

First record of fossil *Priacma* (Coleoptera: Archostemata: Cupedidae) from the Jehol Biota of western Liaoning, China

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Abstract

Four new fossil species of the genus *Priacma*, *P. latidentata* **sp. nov.**, *P. tuberculosa* **sp. nov.**, *P. clavata* **sp. nov.** and *P. renaria* **sp. nov.**, are described from the Yixian Formation of western Liaoning, China. This finding documents the first record of fossil *Priacma* in China and extends the geographical distribution of this genus.

Key words: Cupedidae, *Priacma*, new species, Yixian Formation, China

Introduction

The Cupedidae is regarded as probably the most archaic family of recent Coleoptera (Crowson 1962). During the last century the systematic position of the family has been the subject of much controversy (e. g. Sharp & Muir 1912; Forbes 1926; Atkins 1963). It is currently placed in the suborder, Archostemata which includes Cupedidae, Ommatidae, Micromalthidae and Crowsoniellidae (Lawrence & Newton 1995) and 11 extinct families (Carpenter 1992).

Nowadays, the extant species of Cupedidae are rare, including only nine extant genera and thirty three extant species (Grebennikov 2004; Ge & Young 2004). However, the cupedids were more diverse in the geological past, and particularly in the Mesozoic Era, than today.

Recently we recovered several well-preserved fossil cupedids from the Yixian Formation near Chaomidian Village, Beipiao City, Liaoning Province. These fossils can be assigned to the extant genus *Priacma* Leconte, 1874 of the family Cupedidae.

The Yixian Formation comprises mainly lacustrine sediments intercalated with volcanoclastics (Ren *et al.* 1995). The age of this Formation remains controversial. Three different opinions about the age (Late Jurassic, Late Jurassic-Early Cretaceous and Early

Cretaceous) have been proposed based on both biostratigraphic and radiometric geochronology (Swisher *et al.* 1999; Jiang *et al.* 2000; Lo *et al.* 2000; Wang *et al.* 2004, 2005). Recently, by comparing the Yixian biota with the Solnhofen biota of Germany, the Purbeck biota in England and Late Jurassic Terori-type and Ryoseki-type floras in Japan, Wang *et al.* (2004, 2005) considered that the age of the Yixian Formation may be determined as Late Tithonian to the Berriasian.

The aim of this publication is to describe Mesozoic beetles of the genus *Priacma*. This finding is the first record of this genus from China.

Material and methods

The specimens were examined using a Leica MZ12.5 dissecting microscope and illustrated with the aid of a drawing tube attachment. Morphological terminology follows that of Ponomarenko (1969, 1997). The body length was measured from the apex of the mandibles to the apex of the abdomen. The body width was measured at the base of the elytra. The length of elytra was measured from the base of the elytra to the apex of the elytra.

Genus *Priacma* Leconte, 1874

Type species. *Cupes serrata* Leconte, 1861, by monotypy; Recent.

Included species. In addition to the new species described below, six species were known before. *P. serrata* Leconte, 1861 is the only one extant species from North America. Others are all fossil species from the lower Cretaceous: *P. corrupta* Ponomarenko, 1986 from West Mongolia, *P. longicapitis* Ponomarenko, 1997 and *P. oculata* Ponomarenko, 1997 from South Mongolia, *P. striata* Ponomarenko, 2000 from East Transbaikalia, and *P. sanzii* Sorinao and Delcils, 2006 from Spain.

Diagnosis (based on the original description of the type species and on the study of four new species). Head with two pairs of sub-acute tubercles; antennae filiform, somewhat moniliform, less than half as long as entire insect; mandibles strongly extending, bidentate or tridentate at apex; gula wide, somewhat rectangular, widening posteriorly; genae separated for entire length by gula. Pronotum nearly rectangular, angles sharp; prosternum without tarsal groove; prosternal process only shallowly extending behind coxae. Elytra with nine or ten almost complete rows of punctures, dorsal surface convex, longitudinal ridges bearing small tubercles.

Remarks. The newly described cupedids from the Yixian Formation belong to the tribe Priacmini of the family Cupedidae because of antennae less than half as long as entire insect, inter-antennal distance much greater than diameter of eyes and prosternal process only shallowly extending behind coxae. Priacmini includes two extinct genera

(Ponomarenko 1969): *Cupidium* Ponomarenko, 1968 (from the Late Jurassic of Kazakhstan), *Priacmopsis* Ponomarenko, 1966 (from the Early Cretaceous of Mongolia and Siberia), and one extant genus *Priacma*.

The new fossils can be placed in *Priacma* based on the pedicel obviously shorter than third antennomere and anterior angles of pronotum sharp and extending.

***Priacma latidentata* sp. nov.**

(Figs. 1, 5–9, 24)

Diagnosis. *P. latidentata* sp. nov. differs from *P. serrata* in the absence of spines on edge of elytra, from *P. corrupta* in the mesosternum of new species without cross suture, from *P. longicapitis* and *P. oculata* in the ventral head surface of new one without grooves for inserting antennae, from *P. striata* in the elytron of new one without paler flecks, from *P. sanzii* in new one's pedicel shorter than third antennomere. *P. latidentata* sp. nov. is distinct from *P. tuberculosa* sp. nov. in having wide and flattened mandibles with tridentate in apex, connected posterior pair of tubercles on the dorsal of head, and margin of elytral cells without black macula, from both *P. renaria* sp. nov. and *P. clavata* sp. nov. in having markedly shorter pedicel.

