

## New fossil Priacmini (Insecta: Coleoptera: Archostemata: Cupedidae) from the Jehol Biota of China

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(Accepted 15 November 2006)

### Abstract

Two new species and one new genus of fossil cupedids assigned to the family Cupedidae, *Priacmopsis subtilis* sp. nov. and *Furcicupes raucus* gen. et sp. nov., are described and illustrated from the Jehol Biota of western Liaoning, China. *Priacmopsis subtilis* sp. nov. is not only the first Chinese example but also probably the earliest known species of this genus. Compared to this report and other records of fossil *Priacmopsis*, the age of the Yixian Formation may be older than the Early Aptian about 125 Ma. Morphological peculiarities of *Furcicupes* gen. nov. indicate that it may be one of the intergradations between the relatively primitive tribe Priacmini and more advanced Cupedini.

**Keywords:** *Cupedidae*, new genus, new species, Yixian Formation, China

### Introduction

Beetles are the most diverse group of insects preserved in the Mesozoic fossil sites of northeast China, especially in the Yixian Formation, with about 200 species known and described (Tan et al. 2004). Among them, archostematan beetles are rather abundant, accountable for about 30% of fossils and yielding 56 described species (Tan et al. 2004, 2005). The most common archostematan family in these Late Mesozoic localities is the extant family Cupedidae, including 27 extinct species and 17 extinct genera (Tan et al. 2005). Nowadays, this family is considered to be a relic group, restricted to a few genera and species in Asia, Africa, Australia and America, with limited geographical distribution, while during the Mesozoic the cupedids were distributed all over Laurasia (Soriano and Delclòs 2006). Hence, the study of Mesozoic cupedids is significant in understanding their phylogenetic relationships. Recently, we collected several fossil cupedids from the “Jianshangou Bed” in the lower part of the Yixian Formation at Huangbanjigou Village near the town of Shangyuan, 28 km southeast of Beipiao, western Liaoning Province, China, which is considered as part of the Jehol Biota. The sediments of the Yixian Formation are mainly of lacustrine origin intercalated with volcanic rocks (Ren et al. 1995).

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Published 30 December 2006

ISSN 0022-2933 print/ISSN 1464-5262 online © 2006 Taylor & Francis  
DOI: 10.1080/00222930601121445

Palaeobotanical data from fossil palynomorphs and plants indicates a climate that was both warm and moist (Ding et al. 2001). However, the age of the Yixian Formation still remains disputable. Many authors have discussed the age in light of the biostratigraphic correlation and the radiometric date, but the conclusions varied and were often dubious (Chen et al. 1998; Swisher et al. 1999; Wang et al. 2005).

Here, based on these well-preserved specimens, two new species and a new genus are described. According to these new cupedids, the age of the Yixian Formation is briefly discussed.

## 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 and the system used here follow that of Ponomarenko (1969, 1997).

The body length was measured from the apex of the mandibles to the apex of the abdomen. Body width was measured at the base of the elytra. The length of elytra was measured from the base to the apex.

## Taxonomy

**Order Coleoptera**  
**Family Cupedidae**  
**Tribe Priacmini** Crowson, 1962  
**Genus *Priacmopsis*** Ponomarenko, 1966

*Priacmopsis* Ponomarenko, 1966, Entomo. Oboer. 1:138–143; Ponomarenko, 1969, Tru. Paleontol. Inst. A. N. SSSR 125:70–115; Ponomarenko, 1997, Paleontol. J. 31(4):389–399

Type species: *Priacmopsis adumbrata* Ponomarenko, 1966.

### *Included species*

With the exception of the new species described below, two species were known previously. They are *P. adumbrata* Ponomarenko, 1966 from the lower Cretaceous of Northeastern Siberia and *P. minimus* Ponomarenko, 1997 from the lower Cretaceous of Mongolia.

### *Revised diagnosis*

Head with two distinct tubercles, eyes small, antennae filiform, scape thickest, pedicel obviously shorter than third antennomere, mandibles strongly protruding, pronotum nearly square, anterior angles rounded. Elytra with nine or 10 almost complete rows of punctures, dorsal surface convex. First visible abdominal ventrite longer than other ones, femora shorter than tibiae.

### *Notes*

The modified diagnosis is based on the original description of the type species and on the study of the new materials.

