



The first discovery of fossil rhopalids (Heteroptera: Coreoidea) from Middle Jurassic of Inner Mongolia, China

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Abstract

Two new genera and two new species of fossil rhopalid, *Miracorizus punctatus* **gen. & sp. nov.** and *Longiclavula calvata* **gen. & sp. nov.**, are described and illustrated. They were collected from the Middle Jurassic Jiulongshan Formation of Inner Mongolia, China. This is the earliest fossil record of the family Rhopalidae in the world.

Key words: Heteroptera, Coreoidea, Rhopalidae, fossil, Middle Jurassic, Jiulongshan Formation

Introduction

Rhopalids are found in all major faunal regions and 22 extant genera and about 200 species are recognized (Göllner-Scheiding 1983). This family has often been considered to be a subfamily of an inclusive Coreidae (Kiritshenko 1951; Xiao 1977; Zhang 1985), but modern workers treated it as a distinct family (Schaefer 1965, and discussion therein; Carver *et al.* 1991; Li & Zheng 1994; Vinokurov & Kanyukova 1995; Zheng 1999).

Fossil representatives of the superfamily Coreoidea are known since the Late Triassic (Lin 1992). So far, all fossil species of this group have been placed within Coreidae and Alydidae (Carpenter 1992). Nearly 50 genera have been described, mostly from China (22 genera and 27 species) (Hong 1983, 1984, 1987; Hong & Wang 1987; Lin 1977, 1986, 1992; Yao *et al.* 2004; Zhang 1989; Zhang & Zhang 1990; Zhang *et al.* 1994) and USA (ca. 15 genera) (Cockerell 1909; Scudder 1890), a few species from Kazakhstan (Becker-Migdisova 1962; Becker-Migdisova & Popov 1963; Popov 1968), Germany (Heer 1853; Statz & Wangner 1950; Štys & Říha 1975, 1977), France (Theobald 1937), and Spain (Martínez-Delclòs *et al.* 1991). No fossil species of the family Rhopalidae have been

recorded prior to this study.

A rich entomofauna from the Jiulongshan Formation in Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China is dated as Middle Jurassic (Chen *et al.* 2004; Ren *et al.* 1995; Ren *et al.* 2002; Tan & Ren 2002; Gao & Ren 2006). It is an important component of Yanliao Insect Fauna of Northern China (Hong 1983; Ren & Lu 1996). All extant species of Rhopalidae are phytophagous, in general prefer plants of the subclasses Rosidae and Asteridae (Schaefer & Chopra 1982). In the Middle Jurassic of Northeast China, Gymnospermae forests were dominated by Ginkgopsida, Coniferopsida, Lycoposidas, Sphenopsida, Filicopsida, Cycadopsida (Mi *et al.* 1996), and so the rhopalids probably fed on these plants.

Material and methods

All the type specimens of the new species are housed at the Key Lab of Insect Evolution & Environmental Change, Capital Normal University in Beijing, China. Drawings were made with a camera lucida attached to a Leica MZ12.5 stereomicroscope. Basic terminology in this paper follows Schuh and Slater (1995). The measurements are given in millimeters.

Systematics

Genus *Miracorizus* Yao, Cai & Ren, gen. nov.

Type species. *Miracorizus punctatus* Yao, Cai & Ren, sp. nov.

Diagnosis: Body elongate, lateral sides subparallel, dorsal surface densely punctate. Head large, width and length subequal, over 0.5 times as long as pronotum, anteocular portion longer than postocular, apex surpassing first antennal segment; mandibular plates not surpassing clypeus; eyes relatively small, round; antenna 4-segmented, longer than head and pronotum combined, first segment shortest and thickest, second segment longest and slender, fourth segment fusiform, shorter and stouter than third segment; rostrum extending to mesocoxae, 4-segmented, first segment slightly thicker, second to fourth segments subequal in thickness, first elongate, third longest, fourth shorter than second, acute distally. Pronotum trapezium, length shorter than width, with collar, posterior region with two longitudinal carinae; hind coxae widely separated, femora distinctly thicker than tibiae, fore and mid legs subequal in length, hind leg longer than mid leg, tarsus 3-segmented, subequal in thickness, first and second subequal in length, third longest; hemelytra macropterous, long and narrow, apical margin rounded, reaching to tip of abdomen, with distinctly embolium, corium elongated on costal margin, with deep

medial fracture; clavus considerably longer than lateral side of scutellum, tapering, a veinlike carina and a vein arising at basal point, both crossing claval suture, carina reaching middle of corium, vein through posterior region of corium into membrane; membrane with some cells at middle and nearly 20 longitudinal veins distally. Abdomen oval, with narrow connexivum, ovipositor very long, not projecting beyond last paratergites.

