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## Research article

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# Taxonomic study of the *Macrolycus gracilis* group (Coleoptera: Lycidae), with descriptions of four new species from China

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**Abstract.** *Macrolycus* Waterhouse, 1878 is a lycid genus endemic to the East Palaearctic region and the northern part of the Oriental region; nearly half of the described species are distributed in China. Although the taxonomy of *Macrolycus* has made some progress in recent years, many species remain undescribed in the Chinese fauna. In the present study, the *Macrolycus gracilis* group is reviewed, and four new species are discovered and described from China, viz. *M. nigricollis* sp. nov., *M. graciliramus* sp. nov., *M. breviramus* sp. nov. and *M. acutiapex* sp. nov. The habitus of the male or of both sexes, and the male genitalia, are illustrated. In addition, a distribution map and a key to the species of the *M. gracilis* group are provided.

**Keywords.** Net-winged beetles, *Macrolycus*, alpha taxonomy, new species, China.

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## Introduction

Net-winged beetles (Elateroidea Leach, 1815: Lycidae Laporte, 1836) are among the major elateroid lineages, with about 4600 species worldwide, which is surpassed only by the click and soldier beetles (Bocak *et al.* 2020). In particular, the family has a very high diversity in the Oriental and eastern Palaearctic regions, where many lycid lineages originated and to which many are restricted, e.g.,

Macrolycini Kleine, 1933 (Masek *et al.* 2018). The majority of the members of the Macrolycini are distributed in the southern China and adjacent regions of Indo-Burma (Pic 1923, 1935, 1939; Kleine 1925, 1942; Kazantsev 1993a, 2001, 2002, 2013; Li *et al.* 2012, 2015; Li 2015; Liu *et al.* 2023; Du *et al.* 2024), and only a few species reach northern China, Korea, Japan and the Far East of Russia (Kleine 1925; Barovskij 1929, 1930; Nakane 1967, 1969, 1994; Chernyshev 1996; Kazantsev 1993b, 1995, 2011; Matsuda 2009).

*Macrolycus* Waterhouse, 1878 is the sole genus placed in the tribe Macrolycini (subfamily Ateliinae Kleine, 1928), according to the latest classification of Lycidae (Kusy *et al.* 2019). The genus can be differentiated from other lycid genera by its dimorphic antennae (flabellate in the male while serrate in the female), pronotum sharply projected laterally at posterior angles and with a median longitudinal keel extending from anterior margin to middle of disc, elytra with four primary costae, bifid claws in both sexes, slender male genitalia with a small and rounded phallobase and a simple and membranous internal sac, with at most the apical part exposed (Bocak & Bocakova 1990, 2008; Li *et al.* 2012).

At present, *Macrolycus* has a total of 78 species worldwide, of which 47 are distributed in China (Kleine 1925; Pic 1939; Nakane 1967, 1969, 1994; Kazantsev 1993a, 1993b, 1995, 2001, 2002, 2013; Matsuda 2009; Li *et al.* 2012, 2015; Li 2015; Liu *et al.* 2023; Du *et al.* 2024a, 2024b). Most recently, Li *et al.* (2015) produced the first molecular phylogeny of *Macrolycus*, based on which they divided the genus into two subgenera, *Macrolycus* s. str. (with parameres present in male genitalia) and *Cerceros* Kraatz, 1879 (with parameres absent in male genitalia), and further defined two and six species groups within the subgenera respectively, based on the shapes of the apical part of the phallus and its attachments. Among them, the *M. gracilis* group belongs to the subgenus *Cerceros* Kraatz, 1879, and it differs from all other groups by the phallus with a circular lamellar structure at the apex (Li *et al.* 2015). Prior to this study, 10 species were reported in the *M. gracilis* group, mostly endemic to China, except for one which extends to northern Vietnam and Laos (Li *et al.* 2015).

During our recent study of *Macrolycus*, some material of the *M. gracilis* group from China was obtained. After our examination, we identified among them four new species and one previously known species. The present study is another contribution to the knowledge of *Macrolycus*, with an emphasis on exploring the diversity of the species of this lycid group in the Chinese fauna.

## Material and methods

The studied material is preserved in the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZAS) and the Museum of Hebei University, Baoding, China (MHBU).

We identified the species based on the works of Kazantsev (1993a, 2001, 2002), Li *et al.* (2012, 2015) and Li (2015). The description format and terminology follow that of Li *et al.* (2012, 2015).

The specimens were softened in water, and the male genitalia were dissected and cleared in a 10% NaOH solution, then examined and photographed in glycerol, and finally glued on a paper card for permanent preservation. Images of adults were taken with a Canon EOS 80D digital camera, and aedeagi using a Leica M205A stereo microscope, then stacked in Helicon Focus 7. The final plates were edited in Adobe Photoshop CS3 ver. 10.0.1.

Measurements were taken with Image J ver. 1.50i (NIH, USA). Body length was measured from the anterior margin of head to the elytral apex, and the width across the humeral part of elytra. Pronotal length was measured from the middle of anterior margin to middle of posterior margin, and the width across the widest part of pronotum. Eye diameter was measured at the widest point and the interocular distance was taken at the narrowest point.

The information of distribution was collected from the publications (Kazantsev 2001, 2002, 1993a; Li *et al.* 2012, 2015; Li 2015) and the studied material of the present study. The distribution map was prepared by ArcMap ver. 10.8 and edited in Photoshop CS3 ver. 10.0.1.