Description. Body length 11.0 mm, body width 3.0 mm, elytron length 8.0 mm. Medium-sized and subcylindrical beetle, covered with tubercles (Fig. 1).

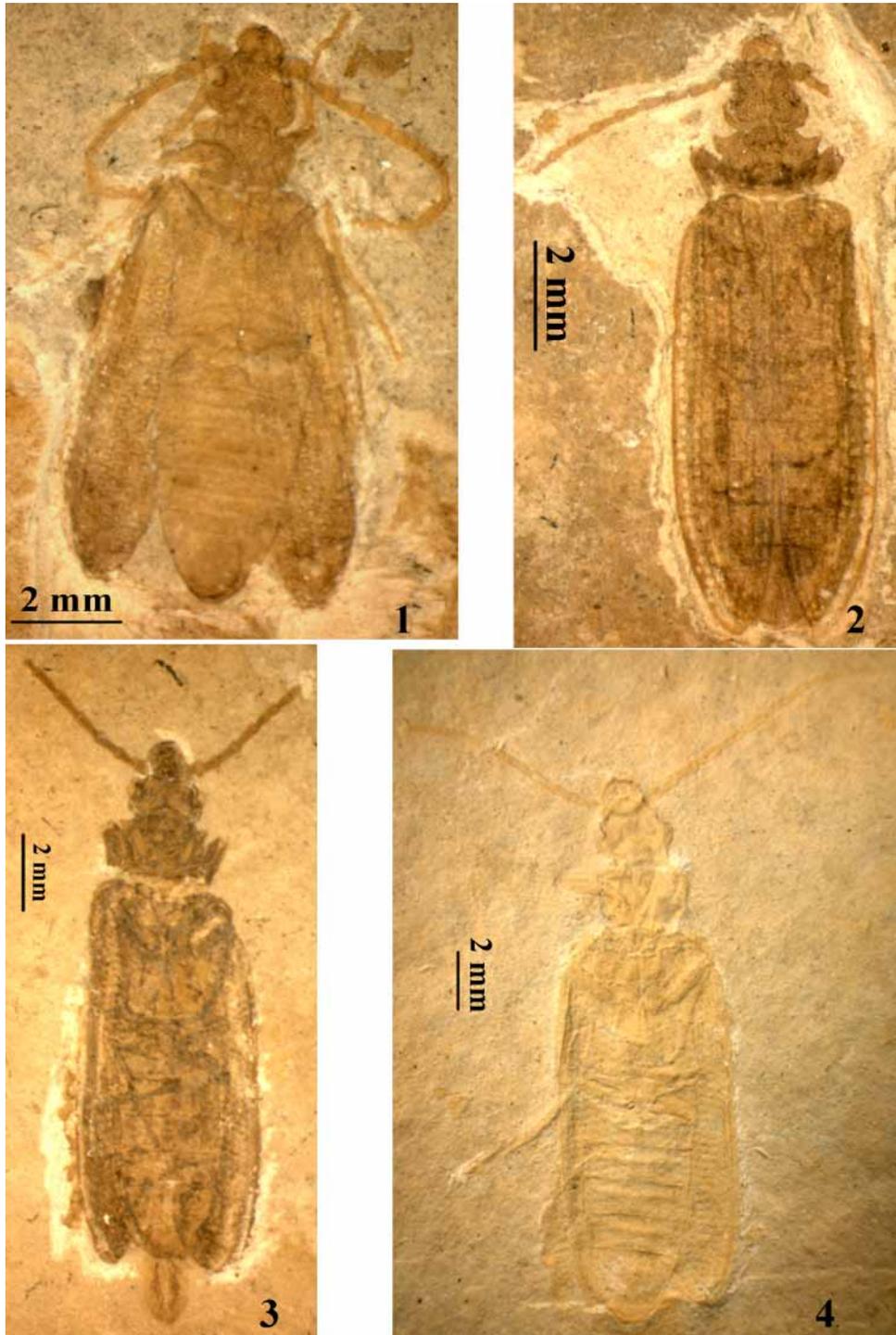
Head slightly wider than long, subtriangular, bearing two pairs of tubercles, anterior pair of tubercles at base of antennae, conical, small, posterior ones sub-elliptic, connected to each other, larger than anterior pair; eyes medium-sized; mandibles prominent, wide, apex flattened, tridentate in apex (Figs. 5, 8), cervical constriction distinct.

Antennae filiform, with 11 segments, less than half as long as entire insect, pedicel 0.4 times as long as third antennomere (Figs. 5, 8), following antennomeres homonomous.

