

# FIRST FOSSIL CLICK BEETLES FROM THE MIDDLE JURASSIC OF INNER MONGOLIA, CHINA (COLEOPTERA: ELATERIDAE)

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**Abstract.**— A new genus with two new species and one new species of fossil elaterids are described: *Paradesmatus baiiae* gen. et sp. nov., *Paradesmatus ponomarenkoi* sp. nov., *Protagrypnus robustus* sp. nov. These findings document the fossils from the Middle Jurassic Jiulongshan Formation of Eastern Inner Mongolia, China. Fossil elaterids of Mesozoic with large triangular plates of metacoxae have been discovered only from the Upper Jurassic strata of Karatau so far, *Paradesmatus baiiae* with the unique feature will expand our knowledge on the early diversification of elaterids.



**Key words.**— Elateridae, fossil, Daohugou, Middle Jurassic, China.

## INTRODUCTION

Extant elaterids are common and abundant. The family Elateridae is composed of more than 10000 recent species (Lawrence 1982) which were placed in 12 subfamilies by Stibick (1979), 8 subfamilies by Calder (1996), although some Chinese authors grouped them into 12 subfamilies with over than 800 recent species recorded from China (Jiang and Wang 1999, Yang 1999).

Up to date, more than 100 Mesozoic fossil species of elaterids have been reported from all over the world (Chang *et al.* 2007, Chang and Ren 2008, Chang *et al.* 2008, Dolin 1973, 1975, 1976, 1980, Dolin and Nel 2002, Dunstan 1923, Gardiner 1961, Hong 1982, 1984, Lin 1986, Martynov 1926, Ping 1928, Zhang 1997). Among these records, 108 species in 32 genera are known from the Upper Jurassic strata of Karatau in Kazakhstan (Dolin 1975, 1976, 1980). According to all the fossil records by now, elaterids probably originated not later than the Early Jurassic and flourished by the Late

Jurassic (Dolin 1980, Ponomarenko 2001, 2009, Zherikhin 1980, 2001). More detailed information on Elateridae in the fossil record can be got in the catalogue by Ponomarenko and Kirejtshuk (2009).

The fossil specimens were recently collected from the Middle Jurassic Daohugou beds, Jiulongshan Formation, Ningcheng County, Inner Mongolia in China, about 165 Ma. (Ren *et al.* 2002, Chen *et al.* 2004, Gao and Ren 2006).

## MATERIALS AND METHODS

The specimens were examined using a Leica MZ12.5 dissecting microscope, illustrated with the aid of a drawing tube attachment, and photograph acquired by Nikon Digital Camera DXM1200C. The morphological terminology used follows Lawrence and Newton (1995) and Beutel and Haas (2000), and the family system was taken from Dolin (1980).

Body length was measured along the midline from the anterior margin of frons to apex of abdomen, and width was measured across the broadest part of elytra. The length of pronotum was measured along the midline; the width was measured across the broadest part at its posterior angles.

## SYSTEMATIC PALEONTOLOGY

Order *Coleoptera* Linnaeus, 1758

Family *Elateridae* Leach, 1815

Subfamily *Protagrypninae* Dolin, 1973

Tribe *Desmatini* Dolin, 1975

*Paradesmatus* Chang, Kirejtshuk et Ren, gen. nov.

**Type species.** *Paradesmatus baiiae* sp. nov.

**Included species.** *P. baiiae* sp. nov. and *P. pono-marenkoi* sp. nov.

**Etymology.** A combination of the Greek prefix “*Para*” (near, besides, at) and “*Desmatus*” (a generic name of the Karatau fossil genus which is characterized also by the large and triangular metacoxal femoral plates).

**Diagnosis.** Prosternum arcuate anteriorly, short, pronotum with trisinate posterior edge, prosternum without median plate; mesocoxae rather narrowly separated, metacoxal femoral plates very large and triangular.

**Comparison.** The new genus shows a great similarity to the genus *Desmatus* (Dolin 1975, 1980) in having the large and triangular metacoxal femoral plates, but differs from the latter in the following characters: (1) much larger body; (2) without median prosternal plate; (3) mesocoxae much closer to each other, and (4) metacoxal femoral plates larger and obtusely triangular.