*Remarks*

The new cupedids from the Yixian Formation are here assigned to the tribe Priacmini of the family Cupedidae because they have antennae less than half as long as the entire insect, inter-antennal distance much greater than diameter of the eyes and prosternal process only shallowly extending behind the coxa. Priacmini includes two extinct genera (Ponomarenko 1969): *Cupidium* Ponomarenko (from the Late Jurassic of Kazakhstan) and *Priacmopsis* Ponomarenko (from the Early Cretaceous of Mongolia and Siberia), and one extant genus *Priacma* (Leconte, 1874) (Leconte 1861, 1874).

The new fossils can be placed in *Priacmopsis* by the following features: (1) pedicel shorter than third antennomere, (2) anterior angles of pronotum rounded and (3) femora shorter than tibiae.

***Priacmopsis subtilis* sp. nov.**

(Figure 1)

*Type material*

Holotype: Collected near Chaomidian Village, Beipiao City, Liaoning Province, China; the Yixian Formation, Late Jurassic-Early Cretaceous (Late Tithonian to Berriasian), two specimens, part and counterpart of a near complete adult, No. CNU-C-LB2006003-1 and No. CNU-C-LB2006003-2, housed in Key Lab of Insect Evolution and Environment Change, Capital Normal University, Beijing, China.

*Diagnosis*

Distinct from the type species in having a smaller size and convex anterior margin of pronotum, from *P. minimus* Ponomarenko, 1997 in that the ventral surface of the new species is without a groove for inserting antennae and less than 40 elytral cells in a row.

*Description*

Body length 11.5 mm, body width 3.0 mm, elytron length 8.0 mm. Medium and subcylindrical beetles, covered with tubercles (Figure 1A).

Head: wider than long, subtriangular, bearing two pairs of tubercles, anterior pair of tubercles at base of antennae, conical, small, posterior ones half-moon shaped, larger than anterior pair, ventral surface without groove for inserting antennae; eyes small; temples as long as eyes, projected laterally; mandibles prominent, broad, apex flattened, tridentate (Figure 1B), cervical constriction distinct.

Antennae: filiform, 11 segments, scape thicker than other antennomeres, both scape and last antennomere longer than other segments, pedicel shortest, slightly longer than wide, following antennomeres more or less homonomous.

Pronotum: transverse, slightly wider than head, about 1.1 times as wide as long, anterior margin convex forward, anterior angle rounded, without propleuron, disc of pronotum bearing two quadrate elevations; scutellum linguiform.

Elytron: about 1.6 times as wide as prothorax, longitudinal ridges with small tubercles, 4.1 times as long as wide, epipleural rim narrow, with 10 rows of cells, elytral cells oblong, without black maculae on their margins (Figure 1D, E), approximately 35 cells formed in a row.