Distribution: China.

Etymology: The generic name is a combination of the Latin *mira* (“special”) and *Corizus* (the type genus of this family).

Remarks: With numerous longitudinal veins in its membrane, the present fossil genus obviously belongs to Coreoidea, but it is difficult to assign it to family. The phylogeny and classification of Coreoidea bugs is based largely on such features as those of the structure of the metathoracic scent-gland, the bucculae, and the genitalia. These features are not well preserved or are invisible in fossil specimens. According to structures of the antenna and clavus and the ratio of head to pronotum, it is better to place the new genus in Rhopalidae. But it differs from extant Rhopalidae in fifth sutures of abdominal straight (vs. fifth segment of abdominal constricted in midline), a vein across claval suture (vs. without this vein). The phenomenon of a across the claval suture has been recorded in extant Enicocephalomorpha and Dipsocoromorpha and in fossil Coleorrhyncha (Popov 1982; Zheng 1999). Obviously, it is an archicharacter.

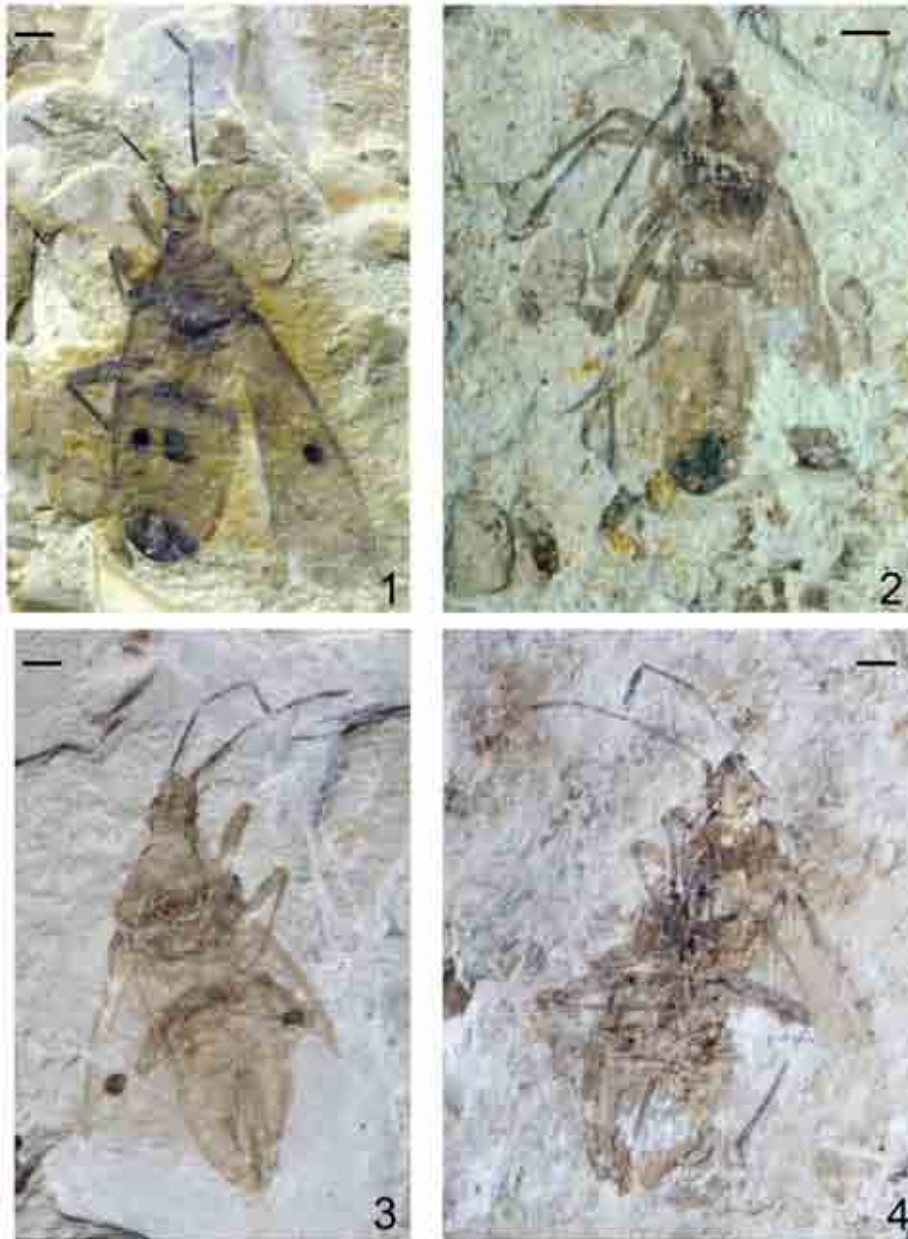
Within all fossil taxa of Coreoidea, the new genus is closely related to *Monstrocureus* Popov, 1968, but easily differs from the latter in the ratio of the antennal second segment to the third (about 1.5:1 [vs. 4.8: 4.4]) and clavus with a veinlike carina and a vein (vs. neither carina nor vein). *Miracorizus* is also similar to *Weichangicoris* Hong, 1984, but can be distinguished from the latter in the ratio of the second antennal segment to the third about 1.5: 1 (vs. 1.4:1.3), and the head distinctly shorter than the pronotum (vs. head and pronotum subequal in length).