## Results

Class Insecta Linnaeus, 1758  
 Order Coleoptera Linnaeus, 1758  
 Family Lycidae Laporte, 1836  
 Subfamily Ateliinae Kleine, 1928  
 Tribe Macrolycini Kleine, 1933  
 Genus *Macrolycus* Waterhouse, 1878

Subgenus *Cerceros* Kraatz, 1879

### *The Macrolycus gracilis* group

#### Diagnosis

Male antennomeres III usually triangular, seldom lamellate or cylindrical. Elytra elongate, with lateral margins feebly to moderately, but never strongly diverging posteriorly. Aedeagus with phallus never notched at apex, but attached with a circular lamellar structure (e.g., Figs 2A–C, 3).

#### Included species

*M. aurantiacus* Kazantsev, 2001, *M. baihualingensis* Li, Bocak & Pang, 2015, *M. gracilis* Pic, 1923, *M. lizipingensis* Li, Bocak & Pang, 2015, *M. mucronatus* Li, Bocak & Pang, 2012, *M. multicostatus*

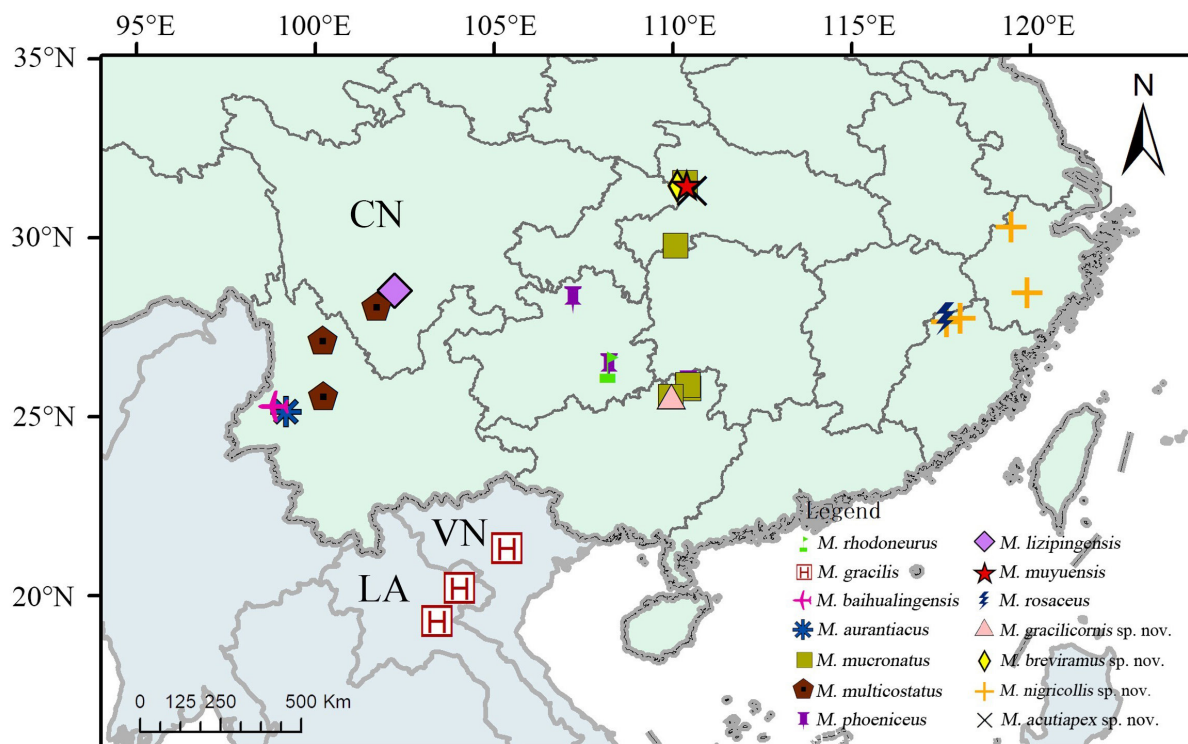


Fig. 1. Worldwide distribution of the *Macrolycus gracilis* group.

Kazantsev, 2002, *M. muyuensis* Li, Bocak & Pang, 2012, *M. phoeniceus* Li, Bocak & Pang, 2015, *M. rhodoneurus* Li, Bocak & Pang, 2015, and *M. rosaceus* Li, Bocak & Pang, 2015.

**Distribution** (Fig. 1)

China, Laos, and Vietnam.