Compared with the genus *Cryptocoelus* Dolin et Nel, 2002 from the Late-Jurassic to Early-Cretaceous Yixian Formation of Western Liaoning Province in China, the new species has these unique characters: (1) lack of basal furrow at posterior margin of pronotum, (2) posterior angles of pronotum without carinae; (3) metacoxal femoral plates much larger and triangular, and (4) mesocoxae more narrowly separated.

Besides, the new genus differs from the Cretaceous genus *Sinoelaterium* Ping, 1928 with unclear systematic position from China in the much larger and triangular metacoxal femoral plates. It also differs from the Early Middle Jurassic *Ovivagina* Zhang, 1997 with unclear systematic position from China in the large triangular metacoxal femoral plates and rather squared pronotum.

**Remarks.** The new genus can be assigned to the family Elateridae due to the following characters: (1) prothorax with backward-pointing posterior angles; (2) distinct mesoventral cavity; (3) metacoxal femoral plates well developed; (4) tarsal formula is 5-5-5; (5) lack of transverse (paracoxal or katepisternal) suture of metaventrite; (6) distinct chin piece in the middle of anterior part of the prosternum. The attribution of the new genus to the tribe Desmatini Dolin, 1975 can be supposed because of the following characters: (1) prosternal sutures closed; (2) mesoventrite short, without transverse suture; (3) metacoxal femoral plates medially 2.0-2.5 times as long as metacoxae.

*P. baiiae* Chang, Kirejtshuk et Ren, sp. nov.  
(Figs 1–5)

**Etymology.** The epithet of this new species is dedicated to Madam Bai Li for her contribution to the fossil collection examined and her research of it.

**Materials.** Holotype: male, CNU-COL-NN2006803PC, almost complete part and counterpart impressions, housed in the Key Lab of Insect Evolution and Environmental Changes, Capital Normal University, Beijing, China. Paratype: males, CNU-COL-NN2007965, CNU-COL-NN2008866PC; females, CNU-C-NN2007868, with the same depository, although one paratype is housed in the Zoological Institute of the Russian Academy of Sciences.

**Locality and horizon.** Daohugou beds, Jiulongshan Formation, Ningcheng County, Inner Mongolia in China, Middle Jurassic.