***Miracorizus punctatus* Yao, Cai & Ren, sp. nov.**

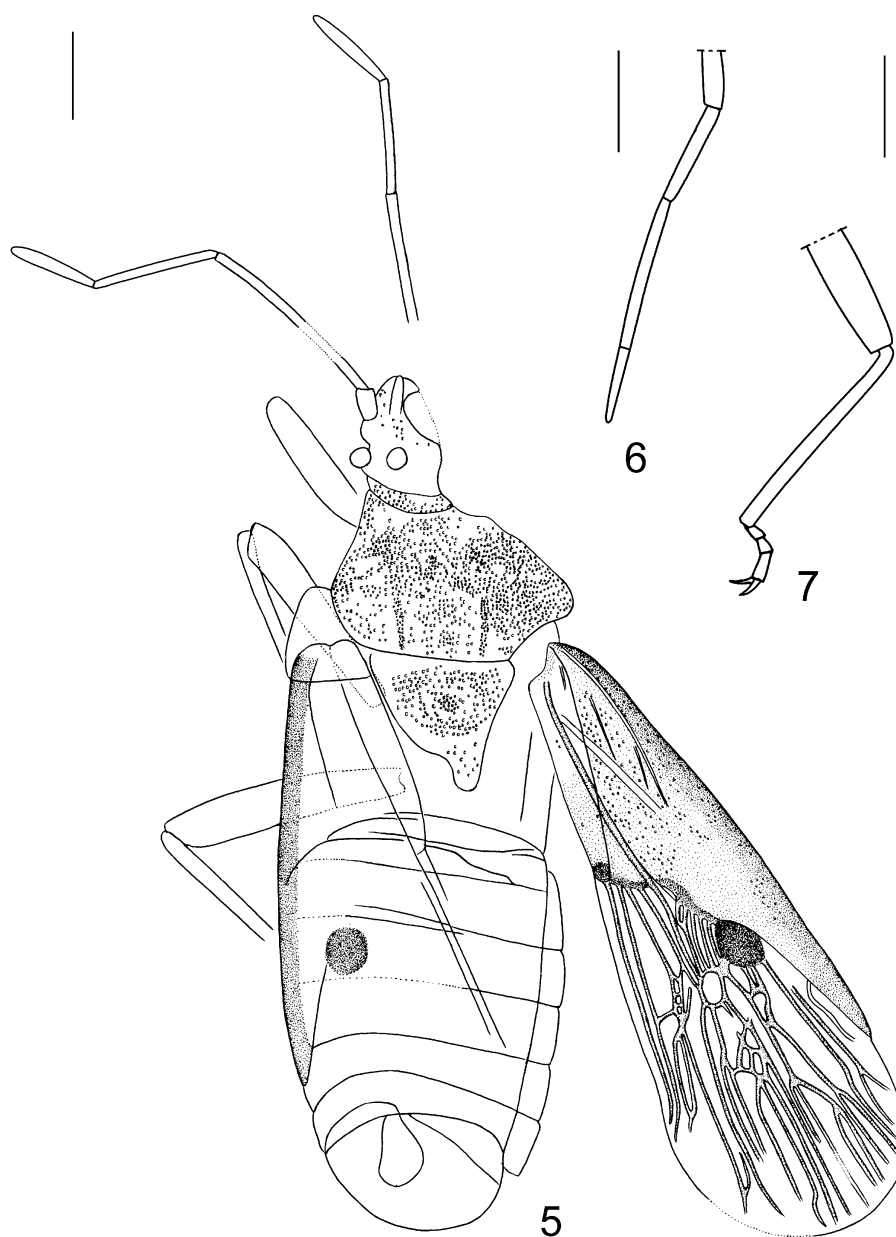
(Figs. 1–10)