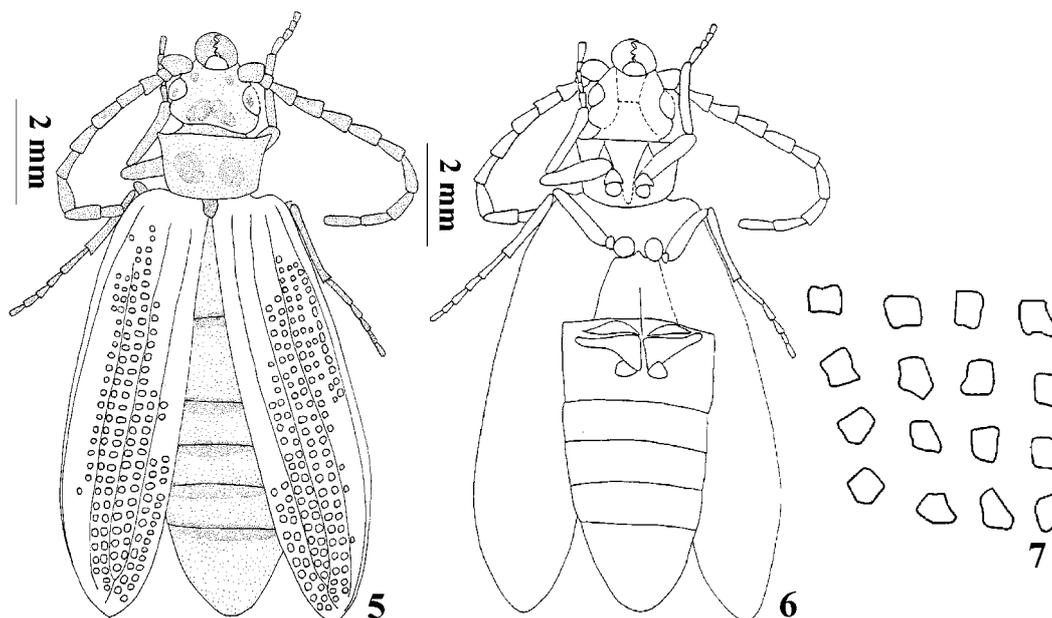
Pronotum transverse, wider than head, narrowed posteriorly, 1.4 times as wide as long at posterior edge, anterior margin nearly straight, anterior angles sharp (Figs. 5, 8), oblique, without propleuron, disc of pronotum bearing two circle elevations; scutellum linguiform.

Elytra about 1.5 times as wide as prothorax, 4 times as long as wide, with 10 rows of cells, elytral cells quadrate, angular rounded, without black macula on their margins (Figs. 7, 24), elongate in distal part of elytron, approximately 34 cells formed in a row.

Ventral surface (Fig. 6) with gula rectangular, reaching posterior ridge of the head, widening posteriorly, genae widely separated ventrally. Prosternal process extending beyond coxae. Metaventrite oblong, 1.2 times as wide as long (at posterior margin), with well expressed longitudinal and transverse sutures (Fig. 9). Abdomen with 5 visible ventrites superimposing each other, first visible abdominal ventrite as long as last one, both of them longer than other visible ventrites, last visible ventrite 2 times as long as previous one, its apex rounded.



FIGURES 1–4. Habiti of new *Priacma* species, photographs of rock impressions. 1—*Priacma latidentata* sp. nov., 2—*Priacma tuberculosa* sp. nov., 3—*Priacma clavata* sp. nov., 4—*Priacma renaria* sp. nov.



FIGURES 5–7. *Priacma latidentata* sp. nov., holotype. 5—dorsal view, 6—ventral view, 7—outline of elytral cells.

Legs (Fig. 6) with procoxae rounded, small, protochanter subtriangular, protibiae longer than profemora, protarsi five-segmented, first tarsomere as long as last one, both of them longer than other three tarsomeres, other tarsomeres short, equal in size; mesocoxae rounded, large, mesotrochanter small, oblong, mesofemora thin, long, mesotibiae nearly as long as mesofemora, mesotarsi five-segmented, first tarsomere longest, following four tarsomeres homonomous.

Holotype. Nearly complete adult, No. CNU–C–LB2005010 deposited in the Key Lab of Insect Evolution & Environmental Changes, College of Life Science, Capital Normal University in Beijing, China.