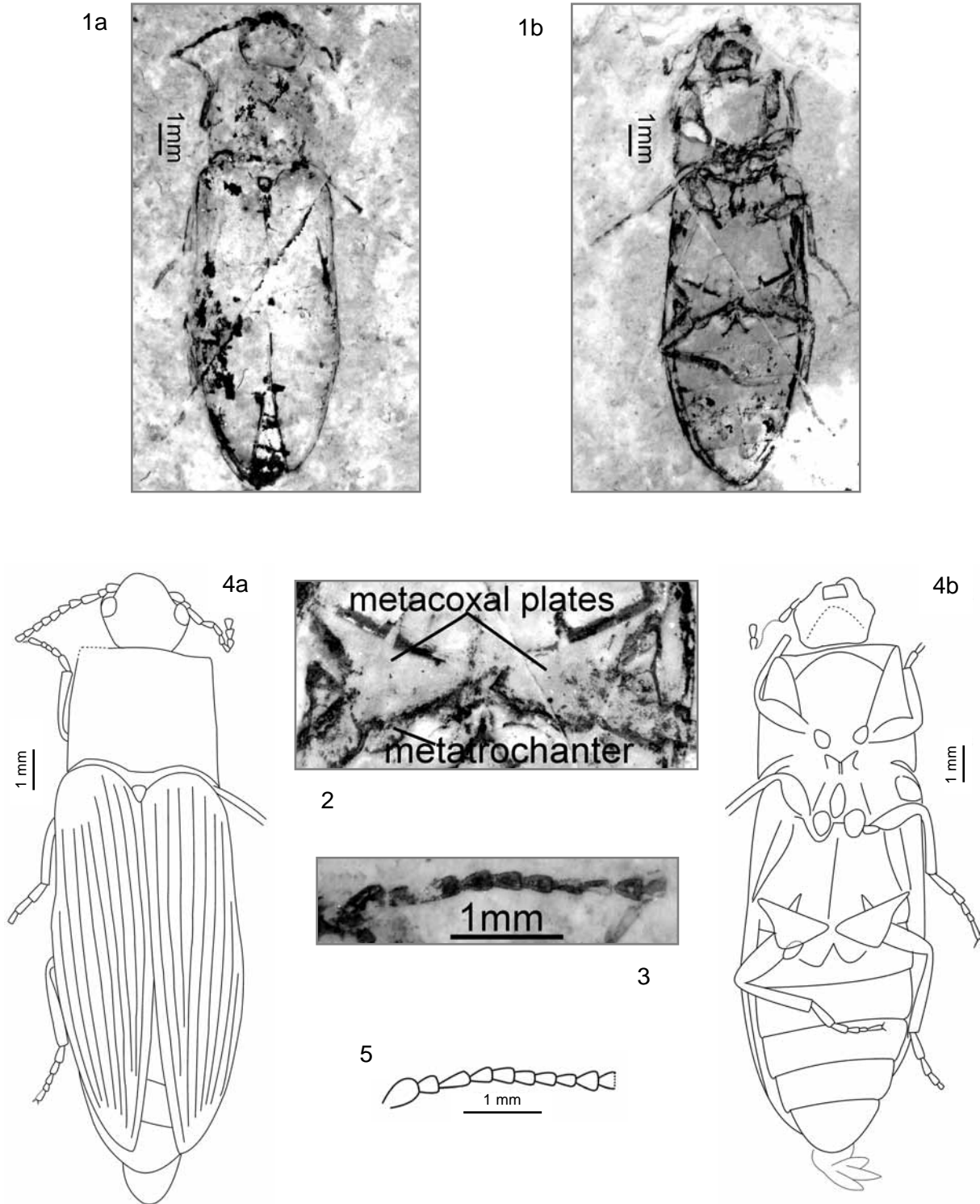
**Diagnosis.** Distinct from another member of the new genus in the somewhat less slender body, longer head with longer temples, wider antennae, wider epipleura, wider tarsi, less distinct puncturation (with somewhat smoothed outlines of punctures) and particularly in the shape of metacoxal femoral plates.

**Description.** Body slender, medium sized. Dorsum with uniform, rather sparse and moderately small punctures; moderately covered with short recurved testaceous setae. Elytra with 9 distinctly longitudinal striae (Figs 1a and 4a).

Head: oval, about 2/3 as long as wide, with temples longer than frons before eyes, apparently slightly convex; eyes oval, medium sized.

Antennae: short, can not reach the posterior angle of pronotum, with 10 preserved segments, scape robust, pillar-like, pedicel much shorter than scape and antennomere 3, antennomere 3 about two times as long as pedicel (Figs 3, 5).

Pronotum: rectangular, transverse, about 1.22 times as wide as long, without clear lateral carinae, anterior and lateral margins nearly straight, basal



Figures 1–5. *Paradesmatus baiiae* sp. nov., male. (1a) Photo, No. CNU-COL-NN2006803-1, (1b) No. CNU-COL-NN2006803-2; (2) photo of metacoxae, No. CNU-COL-NN2006803-2; (3) photo of antennae, No. CNU-COL-NN2006803-1; (4a) line drawing, dorsal view, No. CNU-COL-NN2006803-1, (4b) ventral view, No. CNU-COL-NN2006803-2; (5) line drawing of antennae, No. CNU-COL-NN2006803-1.

margin trisinate and without basal furrows, posterior angles short, without carinae, scutellum subtriangular.

Elytra: somewhat wider than prothorax, about 2.2 times as long as wide combined, subflattened medially, with 9 longitudinal striae (Fig. 4a).