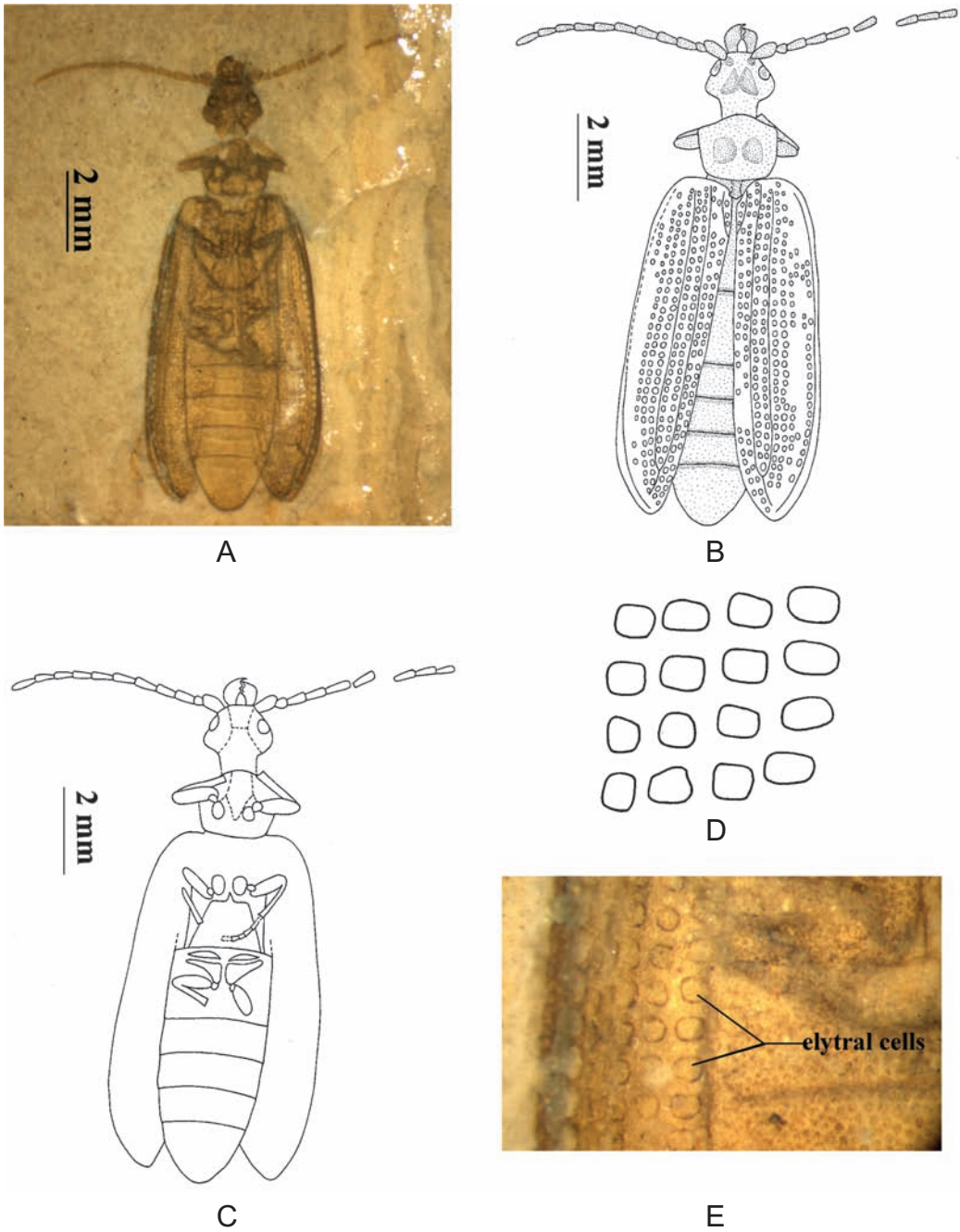


Figure 1. *Priacmopsis subtilis* sp. n., holotype No. CNU-C-LB2006003-1. (A) Photograph; (B) line drawing of dorsal view; (C) line drawing of ventral view; (D) outline of elytral cell; (E) photograph of elytral cell. In all figures, scale bars=2.0 mm.

Ventral surface (Figure 1C): gula rectangular, reaching posterior ridge of head, widening posteriorly, gena widely separated along entire distance ventrally; procoxal cavities separated, prosternal process extending behind coxae; metasternum trapezoidal, transverse, 1.5 times as long as wide (at posterior margin), without longitudinal suture developed on metasternum. Abdomen with five visible ventrites overlapping each other, narrowed from the base of fourth visible ventrite, first visible abdomen ventrite longer than others, two to four visible abdomen ventrites equal in length, last visible ventrite 1.8 times as long as the previous one, its apex rounded.

Legs: procoxae rounded, small, protrochanter semicircular, profemora shorter than protibiae; mesocoxae oblong, mesotrochanter small, circular, mesotibiae as long as mesofemora, mesotarsi with five elongate, unmodified tarsomeres, first tarsomere longer than others, the rest nearly equal in length; metafemora short, not extending beyond side margins of body.

#### *Geographical distribution*

Known only from China.

### ***Furcicupes* gen. nov.**

Type species: *Furcicupes raucus* sp. nov.

#### *Diagnosis*

Body elongated, subcylindrical, head with two pairs of obvious tubercles, antennae filiform, reaching beyond the base of prothorax, scape thicker than others, pedicel slightly shorter than other antennomeres, pronotum rectangle, anterior angles of prosternum bifid, prosternum without tarsal groove, disc without elevations, prosternal process only shallowly extending behind coxae; elytra with eight rows of cells; tarsi with five segments, first and last segments of foreleg equal in length, both of them longer than other tarsomeres, two to four tarsomeres short, equal in length; abdomen with five ventrites, last visible ventrite as long as or longer than first one, last visible ventrite two times longer than preceding one.