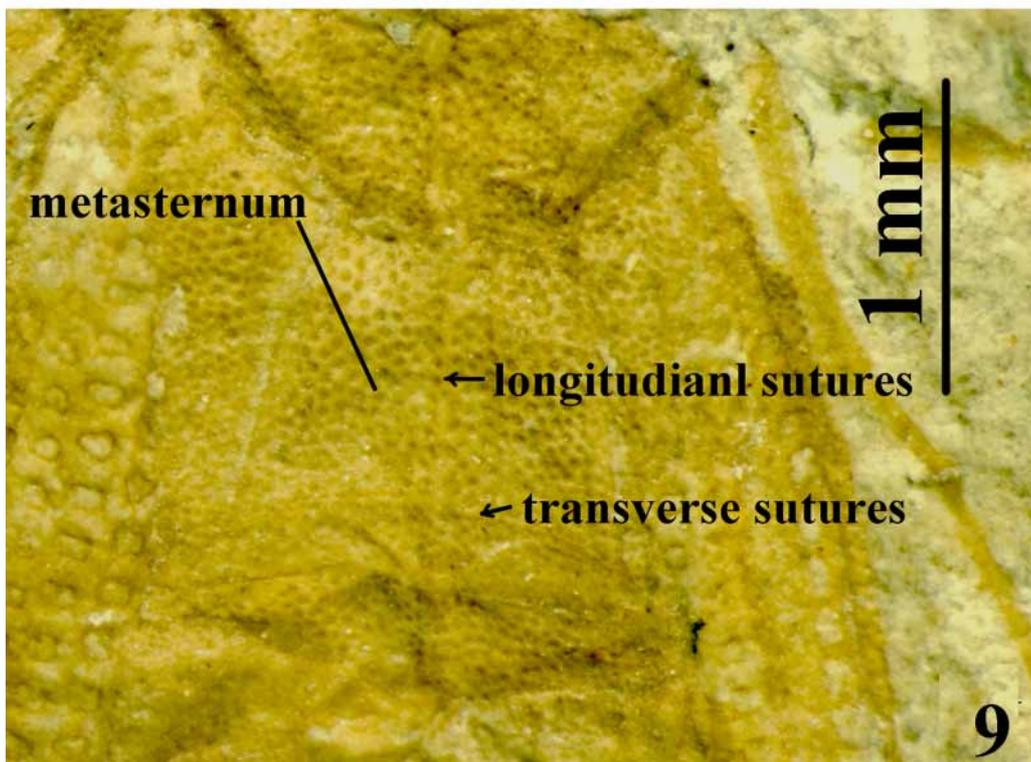
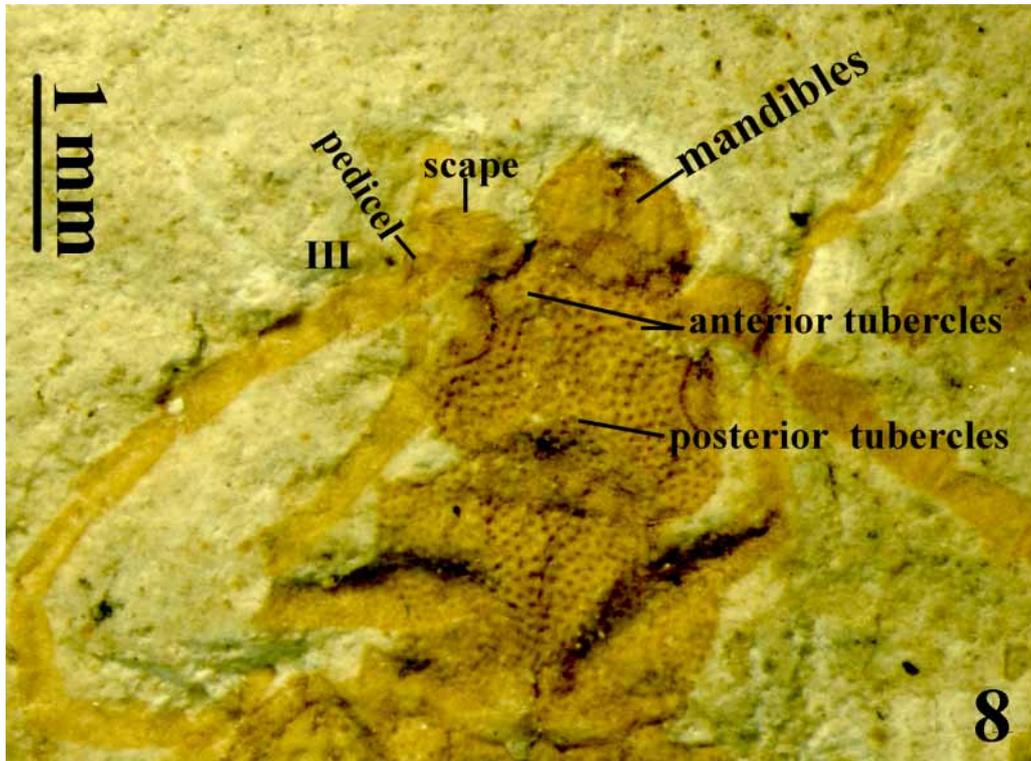
Locality and horizon. Collected near Chaomidian Village, Beipiao City, Liaoning Province, China; the Yixian Formation, Late Jurassic–Early Cretaceous (Late Tithonian to the Berriasian).

Etymology. The specific epithet derives from the Latin adjectives *latus*, *-a*, *-um* (broad, wide) and *dentatus*, *-a*, *-um* (toothed, having teeth). It refers to the broad mandibles of the beetle with flattened apices.

***Priacma tuberculosa* sp. nov.**

(Figs. 2, 10–14)

Diagnosis. *P. tuberculosa* sp. nov. can be distinguished from *P. serrata* in the absence of



FIGURES 8–9. *Priacma latidentata* sp. nov., holotype. 8—head, 9—metaventricle.

spines on edge of elytra, from *P. corrupta* in the mesosternum of new species without cross suture, from *P. longicapitis* and *P. oculata* in the ventral head surface of new one without grooves for inserting antennae, from *P. striata* in the elytron of new one without paler flecks, from *P. sanzii* in new one's antennal second segment shorter than third one. New species differs from *P. latidentata* **sp. nov.** in mandibles not flattened at apex, posterior pair of dorsal head tubercles separated and elytral cells with 3 black macula on their margins, from both *P. renaria* **sp. nov.** and *P. clavata* **sp. nov.** in the pedicel of *P. tuberculosa* distinctly shorter than third antennomere.

Description. Body length 10.5 mm, body width 2.5 mm, elytron length 7.5 mm. Medium-sized and subcylindrical beetle, covered with tubercles (Fig. 2).

Head (Fig. 13) a little wider than long, bearing two pairs of tubercles, anterior pair of tubercles at base of antennae, conical, small, posterior ones circular, separated from each other, larger than anterior pair; eyes medium-sized; apex of mandibles not flattened, bidentate in horizontal cutting surface, cervical constriction unobvious.

Antennae filiform, incomplete (with 10 visible segments), less than half as long as entire insect, scape slightly oblong, pedicel 0.5 times as long as third antennomere, following segments homonomous (Figs. 10, 13).

Pronotum transverse, wider than head, narrowed towards base, 0.8 times as wide as long at posterior edge, anterior angles sharp, extending, without propleuron, disc of pronotum bearing two circular elevations; scutellum subtriangular.

Elytra about 1.5 times as wide as prothorax, 4 times as long as wide, with 9 rows of cells, elytral cells polygonal, with 3 black macula on their margins (Figs. 12, 14), elongated in distal part of elytron, approximately 34 cells formed in a row.