Description: Body narrow, about 2.8 times (male) or 3 times (females) as long as wide. Head slightly shorter than pronotum, surface distinctly granulate; antenna slender, slightly longer than head, pronotum, and scutellum combined, second segment about 1.4 times as long as third, 2 times as long as fourth; eyes somewhat prominent. Pronotum moderately transverse, nearly 2 times as wide as long, anterior margin about 0.5 times as long as posterior one, lateral sides convex, both anterior and posterior angles feebly rounded, surface densely punctate. Scutellum shorter than pronotum on median line, surface granulate similar to pronotum. All femora stout, over two times as thick as corresponding tibia, pro- and mesofemora subequal to corresponding tibiae in length, third tarsomeres

longest, almost 1.5 times as long as second; hind legs distinctly longer than fore and mid legs, tibia longer than femur, with densely setae, tarsi similar to fore and mid tarsi. Fore wing long, costal margin nearly straight, clavus and corium relative sparsely punctate; corium with distinctly thickened embolium, basal zone with two longitudinal sulci, nearly 0.8 times of hemelytra in length; clavus sticklike, in females basal of hind margin convex,

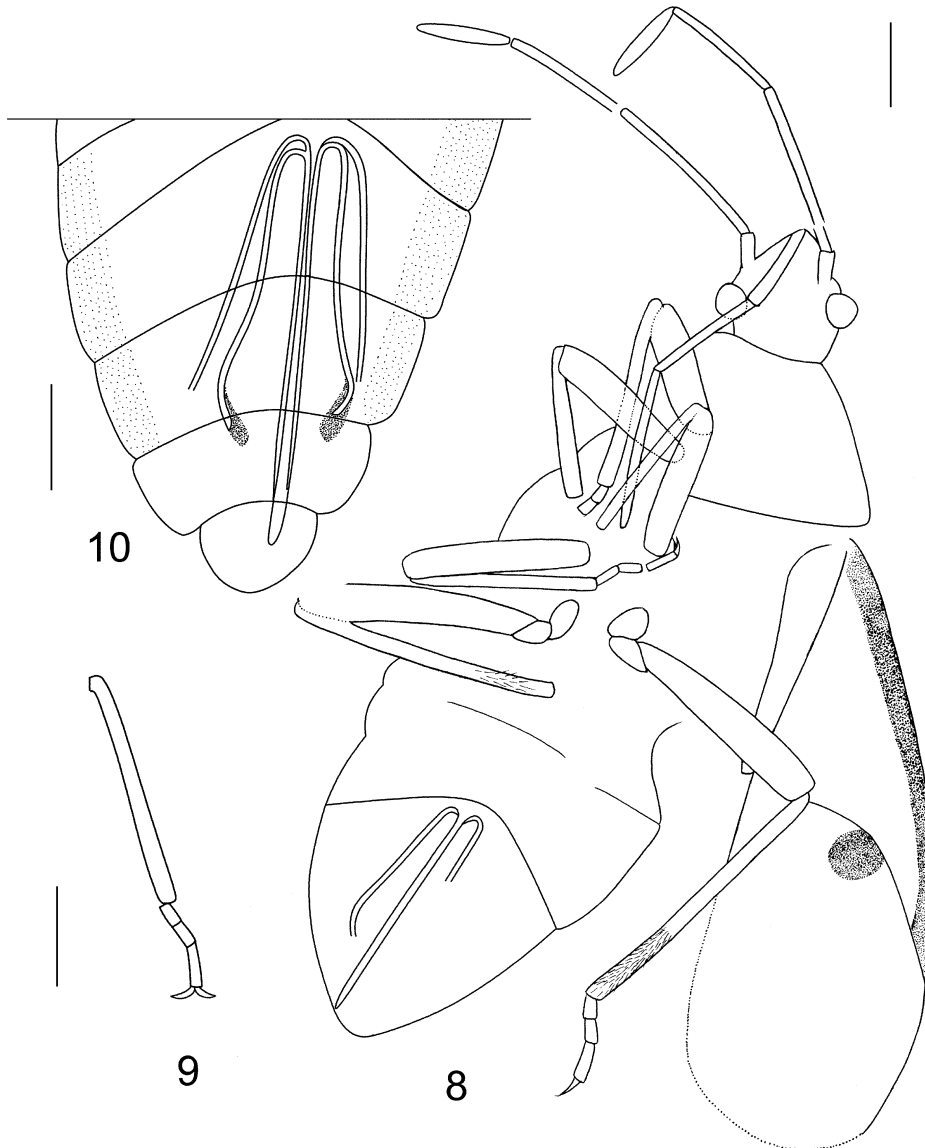


FIGURES 1–4. *Miracorizus punctatus*, gen. & sp. nov. 1. Holotype, ♂, CNU-HE-NN2006002; 2. paratype, ♂, CNU-HE-NN2006027; 3. paratype, ♀, CNU-HE-NN2006021; 4. paratype, ♀, CNU-HE-NN2006023. Scale bar = 1 mm.



FIGURES 5–7. *Miracorizus punctatus*, gen. & sp. nov., ♂. 5. Holotype, CNU-HE-NN2006002; 6. rostrum, paratype, CNU-HE-NN2006027; 7. mid leg, paratype, ♂, CNU-HE-NN2006027. Scale bar = 1 mm.