#### *Remarks*

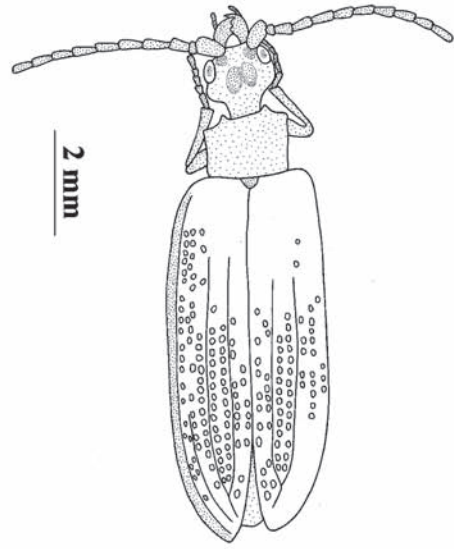
This new genus displays several unique features among the tribe Cupedini and Priacmini, but the length of antennae and antennal insertions allows us to confidently refer it to the tribe Priacmini. The addition of *Furcicupes* brings the total number of genera in the tribe to four (other genera are *Cupidium* Ponomarenko, 1968, *Priacmopsis* Ponomarenko, 1966 and one extant genus *Priacma* (Leconte, 1874) (Ponomarenko 1969).

Although the new genus is assigned to the tribe Priacmini by the following characters: antennae less than half as long as entire insect, antennal insertions separated much greater than diameter of eyes and prosternal process only shallowly extending behind coxae, it clearly differs from other members of the tribe in anterior angles of the prosternum bifid and elytra with eight rows of cells.

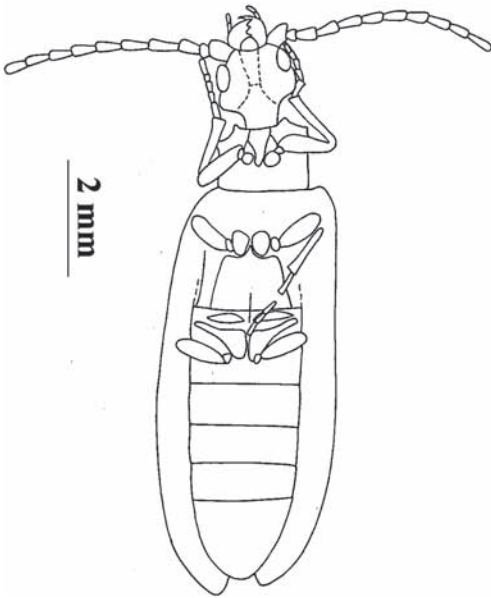
Based on the fossil described below, the new genus includes one new species established.



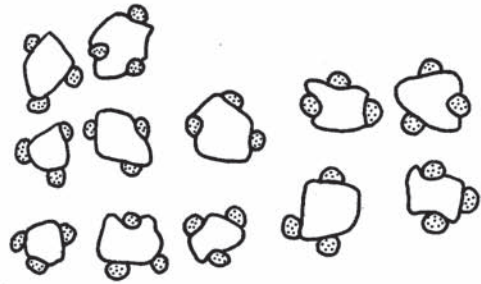
A



B



C



D

Figure 2. *Furcicupes raucus* gen. sp. n., holotype No. CNU-C-LB2006004-1. (A) Photograph; (B) line drawing of dorsal view; (C) line drawing of ventral view; (D) outline of elytral cell. In all figures, scale bars=2.0 mm.

***Furcicipes raucus* sp. nov.**  
(Figure 2)

*Type material*

Holotype: Collected near Chaomidian Village, Beipiao City, Liaoning Province, China; the Yixian Formation, Late Jurassic–Early Cretaceous (Late Tithonian to Berriasian), one specimen, part and counterpart of a near complete adult, No. CNU-C-LB2006004-1 and No. CNU-C-LB2006004-2, housed in Key Lab of Insect Evolution and Environment Change, Capital Normal University, Beijing, China.

*Description*

Body length 10.0 mm; body width 2.5 mm; elytron length 7.0 mm. Medium and subcylindrical beetles, covered with tubercles (Figure 2A).