Ventral side: surface with uniform, rather sparse and moderately small punctures. Mentum subtrapezoid-like. Prosternum arcuate anteriorly, short, without longitudinal furrows, prosternal suture single, closed; procoxal cavities apparently subconical, small, prosternal process slender. Metaventrite small, mesoventral cavity subrhombic, mesepimeron subtriangular. Metaventrite relatively long and apparently subflattened, with longitudinal median suture, metepisterna of usual shape, metacoxal femoral plates large and obtusely subtriangular, longest at the middle of their width and not more than twice as long as wide; epipleura moderately wide at base and gradually narrowing distally (Figs 1b, 2, 4b).

Legs: protibiae more or less straight, slightly widened apically, with one short subapical spur; mesocoxae rounded; apparently somewhat larger than procoxae; mesotrochanters suboval; metacoxa transverse; metatrochanters elongately suboval; tarsi have sexual dimorphism, female with tarsi almost half as wide as tibiae, male with tarsi slightly narrower than tibiae, tarsomere 1 much longer than others, tarsomeres 2 to 4 progressively shortening distally, the tarsomere 4 slightly subcordate, tarsomere 5 nearly as long as tarsomeres 3 and 4 combined; claws simple, falciform.

Aedeagus rather short and moderately sclerotized, with acute apex of penis trunk.

Dimensions (Body length/body width/elytron length, mm): CNU-COL-NN2006803: 15.2/4.8/10.4; CNU-COL-NN2007868: 13/3.6/7.6; CNU-COL-NN-2008866: 16/5.2/11.2.

*P. ponomarenkoi* Chang, Kirejtshuk and Ren, sp. nov. (Figs 6–8)

**Etymology.** The epithet of this new species is dedicated to A.G. Ponomarenko, made a very valuable review to the manuscript of this paper.

**Materials.** Holotype: female, CNU-COL-NN2006876 PC, almost complete part and counterpart impressions; Paratype, (sex uncertain), CNU-C-NN2007870; both housed in the Key Lab of Insect Evolution and Environmental Changes, Capital Normal University, Beijing, China.

**Locality and horizon.** Daohugou beds, Jiulongshan Formation, Ningcheng County, Inner Mongolia in China, Middle Jurassic.

**Note.** This new species is very similar to *Paradesmatus baiiae* sp. nov. and, therefore, many characters

of it shared with another member of the new genus are omitted in the below description.

**Diagnosis.** See the diagnosis of the previous species. And also: head about half as long as wide, epipleura narrow at base, metacoxal plates longer.

**Description.** Body very slender, medium sized. Dorsum with uniform, rather sparse and coarse punctures, moderately covered with short recurved testaceous setae. Elytra with faint longitudinal striae.

Head: oval, transverse, about half as long as wide, with very short temples behind eyes.

Antennae: incomplete, right one with 7 preserved antennomeres and left with 5 antennomeres, antennomeres subtriangular, narrow. (Figs 6b, 8b).

Pronotum: about 1.28 times as wide as long, hind angles covered with more dense short recurved testaceous setae than other place.

Elytra: scarcely wider than prothorax, about 2.15 times as long as wide combined, subflattened medially, with faint longitudinal striae (Figs 6a, 8a).

Ventral side: surface apparently smoothed, nearly lubricous; metacoxal femoral plates large and obtusely subtriangular, longest at the outer part of them and about two thirds as long as wide; epipleura narrow at base and gradually narrowing distally (Figs 6b, 7, 8b).

Legs: protibiae more or less straight, slightly widened apically, with one short subapical spur; mesocoxae rounded, apparently somewhat larger than procoxae, metacoxa transverse, metatrochanters subtriangular, metatarsi with 5 tarsomeres, tarsomere 1 much longer than others taken separately, tarsomeres 2 to 4 progressively shortening distally, tarsomere 5 nearly as long as tarsomeres 3 and 4 combined.

Ovipositor rather long and with narrow and subparallel-sided gocoxites.

Dimensions (Body length/body width/elytron length, mm): CNU-COL-NN2006876: 10.8/3.0/6.8; CNU-COL-NN2007870: 11/3.7/7.0.