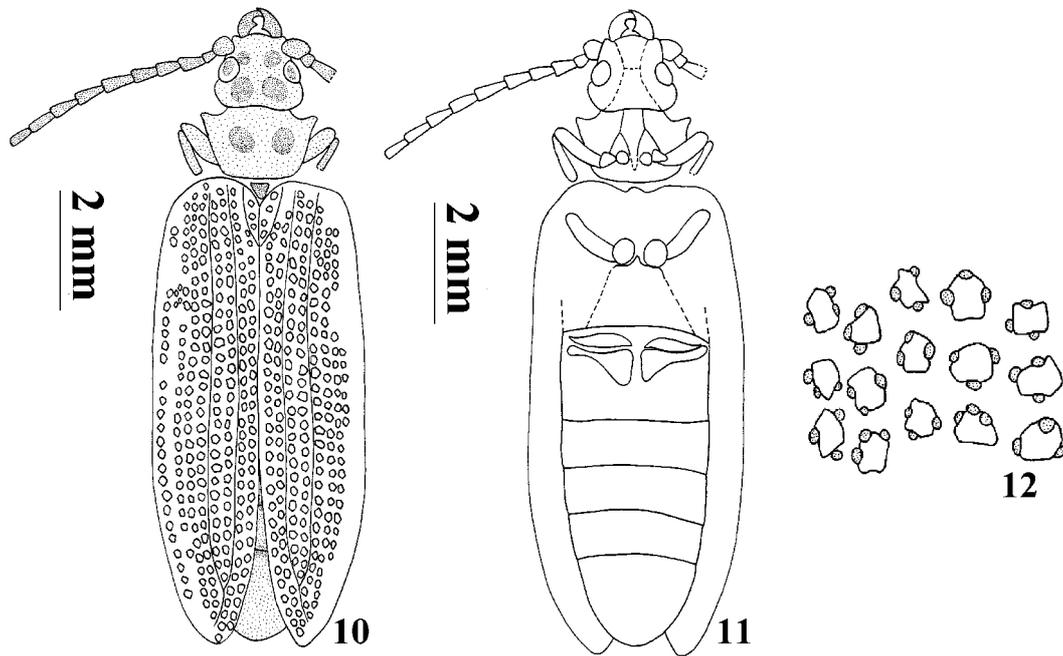
Ventral surface (Fig. 11) with gula rectangular, reaching posterior ridge of the head, widening posteriorly, genae widely separated ventrally. Prosternal process narrower than fore coxa, extending beyond coxae. Metaventrite oblong, 1.5 times as wide as long (at posterior margin); without longitudinal suture on metaventrite. Abdomen with 5 visible ventrites superimposing each other, narrowed from the base of fourth visible ventrite, first visible abdominal ventrite as long as last one, both of them longer than other visible ventrites, last visible ventrite 2.1 times as long as the previous one, its apex rounded.

Legs with procoxae circular, small, protrochanter large, sub-triangular.

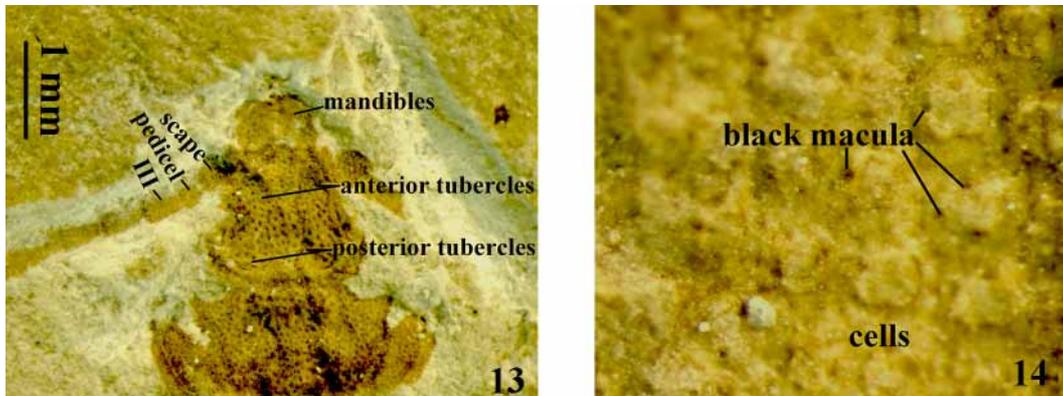
Holotype. Nearly complete adult, No. CNU-C-LB2005011 deposited in the Key Lab of Insect Evolution & Environmental Changes, College of Life Science, Capital Normal University in Beijing, China.

Locality and horizon. Collected near Chaomidian Village, Beipiao City, Liaoning Province, China; the Yixian Formation, Late Jurassic-Early Cretaceous (Late Tithonian to the Berriasian).

Etymology. The specific epithet derives from the Latin noun *tuberculum*, -i, n (a small swelling, bump, or protuberance). It refers to tubercles densely covering the body and, especially, the head.



FIGURES 10–12. *Priacma tuberculosa* sp. nov., holotype. 10—dorsal view, 11—ventral view, 12—outline of elytral cells.



FIGURES 13–14. *Priacma tuberculosa* sp. nov., holotype. 13—head, 14—elytral cells.

Priacma clavata sp. nov.

