, 34L) .....  
..... ***R. svenhedini*** (Lundblad, 1934)
  
- 16. Female: posterior margin of mediotergite VII with a median process; abdominal sternum VII with broadly rounded posterior margin (Fig. 3G); mesosternum anteriorly blackish with subtriangular yellow marking on posterior part, not divided by a blackish line. Male: middle trochanter without spines; paramere strongly curved at basal third, with narrow apex .....  
..... ***R. angustus*** Tran & Nguyen, 2016
- Female: mediotergite VII without median process; posterior margin of sternum VII angularly produced in the middle (Fig. 33D–G); mesosternum chiefly blackish with two median yellowish spots, divided by a blackish line (Fig. 33B). Male: middle trochanter with 3–5 spines; paramere strongly curved at basal fourth, with hook-shaped apex (Figs 8K, 33L) .....  
..... ***R. scorpio*** Andersen & Chen, 1995

### **Checklist of the genus *Rhyacobates* Esaki, 1923**

*Rhyacobates abdominalis* Andersen & Chen, 1995  
*Rhyacobates anderseni* Tran & Yang, 2006  
*Rhyacobates angustus* Tran & Nguyen, 2016  
*Rhyacobates bui* Leng, Tran & Ye sp. nov.  
*Rhyacobates chinensis* Hungerford & Matsuda, 1959  
*Rhyacobates constrictus* Tran & Nguyen, 2016  
*Rhyacobates edentatus* Andersen & Chen, 1995  
*Rhyacobates elongatus* Leng, Tran & Ye sp. nov.  
*Rhyacobates gongvo* Tran & Yang, 2006  
*Rhyacobates lundbladi* (Hungerford, 1957)  
*Rhyacobates malaisei* Andersen & Chen, 1995  
*Rhyacobates recurvus* Andersen & Chen, 1995  
*Rhyacobates scorpio* Andersen & Chen, 1995  
*Rhyacobates svenhedini* (Lundblad, 1934)  
*Rhyacobates takahashii* Esaki, 1923  
*Rhyacobates turgidus* Leng, Tran & Ye sp. nov.  
*Rhyacobates zetteli* Tran & Nguyen, 2016

### **Discussion**

Several species currently placed in *Rhyacobates* possess some unique characteristics that generally do not fit the generic definition of *Rhyacobates*. *Rhyacobates anderseni* is the only species in the genus that has a median process on the posterior margin of the metanotum in the apterous female, which is also present in other three ptilomerine genera, *Pleciobates*, *Stridulobates* Zettel & Thirumalai, 2001 and *Jucundus* (Tran & Yang 2006; Tran & Nguyen 2016). A group of seven species (i.e., *R. angustus*, *R. bui* sp. nov., *R. elongatus* sp. nov., *R. lundbladi*, *R. svenhedini*, *R. takahashii* and *R. zetteli*) might belong to the same clade, as they have a median process on the posterior margin of mediotergite VII of the female, which is absent in other species of *Rhyacobates*, but is present in the genus *Stridulobates* (see also Tran & Nguyen 2016: 515). It is worth noting that the median process in *R. bui* and *R. elongatus* is distinctly elongate, much longer than those of the other five species in this group.

Species of *Rhyacobates* exhibit a high degree of interspecific modification in abdominal segment VII of the female, which makes this structure a reliable character for species identification and may also

indicate the relationship among species of *Rhyacobates*. For instance, *Rhyacobates bui* sp. nov. and *R. elongatus* sp. nov. are probably sister species based on the presence of five processes on abdominal segment VII and on the presence of a median process on the posterior margin of mediotergite VII. *Rhyacobates malaisei* and *R. gongvo* might also be sister species because of the presence of four processes on abdominal segment VII and their unique coloration pattern. *Rhyacobates abdominalis* and *R. chinensis* might have a close relationship due to the similarity of most of their characteristics except the size of the five processes on abdominal segment VII. *Rhyacobates svenhedini* and *R. lundbladi* seem to be sister species, as both have the bilobate connexival processes on abdominal segment VII and the median process on the posterior margin of abdominal mediotergite VII. *Rhyacobates turgidus* sp. nov., *R. constrictus*, *R. recurvus* probably belong to a distinct clade based on the tapering of abdominal segment VII with a pointed median process on the posterior margin. The true taxonomic status of these species as well as the relationships among other species of *Rhyacobates* can be further elucidated based on phylogenetic analyses using molecular data of the subfamily Ptilomerinae.

We have also observed some coloration characteristics in this genus which may be helpful for species identification. In most species, the female has median yellowish stripes on both the mesonotum and metanotum, except for *R. bui* sp. nov., *R. elongatus* sp. nov. and *R. constrictus*, in which both the mesonotum and metanotum are completely black, and for *R. anderseni*, *R. gongvo* and *R. malaisei*, where only the metanotum is completely black. In addition, in most species, the dorsum of the connexivum is brownish-yellow and convergent in the female but blackish and parallel in the male. The exceptions are *R. anderseni*, *R. bui*, *R. elongatus*, *R. gongvo* and *R. malaisei*, in which the connexiva of abdominal segments I–VI are blackish and parallel in both sexes. In addition, we have also observed that there are two color forms in the males of *R. lundbladi* and *R. abdominalis*. In some male individuals of these two species, the metanotum has very narrow yellow stripes, whereas it is completely black in others. It is also notable that the shapes of the markings on the dorsum of the bodies, i.e., the shapes of the black spots on the dorsum of head and yellow stripes on thorax and abdominal terga, are usually variable among and within populations; thus, are not a reliable feature for identifying species. Nonetheless, the presence or absence of these markings is regarded as important features for distinguishing certain groups of species.

Regarding the distribution of the 17 species of *Rhyacobates* known to the present, three have a wide range: *R. chinensis* is distributed around the eastern Sichuan Basin and the Taihang-Yanshan Mountains in China, extending to the Korean Peninsula; *R. abdominalis* is distributed from southeastern China to northwestern Vietnam; and *R. edentatus* is distributed in southern and southwestern China. Six species are only found in two or three disjunct localities: *R. anderseni* has been reported from Yunnan, China and Hà Tĩnh, Vietnam; *R. lundbladi* is now recorded from Zhejiang, Jiangxi, and Hunan, China; *R. malaisei* is now recorded from Yunnan China, Myanmar, and Thailand; *R. recurvus* is now recorded from Jiangxi, Zhejiang and Hubei, China; *R. svenhedini* is recorded from Sichuan and Fujian, China; *R. takahashii* was previously regarded as endemic to Taiwan Island, China, but it has recently been collected from Guangxi, China. Eight species can be considered as endemics, including *R. angustus*, *R. gongvo*, and *R. zetteli*, are all only known from Lào Cai, northwestern Vietnam; *R. bui* sp. nov. is found in the proximity of Guangxi in southern China and Lạng Sơn in northern Vietnam; *R. constrictus* is found in Phú Thọ, northwestern Vietnam; *R. elongatus* sp. nov. is found in Hà Tĩnh, north-central Vietnam; while *R. scorpio* and *R. turgidus* sp. nov. are known from only the southern region around the Sichuan Basin of China. Although we have gained more distribution data for species of *Rhyacobates*, there is still a lack of collection data for some areas within the distributional range of this genus; thus, our understanding of the distribution patterns is still very limited. Future collections should focus on some gap areas, such as the southeastern region around the Sichuan Basin of China, the Yunnan-Guizhou Plateau of China, northern Laos, and Myanmar.

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