***Macrolycus mucronatus* Li, Bocak & Pang, 2012**

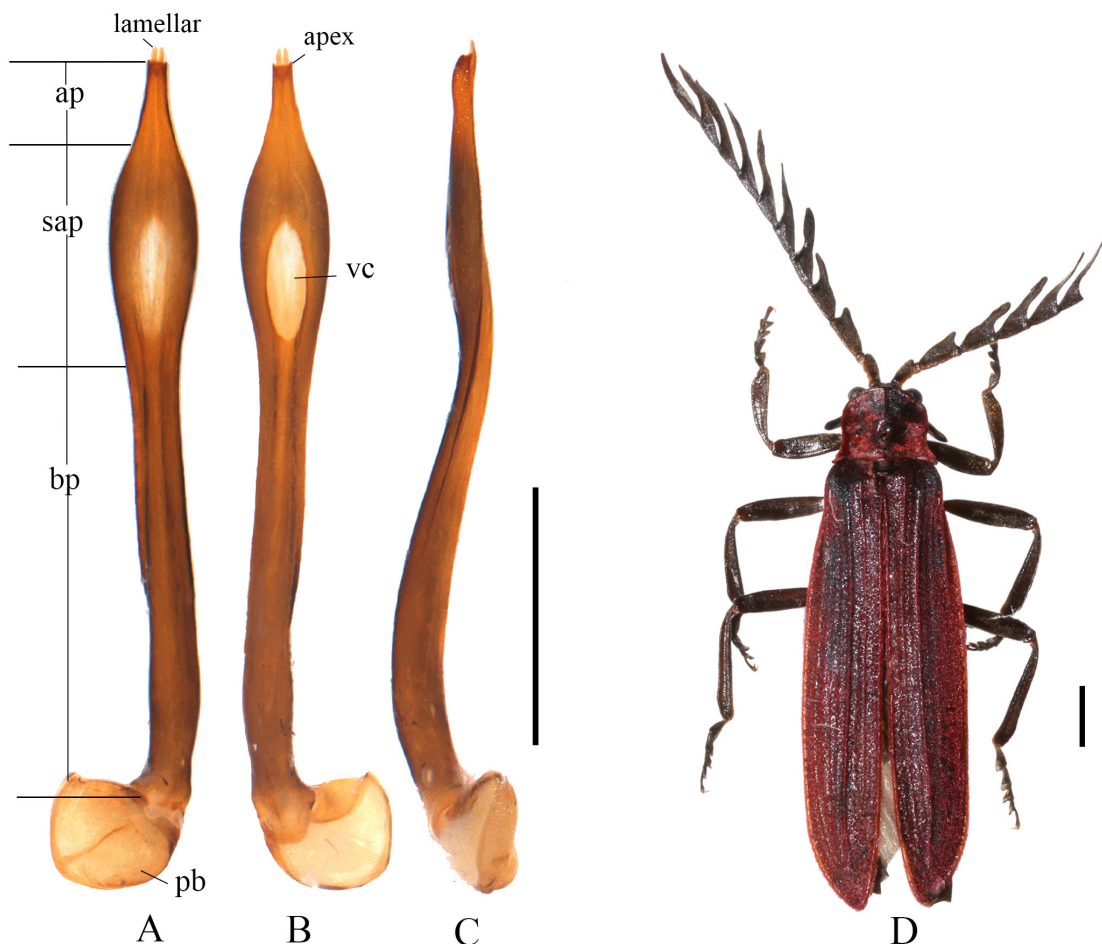
Figs 1–2

*Macrolycus mucronatus* Li, Bocak & Pang, 2012: 53, figs 27, 37–38, 50.

*Macrolycus mucronatus* – Li 2015: 32.

**Material examined**

CHINA • 2 ♂♂; Guangxi, Longsheng, Huaping, Anjiangping; 2 Jun. 2023; H.Q. Lin and S.L. Yuan leg.; MHBUS • 1 ♂; Hubei, Shennongjia, Wenshui Forestry; 17 Jul. 2003; F. Lin leg.; IZAS.



**Fig. 2.** *Macrolycus mucronatus* Li, Bocak & Pang, 2012 from Guangxi (MHBUS). **A–C.** Aedeagus. **A.** Dorsal view. **B.** Ventral view. **C.** Lateral view. **D.** Male habitus, dorsal view. Abbreviations: ap = apical part of phallus; bp = basal part of phallus; pb = phallobase; sap = subapical part of phallus; vc = ventral-cavity of phallus. Scale bars = 1 mm.

### Descriptive notes

#### Male (Fig. 2D)

**AEDEAGUS.** Phallus slender, nearly parallel-sided at basal part in dorsal and ventral views (Fig. 2A–B), subapical part strongly and almost symmetrically inflated laterally, about  $1.8 \times$  as wide as basal part, with ventral, fusiform cavity, apical part abruptly narrowed distad, apex about  $0.22 \times$  as wide as subapical part; curved ventrally at basal  $\frac{1}{4}$  portion, and bent dorsally at apical  $\frac{3}{8}$  portion in lateral view (Fig. 2C), subapical part moderately inflated ventrally, apical part nearly straight and feebly inflated ventrally near apex.

### Distribution

China (Guangxi, Hubei, Hunan).

### Remarks

The external appearance of this species was described well in the original publication (Li *et al.* 2012), but the aedeagus was simply described and illustrated only in lateral and ventral views. Here, the material of this species is available for us, which makes it possible to provide a detailed description and illustrations of the aedeagus, to make better comparison with the new species below.

*Macrolycus nigricollis* Y. Yang, Liu & X. Yang sp. nov.

[urn:lsid:zoobank.org:act:23F1E034-0B3F-4520-A49D-02B8790A8617](https://zoobank.org/urn:lsid:zoobank.org:act:23F1E034-0B3F-4520-A49D-02B8790A8617)

Figs 1, 3A–C, 4A–B

### Diagnosis

This species can be separated from other species of the *M. gracilis* group by a characteristic aedeagus with moderately robust phallus, which is nearly parallel-sided in the basal part in all views (Fig. 3A–C). The species most closely resembles *M. aurantiacus* Kazantsev, 2001 in the triangular antennomere III, but can be easily distinguished from the latter by the black pronotum and dark red elytra, while both pronotum and elytra are orange in *M. aurantiacus*; phallus almost even in width in apical part in lateral view (Fig. 3C), and abruptly narrowed distad in *M. aurantiacus* (Kazantsev 2001: fig. 9).