nearly 6.5 times as long as wide, basal zone with a short longitudinal sulcus; membrane large, membranal suture curved, from which nearly 10 veins arising, these veins at middle forming some cells from which numerous radiating and anastomosing veins arise, basal portion with a distinct black spot. Structure of female genitalia as in Fig. 10, ovipositor attending through last four abdominal segments, one-fourth as long as body.



FIGURES 8–10. *Miracorizus punctatus*, gen. & sp. nov., ♀. 8. Paratype, CNU-HE-NN2006023; 9. tibia and tarsus of fore leg, paratype, CNU-HE-NN2006022; 10. last five segments of abdomen and genitalia, paratype, CNU-HE-NN2006021. Scale bar = 1 mm.

Dimensions (in mm): Body length 9.3 (♂), 10.9 (♀); maximum width of abdomen 3.2 (♂), 3.6 (♀); head length 1.3 (♂), 1.5 (♀), width 1.6 (♀); antennal segment length I–V: 0.32, 2.16, 1.32, 1.0 (♂), 0.3, 2.0, 1.4, 1.0 (♀); rostrum length ca. 4.0, rostral segment length II–IV: 1, 1.5, 0.75 (♂), 4.1, 1–4: 0.9, 1.3, 1.4, 0.5 (♀); length of pronotum 1.79 (♂), 1.8 (♀), width 2.8 (♀); length of hemelytra 7.1 (♂), 7.8 (♀), width 2.42 (♂), 2.3 (♀), anterior margin of corium length 5.47 (♂), 5.6 (♀), clavus length 2.74 (♂), 2.8 (♀), width 0.42 (♂), 0.5 (♀); length of fore leg: femur 1.5 (♂), 1.9 (♀), tibia 2.1 (♂) (incomplete), 2.2

(♀), tarsomeres 1-3: 0.2, 0.2, 0.35 (♀); length of middle leg: femur 1.6 (♂), 2.1 (♀), tibia 2.3 (♂), 2.1 (♀), tarsomeres 1-3: 0.2, 0.2, 0.3 (♂), 0.3, 0.3, 0.4 (♀); length of hind leg: femur 2.2 (♂), 2.5 (♀), tibia 2.8 (incomplete) (♂), 3.4 (♀), tarsomeres 1-3: 0.3, 0.3, 0.45 (♀); ovipositor length 2.8.