Order **Coleoptera** Linnaeus, 1758

Family **Elateridae** Leach, 1815

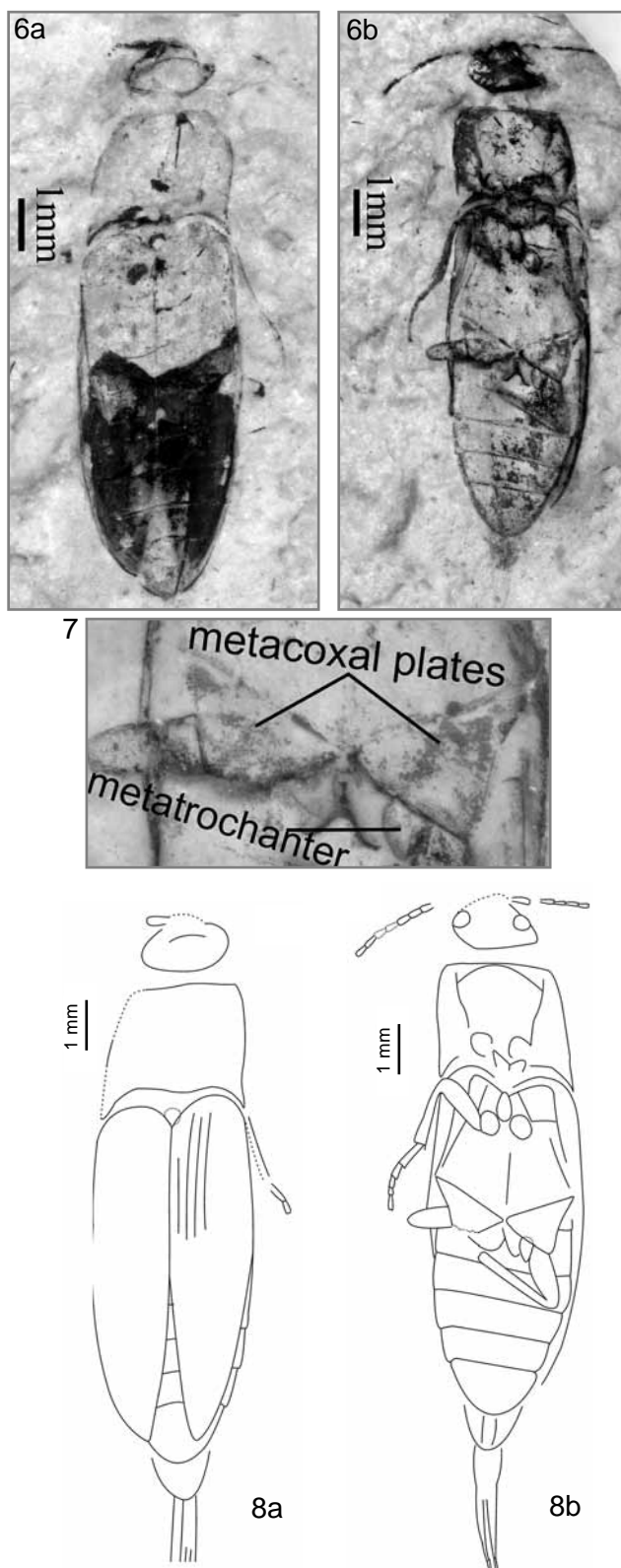
Subfamily **Protagrypninae** Dolin, 1973

Tribe **Protagrypnini** Dolin, 1975

*Protagrypnus* Dolin, 1973

**Type species.** *Protagrypnus exoletus* Dolin, 1973.

**Revised diagnosis of tribe.** (based on study of the type of *Protagrypnus exoletus* and new materials). Small to comparatively large elongate body; head transverse to subtriangular; prothorax with pointed



Figures 6–8 *Paradesmatus ponomarenkoi* sp. nov., female. (6a) Photo, No. CNU-COL-NN2006876-1, (6b) No. CNU-COL-NN2006876-2; (7) photo of metacoxae, No. CNU-COL-NN2006876-2; (8a) line drawings, dorsal view, No. CNU-COL-NN2006876-1, (8b) ventral view, No. CNU-COL-NN2006876-2.

acute posterior angles, prosternum rounded anteriorly, pronotosternal sutures apparently associated with sulciform grooves, procoxae opened posteriorly, mesoventrite short with many transverse sutures divided into small “praeepisterna” and larger “postepisterna”, mesepisterna with transverse suture, metacoxal femoral plates weakly narrowed outwardly.