### Etymology

The specific epithet is derived from the Latin ‘*niger*’ (‘black’) and ‘*collum*’ (‘neck’), referring to its uniformly black pronotum.

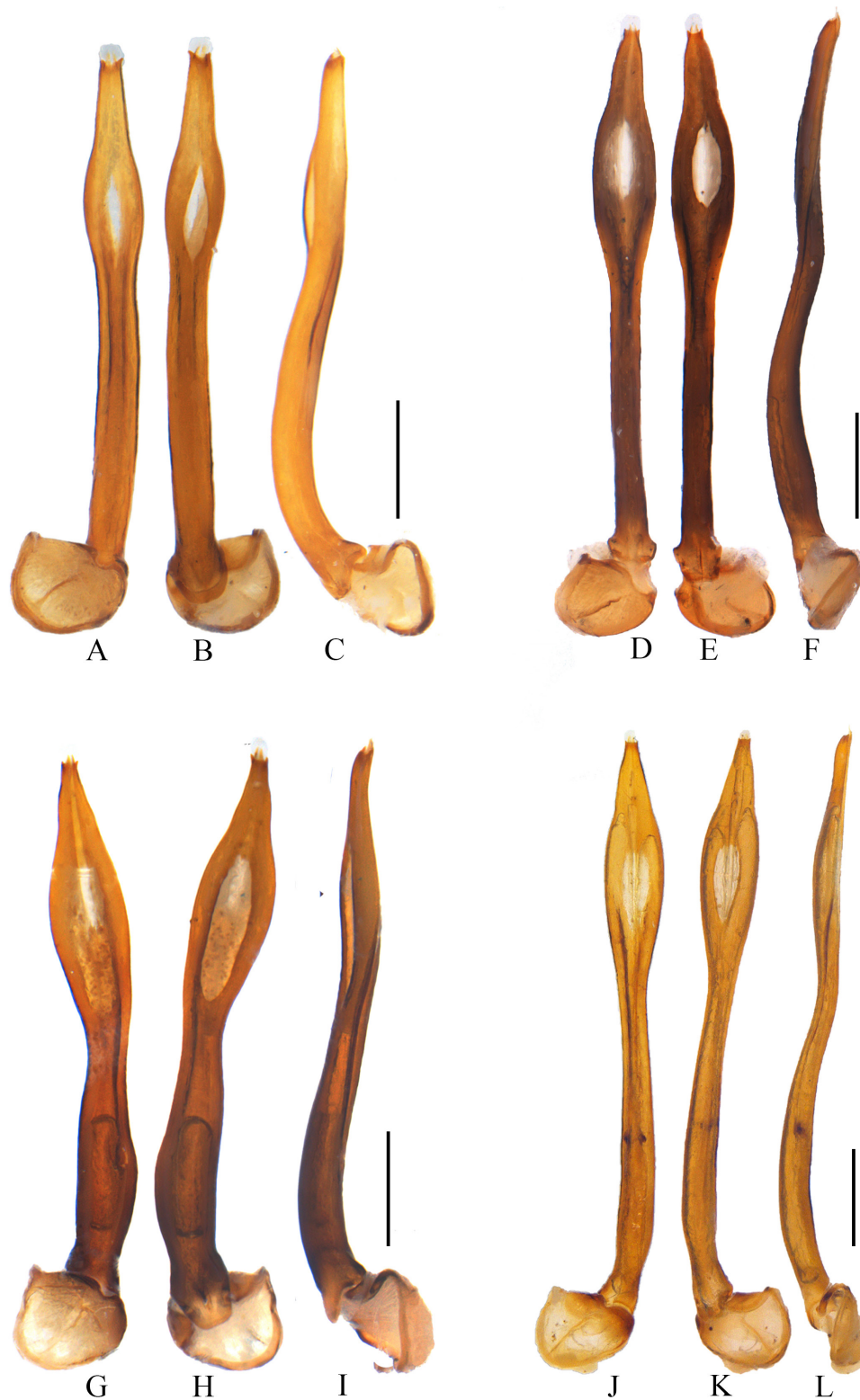
### Type material

#### Holotype

CHINA • ♂; Zhejiang, Fengyangshan, Ludai; 1123 m a.s.l.; 3 May 2021; Y. Kang and X.X. Wang leg.; HBU(E)410056; MHB.U.

#### Paratypes

CHINA • 1 ♂; Zhejiang, Tianmushan, Dahenglu; 1200 m a.s.l.; 6 Jun. 1998; M.S. Zhao leg.; IOZ(E)2058406; IZAS • 1 ♂; Fujian, Chongan, Xingcun, Road of Sangang to Jianyang, Aotou; 740–1170 m a.s.l.; 20 May 1960; C.L. Ma leg.; IOZ(E)1119994; IZAS • 1 ♀; Fujian, Chongan, Xingcun, Sangang; 740 m a.s.l.; 25 May 1960; Y.R. Zhang leg.; IOZ(E)1120123; IZAS.