Material: Holotype (♂): CNU-HE-NN2006002 (dorsoventrally compressed); paratypes: 1 ♂, CNU-HE-NN2006027 (laterally compressed); 1 ♀, CNU-HE-NN2006020 (dorsoventrally compressed), 1 ♀, CNU-HE-NN2006021 (dorsoventrally compressed), 1 ♀, CNU-HE-NN2006022 (dorsoventrally compressed), 1 ♀, CNU-HE-NN2006023 (laterally compressed), 1 ♀, CNU-HE-NN2006025 (dorsoventrally compressed).

Locality and horizon: Jiulongshan Formation, Middle Jurassic Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

Etymology: The name derived from Latin *punctatus* ('punctate').

Genus *Longiclavula* Yao, Cai & Ren, gen. nov.

Type species: *Longiclavula calvata* Yao, Cai & Ren, sp. nov.

Diagnosis: Body moderately sized, elongate, general body plan resembling alydids', dorsal surface smooth, impunctate. Head width and length subequal, slightly shorter than pronotum, apex surpassing first segment of antenna; antennae 4-segmented, longer than half of body, first segment short and thick, second, third, and fourth segments slender, second segment longest, fourth shorter than third segment; eyes moderately large, round and prominent, distance between two eyes wider than diameter of an eye. Pronotum trapezoidal, slightly transverse, with collar; femur lacking spine; hemelytron macropterous, long and narrow, apical margin rounded, nearly reaching to tip of abdomen, with distinct embolium, corium elongated on costal margin, with only one wavy longitudinal vein; clavus tapering, without carina and vein; membrane with numerous veins. Abdomen oval, all sutures of abdominal straight, third to fifth sterna subequal in width, distinctly wider than other sterna.

Distribution: China.

Etymology: The name is a combination of the Latin *longus* ('long') and *clavula* ('clavus'), alludes to its very long clavus and lack of a claval commissure. The gender is feminine.