**Comparison.** The genus *Protagrypnus* compared with the genus *Crytocoelus* Dolin et Nel, 2002 from the Late-Jurassic to Early-Cretaceous Yixian Formation of Western Liaoning Province in China has the following unique characters: (1) prosternum with distinct median plate; (2) pronotum without basal furrow at posterior margin; (3) metacoxal femoral plates wider and triangular, and (4) with transverse sutures on mesoventrite.

The genus *Protagrypnus* differs from the both Cretaceous genus *Sinoelaterium* Ping, 1928 with unclear systematic position from China and Early-Middle Jurassic *Ovivagina* Zhang, 1997 with unclear systematic position from China in the median prosternal plate and transversely sutured mesoventrite.

*P. robustus* Chang, Kirejtshuk et Ren, sp. nov.  
(Figs 9–12)

**Etymology.** The epithet of the new species is derived from Latin “robustus”, (robust, large, coarse, rough), referring to the more robust body of the new species than that in other species in this genus.

**Materials.** Holotype: male, CNU-COL-NN2006843, housed in Key Lab of Insect Evolution and Environmental Changes, Capital Normal University, Beijing, China; paratypes: males, CNU-COL-NN2006875, CNU-COL-NN2007869 with the same depository.

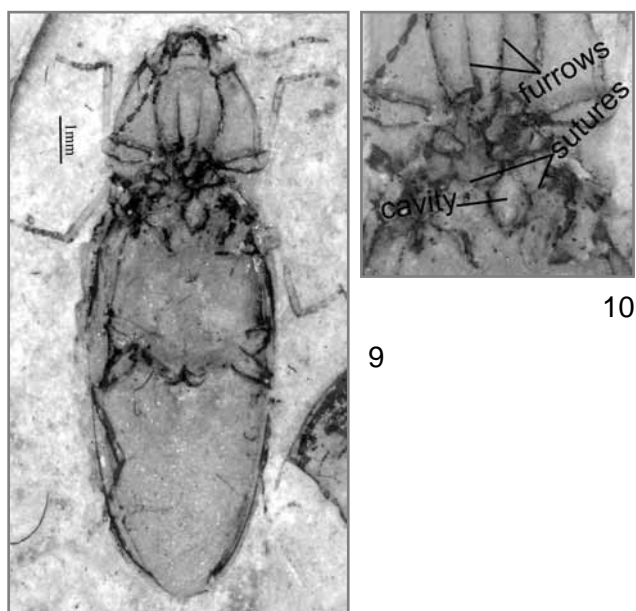
**Locality and horizon.** Daohougou beds, Jiulongshan Formation, Ningcheng County, Inner Mongolia in China, Middle Jurassic.

**Diagnosis.** Body robust. Head subtriangular. Pronotum subquadrate, about as wide as long. Tarsomere 1 short, tarsomere 5 much longer than tarsomere 1 (Fig. 12).

**Comparison.** The new species differs from *Protagrypnus exoletus* Dolin, 1973 in the following features: (1) body much larger and more robust; (2) head subtriangular; (3) pronotum subquadrate, nearly as wide as long; (4) tarsomere 1 short, tarsomere 5 much longer than tarsomere 1.

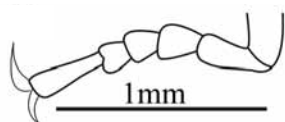
**Description.** Body slender, apparently subflattened, medium sized. Integument with very small and rather dense punctures. Elytra with longitudinal rows of transverse to subquadrangular punctures. (Fig. 9).

Head: sub-triangular, apparently convex; transverse; eyes oval, medium sized.