(Figs. 3, 15–18)

Diagnosis. Differs from *P. serrata* in the absence of spines on edge of elytra. From *P. corrupta* in the mesosternum of new species without cross suture, from *P. longicapitis* and *P. oculata* in the ventral head surface of new one without grooves for inserting antennae,

from *P. striata* in the elytron of new one without paler flecks, from *P. sanzii* in new one's antennal second segment shorter than third segment. *P. clavata* **sp. nov.** is distinct from *P. latidentata* **sp. nov.** and *P. tuberculosa* **sp. nov.** in the pedicel of *P. clavata* not less than two third of the third antennomere in length, from *P. renaria* **sp. nov.** in longer mandibles and narrower pronotum.

Description. Body length 14.0 mm, body width 3.5 mm, elytron length 10.0 mm. Medium-sized and subcylindrical beetle, covered with tubercles (Fig. 3).

Head wider than long, trapeziform, bearing two pairs of tubercles, anterior pair of tubercles at base of antennae, conical, posterior ones thick, claviform, slightly larger than anterior pair; eyes large; mandibles prominent, as long as width of head, tridentate in horizontal cutting surface (Fig. 17), cervical constriction weak.

Antennae filiform, incomplete (with 6 visible segments), scape thickest, pedicel about 0.8 times as long as third antennomere, following segments homonomous.

Pronotum transverse, nearly as wide as head, narrowed towards base, about 1.3 times as wide as long at posterior edge, anterior margin slightly extruding forward, anterior angles sharp (Figs. 15, 17), extending, without propleuron, disc of pronotum bearing semicircular elevation divided by longitudinal line in the middle; scutellum subtriangular.

Elytra about 2.5 times as wide as prothorax, 4.6 times as long as wide, epipleural rim narrow, veins poorly traceable, almost invisible, cells indistinct (Fig. 15).

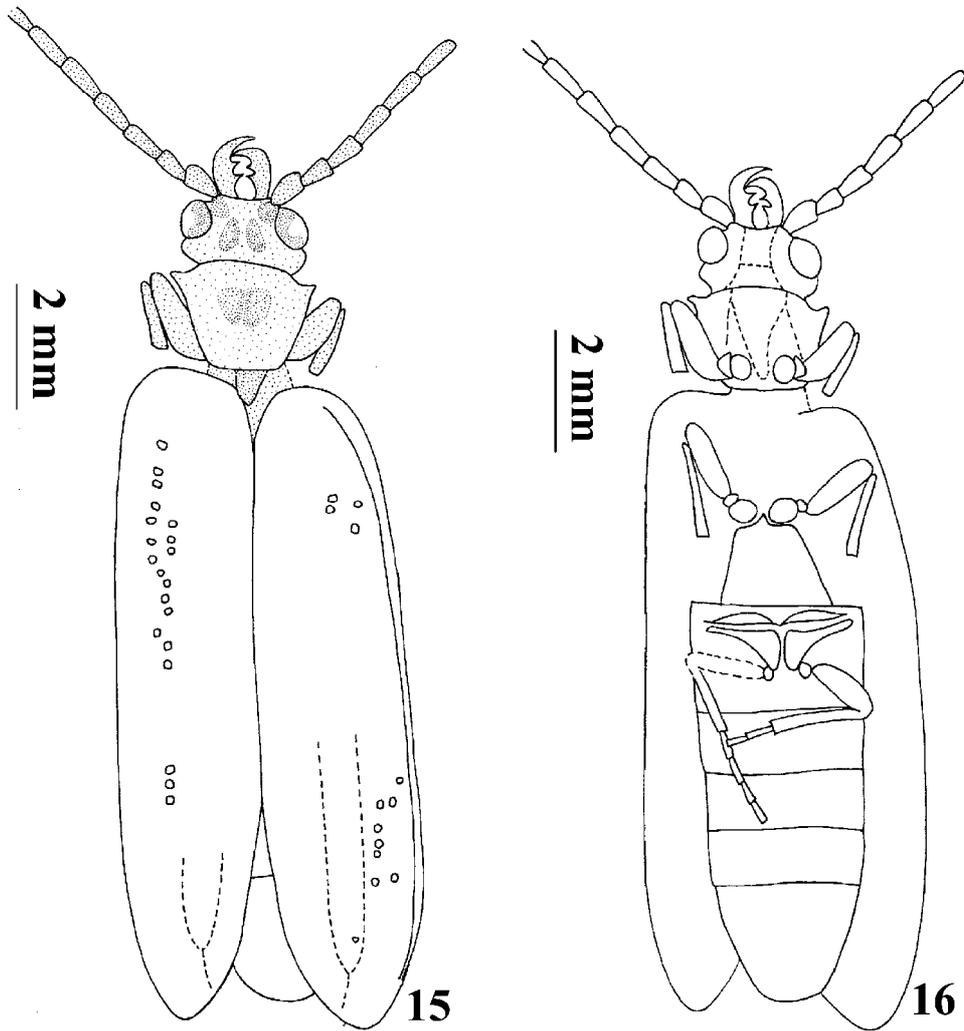
Ventral surface (Fig. 16) with gula rectangular, reaching posterior ridge of the head, widening posteriorly, genae widely separated ventrally. Prosternal process extending beyond coxae. Metaventricle oblong, 0.7 times as wide as long (at posterior margin), without longitudinal suture on metaventricle (Fig. 18). Abdomen with 5 visible ventrites superimposing each other, narrowed from the base of fifth visible ventrite, 2–4 visible abdomen ventrites equal in length, last visible abdominal ventrite 2.1 times as long as the previous one, its apex rounded.