**Fig. 3.** Aedeagi of species of *Macrolycus* Waterhouse, 1878. **A–C.** *M. nigricollis* sp. nov., holotype (HBU(E)410056, MHBUS). **D–F.** *M. graciliramus* sp. nov., holotype (HBU(E)410057, MHBUS). **G–I.** *M. breviramus* sp. nov., holotype (HBU(E)410058, MHBUS). **J–L.** *M. acutiapex* sp. nov., holotype (IOZ(E)1119901, IZAS). **A, D, G, J.** Dorsal views. **B, E, H, K.** Ventral views. **C, F, I, L.** Lateral view. Scale bars = 0.5 mm.

## Description

### Male (Fig. 4A)

MEASUREMENTS. Length 7.8–10.0 mm (8.7 mm in holotype), width at humeri 1.7–2.3 mm (1.9 mm in holotype).

HABITUS AND COLORATION. Body black brown. Pronotum and scutellum black, elytra dark red. Surface covered with decumbent red pubescence.

HEAD. Eyes small, interocular distance about  $1.7\times$  as long as eye diameter. Antennae flabellate starting from antennomeres IV, overlapping basal  $\frac{2}{3}$  length of elytra when inclined. Antennomere III triangular and feebly longer than wide, IV–XI lamellate, lamellae pointed at apices, lamella of IV as half long as joint itself, lamella of IX longest,  $3.3\times$  as long as joint itself (Fig. 4A).

PRONOTUM. Trapezoidal,  $1.2\times$  as wide as long. Anterior margin widely rounded, lateral margins feebly sinuate and posterior margin bisinuate; anterior angles rounded, posterior angles sharp and feebly projected. Scutellum trapezoidal, emarginate at apex (Fig. 4A).

ELYTRA.  $3.8\times$  as long as humeral width. Costa I weak but visible in whole length, costa IV as strong as II and both separated terminally, costa III visible only at the basal half part (Fig. 4A).

AEDEAGUS. Phallus slender, nearly parallel-sided at basal part in dorsal and ventral views (Fig. 3A–B), subapical part moderately and asymmetrically inflated laterally, about  $1.45\times$  as wide as basal part, with ventral, fusiform cavity, apical part gradually narrowed distad, apex about  $0.38\times$  as wide as subapical part; curved ventrally at basal  $\frac{2}{7}$  portion, and bent dorsally at apical  $\frac{5}{14}$  portion in lateral view (Fig. 3C), subapical part moderately inflated ventrally, apical part nearly straight and flat near apex.

### Female (Fig. 4B)

Similar to males, but larger in body size. Antennae serrate and shorter, reaching elytral midlength when inclined, antennomere III feebly widened apically, about  $2.5\times$  as long as wide. Pronotum narrower,  $1.1\times$  as wide as long. Elytral costa II stronger than IV and both fused then split terminally at apical part of elytra.

## Variation within type series

Pronotum of some specimens has the posterior margin straight.

## Distribution

China (Zhejiang, Fujian).

*Macrolycus graciliramus* Y. Yang, Du & Liu sp. nov.

[urn:lsid:zoobank.org:act:4DB1D779-6B9E-4291-8609-CA259A12D17D](https://zoobank.org/act:4DB1D779-6B9E-4291-8609-CA259A12D17D)

Figs 1, 3D–F, 4D–E

## Diagnosis

This species can be easily distinguished from all others of the *M. gracilis* group by the male antennae with extremely slender branches on antennomeres III–X (Fig. 4D). The species more resembles *M. gracilis* Pic, 1923 in the presence of lamella on antennomere III, but differs in the following characters: longer antennae, overlapping basal  $\frac{3}{4}$  length of elytra when inclined, lamella of antennomere III shorter,  $0.7\times$  as long as joint itself; black pronotum; apical part of phallus gradually narrowed distad in ventral view (Fig. 3E). In comparison, in *M. gracilis*, the antennae are shorter, at most reaching basal  $\frac{2}{3}$  length of

elytra, lamella of antennomere III is longer, as long as joint itself; pronotum is orange; apical part of the phallus is parallel-sided at apical  $\frac{1}{5}$  portion in ventral view (Li 2015: fig. 7u).

### Etymology

The specific epithet is derived from the Latin ‘*gracilis*’ (‘slender’) and ‘*ramus*’ (‘branch’), referring to the slender lamellae on male antennomeres III–X.

### Type material

#### Holotype

CHINA • ♂; Guangxi, Longsheng, Huaping, Anjiangping; 4 Jun. 2023; H.Q. Lin and S.L. Yuan leg.; HBU(E)410057; MHBU.

#### Paratypes

CHINA • 2 ♂♂; same data as for holotype; HBU(E)410059 to 410060; MHUB • 2 ♀♀; same data as for holotype; HBU(E)410061 to 410062; MHUB • 1 ♀; same data as for holotype; 2 Jun. 2023; HBU(E)410063; MHBU.

### Description

#### Male (Fig. 4D)

MEASUREMENTS. Length 10.0–10.6 mm (10.6 mm in holotype), width at humeri 2.1–2.4 mm (2.4 mm in holotype).

HABITUS AND COLORATION. Body black brown. Pronotum and scutellum black, elytra dark red. Surface covered with decumbent red pubescence.