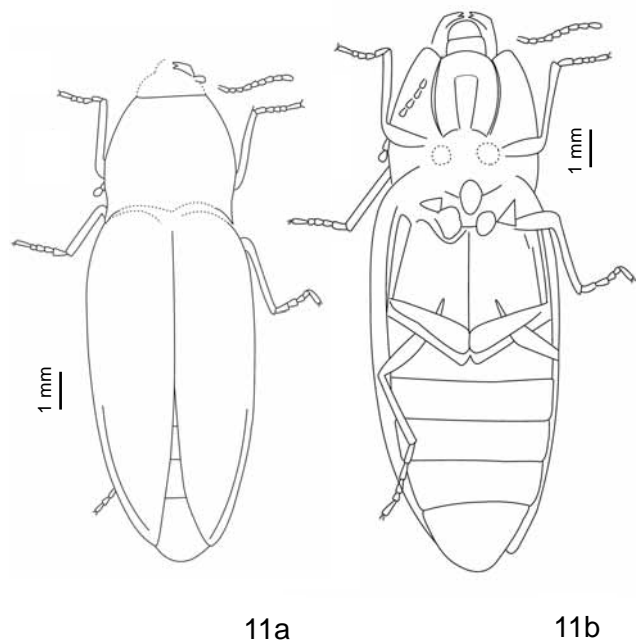


10

9



12



11a

11b

Figures 9–12 *Protagrypnus robustus* sp. nov., male. (9) Photo, No. CNU-COL-NN2006843; (10) photo of prosternum and mesoventrite, No. CNU-COL-NN2006843; (11a) line drawings, dorsal view, (11b) ventral view, No. CNU-COL-NN2006843; (12) line drawing of protarsus, No. CNU-COL-NN2006843.

Antennae: submoniliform, with 8 preserved segments; antennomeres 3–10 subtriangular, antennomere 11 oblong.

Pronotum: pronotum narrowed anteriorly, about as wide as long, anterior margin nearly straight, lateral margins arcuate, posterior margin apparently bisinuate, disc apparently subflattened, posterior angles without carinae.

Elytra: wider than prothorax, about 2.1 times as long as wide; subflattened medially.

Ventral side: prosternum with chin piece usually arcuate, prosternum with medial plate, pronotosternal sutures apparently associated with sulciform grooves; mesoventrite with transverse sutures, mesoventral cavity suboval, mesepimeron subtriangular; metaventrite metaventrite relatively long and apparently subflattened, with longitudinal median suture; metepisterna of usual shape; metacoxal femoral plates long and obtusely subtriangular, evenly narrowed laterally (Figs 9, 10, 11b).

Legs: tibiae and tarsi setosed; procoxae rounded, mesotrochanters oval; metacoxae transverse, tarsomeres 1 to 4 progressively shortening distally, the fourth one subcordate; tarsomere 5 elongate and much longer than others, claws falciform (Fig. 12).

Dimensions (Body length/body width/elytron length, mm): CNU-COL-NN2006843: 12.6/3.9/9.0; CNU-COL-NN2007869: 10/3.5/6.5; CNU-COL-NN2006875: 14.8/4.0/10.1.

## DISCUSSION

These new findings of elaterids are present a first record of fossil elaterids from the Middle Jurassic Jiulongshan Formation of Daohugou, Inner Mongolia in China, and this is also the first report in China of the fossil elaterids with large triangular femoral plates of metacoxae. The fossil species with large triangular femoral plates of metacoxae of the Mesozoic elaterids have been discovered only from the Upper Jurassic strata of Karatau so far, these new findings may have further indications on diversity and distribution of extinct fauna of elaterids. Zherikhin (1980) supposed that Protagrypninae, as other ancient elaterids had carnivorous larvae inhabiting in wood. Elateridae are represented in deposits from the Middle Jurassic Daohugou by a comparable proportion with Cerophytidae (Chang *et al.*, in press), which makes possible to admit that both closely related families were parallelly developing at early stages of their history. They could inhabit similar localities having different regime of feeding: first Elateridae might be larval predators, while the larvae of early Cerophytidae as recent ones seemed to be associated with feeding on decayed wood. It is thought that later, when elaterids mastered

xylomycetophagous feeding, they could in some sense dislodge cerophytids in the habitats, where the representatives of both groups could live simultaneously.

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