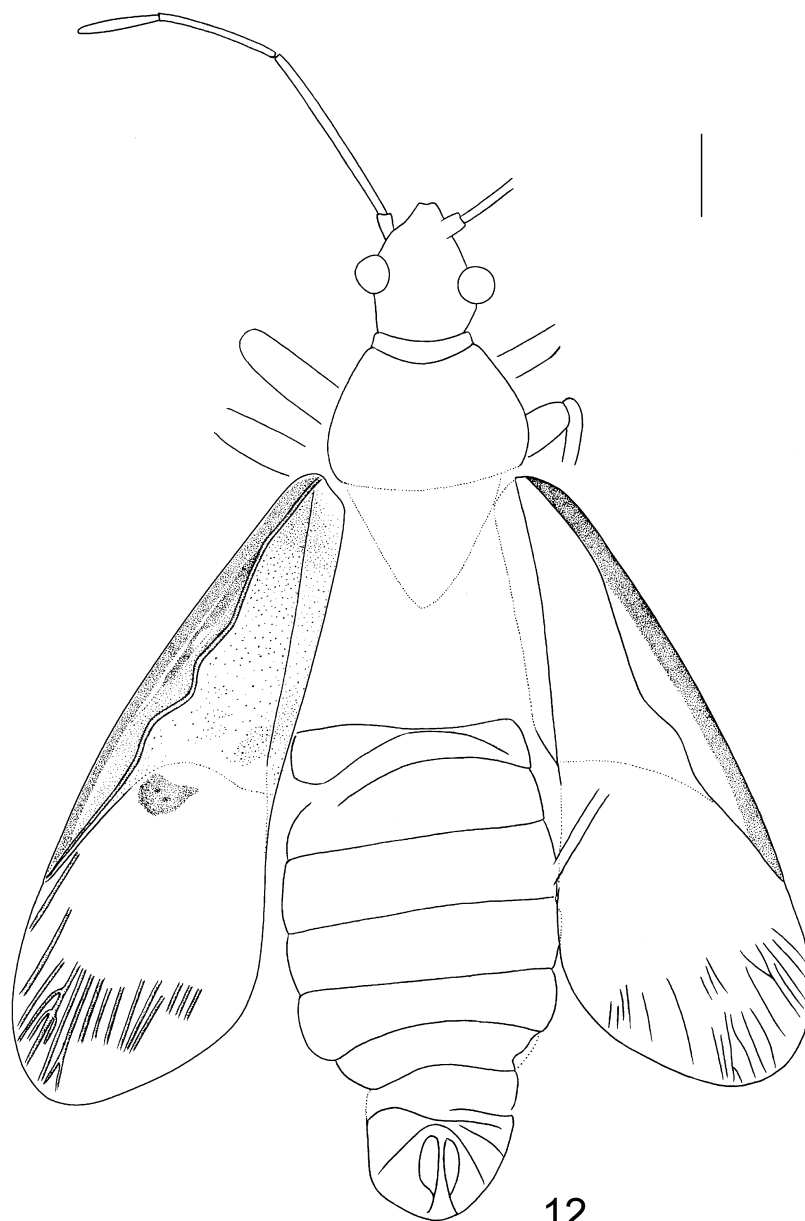
Remarks: This new genus can be placed next to *Miracorizus* as they are similar in the following characters: antenna long and slender, the first segment shortest, not extending beyond head apex, the second segment longest, fourth segment shorter than third segment; legs without spine; hemelytron macropterous, costal margin of corium elongated, clavus tapering, longer than lateral side of scutellum, without claval commissure. But *Longiclavula* can be easily distinguished from *Miracorizus* by dorsal surface smooth (vs. densely punctate), length of body about 4 times of the width (vs. about 3 times), corium

with only M and without medial fracture (vs. without M and medial fracture), clavus without veinlike carina and vein (vs. with a veinlike carina and a vein arising at its basal point).

Longiclavula is also similar to *Monstrocoreus* Popov, 1968 in body relatively elongated, clavus tapering, only one vein on corium; but the new genus can be distinguished from the latter by head over 0.5 times as wide as base of pronotum (vs. less than 0.5 times as wide as base of pronotum); antenna relatively shorter, slightly longer than half of body (vs. subequal to body); M crooked (vs. M nearly straightly); third to fifth abdominal sterna subequal in width (vs. third to sixth subequal in width).



FIGURES 11. *Longiclavula calvata*, **gen. & sp. nov.**, holotype. Photograph of body. Scale bar = 1 mm.



FIGURES 12. *Longiclavula calvata*, gen. & sp. nov., holotype. Line illustration of habitus. Scale bar = 1 mm.

Longiclavula calvata Yao, Cai & Ren, sp. nov.
(Fig. 11–12)

Description: Male. Body almost 4 times as long as wide. Head disproportionately large, slightly shorter than pronotum, over 0.5 times as wide as base of pronotum; antenna thin

and long, second segment about 1.5 times as long as third, third segment about 1.5 times as long as fourth; width between eyes about twice as wide as diameter of eye. Pronotum slightly transverse, about 1.4 times as wide as long, posterior margin over two times as long as anterior one; collar conspicuous. Costal margin of hemelytron nearly straight, corium with distinctly thickened embolium and almost 0.7 times as long as hemelytra, M extending at basal portion and terminating at apex of corium; clavus 2.8 times as long as wide; membrane with nearly 20 veins at distal part.

Dimensions (in mm): Body length 12, maximum width of abdomen 3.2; head length 1.63, width 1.63; antennal segment length I–IV: 0.26, 2.16, 1.42, 0.95; length of pronotum 1.74, width 2.37; length of hemelytra 8, width 2.63, anterior margin of corium length 5.84, clavus length 3.26, width 0.32.

Holotype: Specimen No. CNU-HE-NN 2006003. An almost completely preserved individual, dorsoventrally compressed.

Type locality and horizon: Jiulongshan Formation, Middle Jurassic Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

Etymology: The name derived from Latin *calvata*, “smooth.”

Female: Unknown.

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