HEAD. Eyes small, interocular distance about  $1.8\times$  as long as eye diameter. Antennae flabellate starting from antennomeres III, overlapping basal  $\frac{3}{4}$  length of elytra when inclined. Antennomeres III–XI lamellate, lamellae pointed at apices, lamella of III  $0.7\times$  as long as joint itself, lamella of VIII longest,  $3.4\times$  as long as joint itself (Fig. 4D).

PRONOTUM. Trapezoidal,  $1.1\times$  as wide as long. Anterior margin widely rounded and projecting anteriorly, lateral margins feebly sinuate and posterior margin straight; anterior angles rounded, posterior angles sharp and moderately projected. Scutellum trapezoidal, nearly straight at apex (Fig. 4D).

ELYTRA.  $3.8\times$  as long as humeral width. Costa I weak but visible at basal  $\frac{2}{3}$  length, costa II stronger than IV and both separated terminally at apical part of elytra, costa III visible only at the basal  $\frac{1}{4}$  part (Fig. 4D).

AEDEAGUS. Phallus slender, nearly parallel-sided at basal part in dorsal and ventral views (Fig. 3D–E), subapical part strongly and almost symmetrically inflated laterally, about twice as wide as basal part, with an oval ventral-cavity, apical part gradually narrowed distad, apex about  $0.25\times$  as wide as subapical part; curved ventrally at basal  $\frac{1}{3}$  portion, and bent dorsally at apical  $\frac{4}{7}$  portion in lateral view (Fig. 3F), subapical part feebly inflated ventrally, apical part slightly inclined dorsally and flat near apex.

#### Female (Fig. 4E)

Similar to males, but larger in body size. Antennae serrate and shorter, reaching elytral midlength when inclined. Pronotum wider,  $1.2\times$  as wide as long, anterior angles obtuse-angled. Elytra wider and  $3.6\times$  as long as humeral width, costa II much stronger than IV and both fused terminally at apical part of elytra.

**Distribution**

China (Guangxi).

*Macrolycus breviramus* Y. Yang, Du & Liu sp. nov.

[urn:lsid:zoobank.org:act:042B1564-6E58-4915-BF4C-A5C933F5040F](https://zoobank.org/urn:lsid:zoobank.org:act:042B1564-6E58-4915-BF4C-A5C933F5040F)

Figs 1, 3G–I, 4C

**Diagnosis**

This species can be easily distinguished from all others of the *M. gracilis* group by the cylindrical antennomere III, orange red margins of pronotum and elytra (Fig. 4C), and very robust but uneven phallus (Fig. 3G–I).



**Fig. 4.** Species of *Macrolycus* Waterhouse, 1878. **A, C, D, F.** Male habitus of species of *Macrolycus*, dorsal views. **B, E.** Female habitus of species of *Macrolycus*, dorsal views. **A–B.** *M. nigricollis* sp. nov., holotype (HBU(E)410056, MHBUS). **C.** *M. breviramus* sp. nov., holotype (HBU(E)410058, MHBUS). **D–E.** *M. graciliramus* sp. nov., holotype (HBU(E)410057, MHBUS). **F.** *M. acutiapex* sp. nov., holotype (IOZ(E)1119901, IZAS). Scale bars = 1 mm.

### Etymology

The specific epithet is derived from the Latin ‘*brevis*’ (‘short’) and ‘*ramus*’ (‘branch’), referring to its short antennal lamellae on male antennomeres VI–X.

### Type material

#### Holotype

CHINA • ♂; Hubei, Shennongjia, Pingqian, Baiwawu; 1350 m a.s.l.; 2 Jul. 2022; J.B. Tong and X.Y. Ge leg.; HBU(E)410058; MHBU.

### Description

#### Male (Fig. 4C)

MEASUREMENTS. Length 8.7 mm, width at humeri 2.0 mm.

HABITUS AND COLORATION. Body black brown. Pronotum and elytra dark red, with red margins. Scutellum black. Surface covered with decumbent red pubescence.

HEAD. Eyes small, interocular distance about  $1.6\times$  as long as eye diameter. Antennae flabellate starting from antennomeres VI, overlapping basal  $\frac{2}{3}$  length of elytra when inclined. Antennomere III cylindrical, IV long-triangular, about  $2\times$  as long as wide, V wide-triangular, feebly longer than wide, VI–XI lamellate, with lamellae acute at apices, lamella of IX longest,  $2\times$  as long as joint itself (Fig. 4C).

PRONOTUM. Square,  $1.1\times$  as wide as long. Anterior margin widely rounded and projecting anteriorly, lateral margins feebly sinuate and posterior margin nearly straight; anterior angles obtuse-angled, posterior angles sharp and moderately projected. Scutellum trapezoidal, nearly straight at apex (Fig. 4C).

ELYTRA.  $3.8\times$  as long as humeral width. Costa I weak but visible at basal  $\frac{2}{3}$  length; costa III visible only at the base; costa II stronger than IV and both fused terminally at apical part of elytra (Fig. 4C).

AEDEAGUS. Phallus stout, expanded to one side at basal part in dorsal and ventral views (Fig. 3G–H), subapical part moderately and asymmetrically inflated laterally, about  $1.25\times$  as wide as basal part, with an oblong ventral-cavity, apical part gradually narrowed distad, apex about  $0.20\times$  as wide as subapical part; curved ventrally at basal  $\frac{5}{14}$  portion, and bent dorsally at apical  $\frac{1}{3}$  portion in lateral view (Fig. 3I), subapical part flat, apical part slightly inclined dorsally and feebly inflated ventrally near apex.