Legs with procoxae elliptical, large, protrochanter sub-triangular, profemora thick, protibiae slim, nearly as long as profemora; mesocoxa round, mesotrochanter small, circular, mesotibiae slightly longer than mesofemora; metafemora short, thick, metatibiae long, metatarsi with 4 visible segments, first segment longest, following three segments homonomous (Fig. 16).

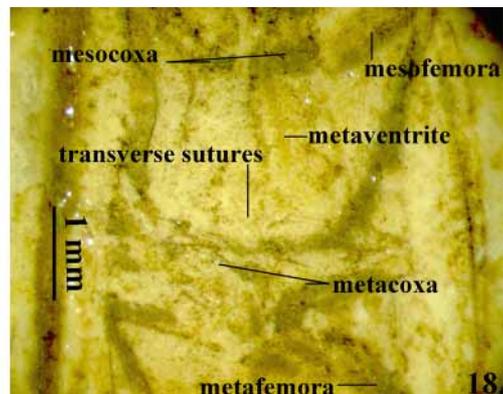
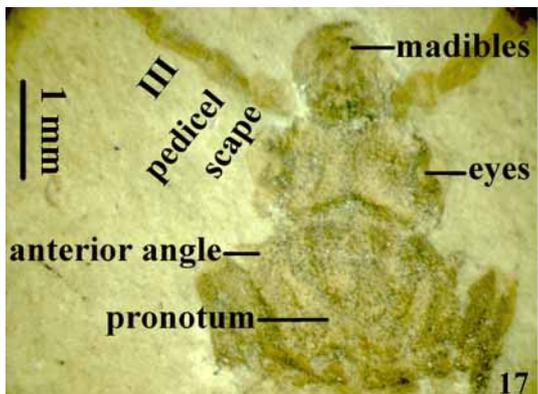
Holotype. Nearly complete adult, No. CNU–C–LB2006001, housed in the Key Lab of Insect Evolution & Environment Change, College of Life Science, Capital Normal University, Beijing, China.

Locality and horizon. Collected near Chaomidian Village, Beipiao City, Liaoning Province, China; the Yixian Formation, Late Jurassic-Early Cretaceous (Late Tithonian to the Berriasian).

Etymology. The specific epithet derives from the Latin adjective *clavatus*, *-a*, *-um* (furnished with or fasten with nails). It refers to the shape of the tubercles on the head.



FIGURES 15–16. *Priacma clavata* sp. nov., holotype. 15—dorsal view, 16—ventral view.



FIGURES 17–18. *Priacma clavata* sp. nov., holotype. 17—head, 18—metaventricle.

***Priacma renaria* sp. nov.**

(Figs. 4, 19–23, 25)

Diagnosis. Differs from *P. serrata* in the absence of spines on edge of elytra. From *P. corrupta* in the mesosternum of new species without cross suture, from *P. longicapitis* and *P. oculata* in the ventral head surface of new one without grooves for inserting antennae, from *P. striata* in the elytron of new one without paler flecks, from *P. sanzii* in new one's antennal second segment shorter than third segment. *P. renaria* sp. nov. is distinct from other new species described here by being largest, by having elytral cells polygonal without black macula on their margins, and by the presence of about 43 elytral cells in a row.

Description. Body length 19.5 mm, body width 5.0 mm, elytron length 14.0 mm. Large-sized and subcylindrical beetle, covered with tubercles (Fig. 4).

Head wider than long, trapeziform, bearing two pairs of tubercles, anterior pair of tubercles at base of antennae, conical, small, shape of posterior ones like kidney-form, larger than anterior pair; eyes medium-sized; mandibles prominent, broad, flattened, shorter than half width of head, tridentate in horizontal cutting surface (Fig. 22), cervical constriction distinct.

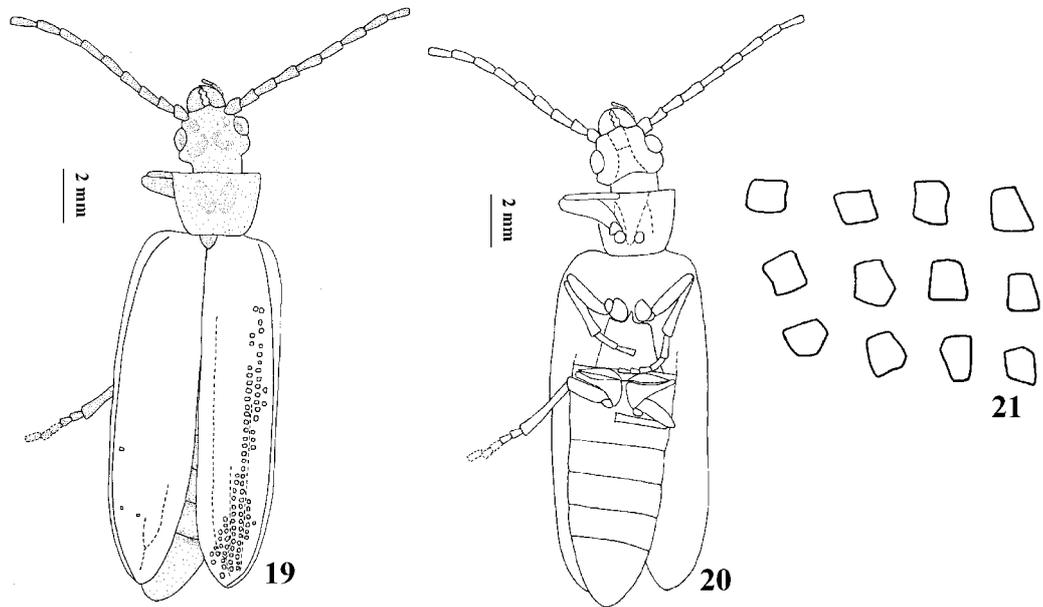
Antennae filiform, incomplete (with 9 visible segments), scape shortest, thicker than other segments, pedicel 0.85 times as long as third antennomere (Figs. 19, 22), following segments homonomous.