#### Female

Unknown.

### Distribution

China (Hubei).

*Macrolycus acutiapex* Y. Yang, Liu & X. Yang sp. nov.

[urn:lsid:zoobank.org:act:28C36CE6-34D4-4FBE-84A8-0151F8ACF9DC](https://zoobank.org/act:28C36CE6-34D4-4FBE-84A8-0151F8ACF9DC)

Figs 1, 3J–L, 4F

### Diagnosis

This species can be distinguished from the remaining species of the *M. gracilis* group by the antennomere III with slender and short lamella,  $0.7\times$  as long as joint itself. It is more similar to *M. mucronatus* Li, Bocak & Pang, 2012, but can be differentiated by the antennomere III with slender lamella,  $0.7\times$  as long as joint itself; apical part of the phallus gradually narrowed distad in ventral view (Fig. 3K), and

subapical part inflated ventrally in lateral view (Fig. 3L). Unlikely, in *M. mucronatus*, the antennomere III is stouter, with lamella about half length of joint itself; apical part of the phallus is abruptly narrowed distad in ventral view (Li *et al.*, 2012: fig. 38), and subapical part flat in lateral view (Li *et al.*, 2012: fig. 37).

### Etymology

The specific epithet is derived from the Latin ‘*acutus*’ (‘sharp’) and ‘*apex*’ (‘tip’), referring to its lamella of antennomere III with pointed apex.

### Type material

#### Holotype

CHINA • ♂; Hubei, Xingshan, Longmenhe; 2200 m a.s.l.; 13 Jun. 1995; S.Y. Wang leg.; IOZ(E)1119901; IZAS.

### Description

#### Male (Fig. 4F)

MEASUREMENTS. Length 7.3 mm, width at humeri 1.6 mm.

HABITUS AND COLORATION. Body black brown. Pronotum, elytra and scutellum dark red. Elytral costae IV orange-red. Surface covered with decumbent red pubescence.

HEAD. Eyes small, interocular distance about  $1.7\times$  as long as eye diameter. Antennae flabellate, overlapping basal  $\frac{2}{3}$  length of elytra when inclined. Antennomeres III–XI lamellate, lamellae pointed at apices, lamella of III extremely slender, about  $0.7\times$  as long as joint itself, lamella of IX longest,  $4.2\times$  as long as joint itself (Fig. 4F).

PRONOTUM. Trapezoidal,  $1.3\times$  as wide as long. Anterior margin widely rounded, lateral margins obviously sinuate and posterior margin nearly straight; anterior angles confluent with anterior margin, posterior angles sharp and moderately projected. Scutellum trapezoidal, nearly straight at apex (Fig. 4F).

ELYTRA. Slender and subparallel-sided,  $3.9\times$  as long as humeral width. Costae I and III weak but visible at whole length, costa IV weaker than II and both separated at apical part of elytra (Fig. 4F).

AEDEAGUS. Phallus slender, with basal part narrowed to middle in dorsal and ventral views (Fig. 3J–K), subapical part strongly and almost symmetrically inflated laterally, about  $1.67\times$  as wide as basal part, with an oval ventral-cavity, apical part gradually narrowed distad, apex about  $0.25\times$  as wide as subapical part; curved ventrally at basal  $\frac{5}{16}$  portion, and bent dorsally at apical  $\frac{7}{16}$  portion in lateral view (Fig. 3L), subapical part feebly inflated ventrally, apical part nearly straight and flat ventrally.

#### Female

Unknown.

### Distribution

China (Hubei).

### Key to the species of the *Macrolycus gracilis* group

1. Antennomere III lamellate in male, lamella at least  $0.7\times$  as long as joint itself (e.g., Fig. 4D, F; Li 2015: fig. 3e) ..... 2
- Antennomere III triangular or cylindrical in male, without any lamella (e.g., Fig. 4A, C; Kazantsev 2001: fig. 8; 2002: fig. 9; Li *et al.* 2012: figs 50–51; 2015: figs 2–6) ..... 4