Pronotum transverse, slightly wider than head, narrowed towards base, about 0.85 times as wide as long at posterior edge, anterior margin straight, anterior angles oblique (Figs. 19, 22), without propleuron, disc of pronotum bearing 2 oblong elevations; scutellum sub-triangular.

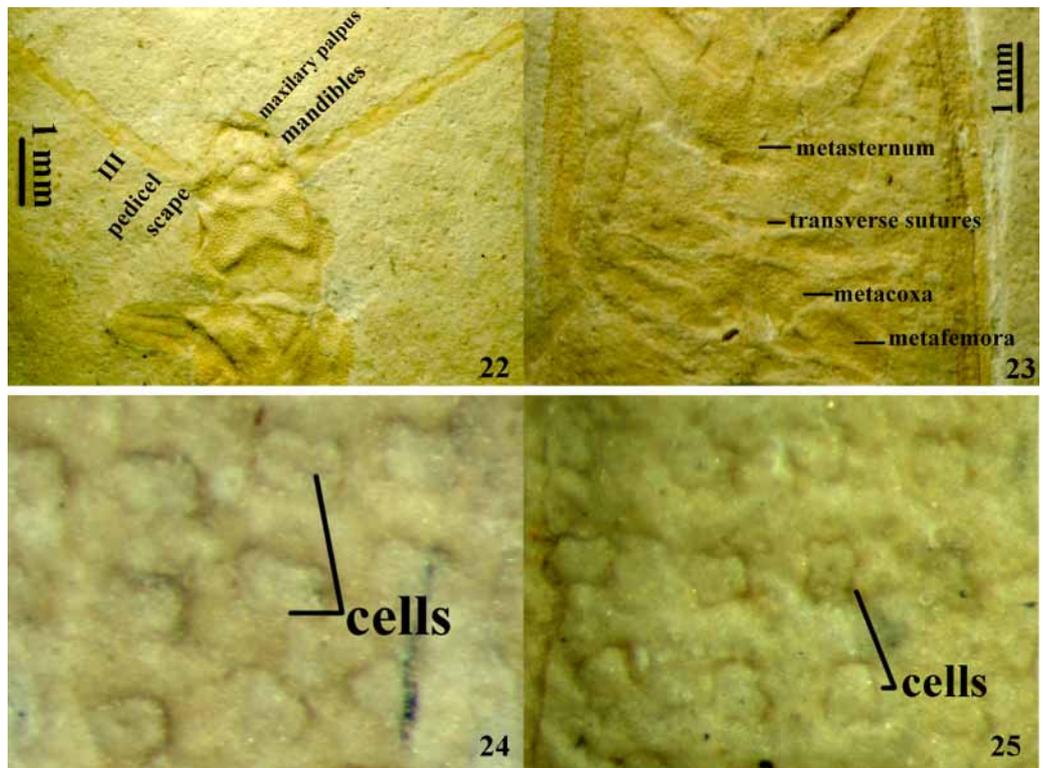
Elytra about 2 times as wide as prothorax, 4.4 times as long as wide, epipleural rim narrow, with 10 rows of cells, elytral cells quadrangular, without black macula on their margins (Figs. 21, 25), approximately 43 cells formed in a row.

Ventral surface (Fig. 20) with gula rectangular, reaching posterior ridge of the head, widening posteriorly, genae widely separated ventrally. Procoxal cavities separated, prosternal process extending beyond coxae. Metaventrite trapezoidal, transverse, 0.7 times as wide as long (at posterior margin), without longitudinal suture on metaventrite (Fig. 23). Abdomen with 5 visible ventrites superimposing each other, narrowed from the base of fifth visible ventrite, first visible abdomen ventrite longest, 2–4 visible abdomen ventrites equal in length, last visible ventrite 2.2 times as long as the previous one, its apex tapered.

Legs with procoxae rounded, small, protrochanter triangular, profemora long, thick, protibiae comparatively slim, shorter than profemora; mesocoxae oblong, mesotrochanter small, circular, mesotibiae as long as mesofemora; metafemora short, metatibiae longer than metafemora, metatarsi with 5 segments, fifth segment longest, following segments homonomous (Fig. 20).



FIGURES 19–21. *Priacma renaria* sp. nov., holotype. 19—dorsal view, 20—ventral view, 21—outline of elytral cells.



FIGURES 22–25. 22—head of *Priacma renaria* sp. nov., 23—metaventricle of *Priacma renaria* sp. nov., 24—elytral cells of *Priacma latidentata* sp. nov., 25—elytral cells of *Priacma renaria* sp. nov.

Holotype. Nearly complete adult, No. CNU-C-LB2006002, housed in the Key Lab of Insect Evolution & Environment Change, College of Life Science, Capital Normal University, Beijing, China.

Locality and horizon. Collected near Chaomidian Village, Beipiao City, Liaoning Province, China; the Yixian Formation, Late Jurassic-Early Cretaceous (Late Tithonian to the Berriasian).

Etymology. The specific epithet derives from the Latin adjective *renarius*, -a, -um (of or belonging to kidneys). It refers to the kidney-shaped tubercles on the head.

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