2. Pronotum black (Fig. 4D); phallus with apical part slightly bent dorsally in lateral view (Fig. 3F) ..  
 ..... *M. graciliramus* sp. nov.  
 – Pronotum dark red or orange (e.g., Fig. 4F; Li 2015: fig. 3e); phallus with apical part straight in lateral view (e.g., Fig. 4L; Li 2015: fig. 10e) ..... 3
3. Lamella of antennomere III as long as joint itself (Li 2015: fig. 7u); apical part of phallus parallel-sided in ventral view (Li 2015: fig. 10f) ..... *M. gracilis* Pic, 1923  
 – Lamella of antennomere III 0.7× as long as joint itself (Fig. 4F); apical part of phallus narrowed distad in ventral view (Fig. 4K) ..... *M. acutiapex* sp. nov.
4. Antennomere III cylindrical in male (Fig. 4C); basal part of phallus obviously asymmetrical, expanded to one side in ventral view (Fig. 3H) ..... *M. breviramus* sp. nov.  
 – Antennomere III triangular in male (e.g., Fig. 4A; Kazantsev 2001: fig. 8; 2002: fig. 9; Li *et al.* 2012: figs 50–51; 2015: figs 2–6); basal part of phallus nearly symmetrical (e.g., Fig. 3B; Kazantsev 2001: fig. 9; 2002: fig. 10; Li *et al.* 2012: figs 38, 40; 2015: figs 15, 17, 19, 21, 23) ..... 5
5. Apical part of phallus moderately inflated distad in ventral view (Li *et al.* 2015: fig. 15) .....  
 ..... *M. baihualingensis* Li, Bocak & Pang, 2015  
 – Apical part of phallus narrowed distad in ventral view (e.g., Fig. 3B; Kazantsev 2001: fig. 9; 2002: fig. 10; Li *et al.* 2012: figs 38, 40; 2015: figs 17, 19, 21, 23) ..... 6
6. Pronotum black (Fig. 4A); subapical part of phallus moderately inflated ventrally in lateral view (Fig. 3C) ..... *M. nigricollis* sp. nov.  
 – Pronotum dark red or orange; subapical part of phallus flat ventrally in lateral view (e.g., Kazantsev 2001: fig. 10; 2002: fig. 11; Li *et al.* 2012: figs 37, 39; 2015: figs 16, 18, 20, 22) ..... 7
7. Phallus with apical part curved dorsally in lateral view (e.g., Li *et al.* 2015: figs 20, 22) ..... 8  
 – Phallus with apical part straight in lateral view (e.g., Kazantsev 2001: fig. 10; 2002: fig. 11; Li *et al.* 2012: figs 37, 39; 2015: figs 16, 18) ..... 9
8. Elytral costa II orange-red; phallus with basal part narrowed to middle in ventral view (Li *et al.* 2015: fig. 21), and apical part moderately curved dorsally in lateral view (Li *et al.* 2015: fig. 20) ..... *M. rhodoneurus* Li, Bocak & Pang, 2015  
 – Elytral costa II dark red; phallus with basal part parallel-sided in ventral view (Li *et al.* 2015: fig. 23), and apical part strongly curved dorsally in lateral view (Li *et al.* 2015: fig. 22) .....  
 ..... *M. rosaceus* Li, Bocak & Pang, 2015
9. Phallus with apical part gradually narrowed distad (e.g., Kazantsev 2001: fig. 9; 2002: fig. 10; Li *et al.* 2015: fig. 19) ..... 10  
 – Phallus with apical part abruptly narrowed distad (e.g., Li *et al.* 2012: figs 38, 40; Li *et al.* 2015: fig. 17) ..... 12
10. Pronotum and elytra orange; apex of phallus about ¼ as wide as subapical part (Kazantsev 2001: fig. 9) ..... *M. aurantiacus* Kazantsev, 2001  
 – Pronotum and elytra dark red (e.g., Li *et al.* 2015: fig. 4); apex of phallus at most 1/5 as wide as subapical part (e.g., Kazantsev 2002: fig. 10; Li *et al.* 2015: fig. 19) ..... 11
11. Pronotum and elytra orange red (Li *et al.* 2015: fig. 4); basal part of phallus uneven in width in ventral view (Li *et al.* 2015: fig. 19); apical part moderately inflated ventrally near apex in lateral view (Li *et al.* 2015: fig. 18) ..... *M. phoeniceus* Li, Bocak & Pang, 2015  
 – Pronotum and elytra dark red; basal part of phallus parallel-sided in ventral view (Kazantsev 2002: fig. 10), apical part flat ventrally in lateral view (Kazantsev 2002: fig. 11) .....  
 ..... *M. multicostatus* Kazantsev, 2002

12. Phallus with apical part abruptly narrowed distad in lateral view (Li *et al.* 2015: fig. 16) .....  
 ..... *M. lizipingensis* Li, Bocak & Pang, 2015  
 – Phallus with apical part nearly parallel-sided in lateral view (e.g., Li *et al.* 2012: figs 37, 39) ..... 13
13. Antennae relatively long, overlapping basal  $\frac{4}{5}$  length of elytra when inclined (Li *et al.* 2012: fig. 50);  
 phallus bent dorsally at basal  $\frac{1}{3}$  portion in lateral view (Li *et al.* 2012: fig. 37) .....  
 ..... *M. mucronatus* Li, Bocak & Pang, 2012  
 – Antennae relatively short, overlapping basal  $\frac{1}{2}$  length of elytra when inclined (Li *et al.* 2012: fig. 51);  
 phallus bent dorsally at basal  $\frac{1}{6}$  portion in lateral view (Li *et al.* 2012: fig. 39) .....  
 ..... *M. muyuensis* Li, Bocak & Pang, 2012

## Discussion

Within *Macrolycus*, the species groups were defined only by the morphology of the aedeagus, particularly in the structure of the apex of the phallus (Li *et al.* 2015). In our study on the *M. gracilis* group, we tried to find other characters to supplement the diagnosis but failed because of the plasticity of its morphology. Except the male genitalia, only the shape of antennomere III is considered as a reliable diagnostic character in species identification (Li *et al.* 2015). It is always triangular or lamellate in the *M. gracilis* group, but cylindrical in *M. acutiapex* sp. nov. The lamellae of the antennae in males are often present on antennomeres III or IV–X, while on V–X in *M. acutiapex* sp. nov. In addition, the body coloration is helpful in recognizing the species, as noted by Li *et al.* (2012). Based on the aforementioned structures and characters, we provide a key to the species of the *M. gracilis* group in the Results part.

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