Head: wider than long, subtriangular, bearing two pairs of tubercles, anterior pair of tubercles at base of antennae, conical, small, posterior ones oblong, larger than anterior pair, ventral surface without groove for inserting antennae; eyes small; temples a little shorter than eyes, projected laterally; mandibles prominent, broad, apex flattened, tridentate (Figure 2B), palpi visible with two segments.

Antennae: filiform, 11 segments, scape thicker and longer than other antennomeres, pedicel shortest, as long as wide, following antennomeres more or less homonomous.

Pronotum: transverse, slightly wider than head, about 1.3 times as wide as long, anterior margin straight, anterior angles bifid, without propleuron, disc of pronotum without elevations, scutellum semicircular.

Elytron: about 1.4 times as wide as prothorax, longitudinal ridges with small tubercles, 4.5 times as long as wide, epipleural rim comparatively wide, with eight rows of cells, elytral cells polygonal, with three black maculae on their margins (Figure 2D), approximately 30 cells formed in a row.

Ventral surface (Figure 2C): gula rectangular, reaching posterior ridge of the head, widening posteriorly, gena widely separated along entire distance ventrally; procoxal cavities at the middle of prosternum, small, separated, prosternal process not extending behind coxae; metasternum trapezoidal, transverse, 1.5 times as long as wide (at posterior margin), with longitudinal and transverse sutures developed on metasternum. Abdomen with five visible ventrites superimposed on each other, narrowed from the base of fourth visible ventrite, first visible abdomen ventrite slightly longer than others, two to four visible abdomen ventrites nearly equal in length, last visible ventrite two times as long as the previous one, its apex rounded.

Legs: procoxae rounded, small, protrochanter very small, oblong, profemora shorter than protibiae, protarsi with five segments, first and last tarsomeres equal in length, both of them longer than other ones, two to four tarsomeres short, equal in length; mesocoxae subcircular, mesotrochanter oblong, mesofemora thick, mesotibiae as long as mesofemora; metafemora short, slightly extending beyond side margins of body.

*Geographical distribution*

Known only from the type locality.

### The age of the Yixian Formation

*Priacmopsis subtilis* sp. nov. represents the first record of the genus *Priacmopsis* from China. Besides China, only two Lower Cretaceous localities, in Northeastern Siberia and Mongolia, yielded fossil species of *Priacmopsis* (Ponomarenko 1966, 1997): *P. adumbrata* from the Middle Albian and *P. minimus* from the Early Aptian. By comparing this new report with other fossil records of *Priacmopsis*, we find that the fourth tarsomere of *P. subtilis* is elongate, not bilobate as in the type species of *P. adumbrata* Ponomarenko, 1966. According to Atkins (1958), the primitive tarsal condition consists of five elongate, unmodified tarsomeres. Furthermore, many reported fossil beetles from older localities have also this unmodified tarsus (Ponomarenko 1969). So *Priacmopsis subtilis* is probably more primitive than the other two, as the earliest known representative of this extinct genus. The new species was collected from the Yixian Formation, which suggest it should, therefore, be older than the Early Aptian.

Until now, the age of the Yixian Formation remained contentious. Swisher et al. (1999) determined a younger age of  $124.6 \pm 0.1$  Ma by  $^{40}\text{Ar}$ - $^{39}\text{Ar}$ ; however, some authors (Jiang et al. 2000; Lo et al. 2000) maintain that the samples that Swisher et al. (1999) analyzed were from intrusive volcanic rocks many millions of years younger, rather than from the fossil bearing sediments, which they proposed were deposited in the Upper Jurassic. Recently, by comparing the Yixian and 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. According to the new cupedid data, the age of the Yixian Formation is no less than the Early Aptian, about 125 Ma. However, due to lack of widespread fossil cupedid specimens to provide more evidences, we still can not draw a final, definitive conclusion about its age. Here, we tentatively follow Wang et al. (2004, 2005) in considering the Yixian Formation as Late Jurassic to Early Cretaceous (Late Tithonian to Berriasian).

### Possible phylogenetic relationship of *Furcicupes* to extant cupedids

The anterior prosternal angles of the recent genus *Rhipsideigma* are also bifid, as are those of the new fossil genus *Furcicupes*. This fact indicates that the bifid anterior prosternal angles originated more than once, independently. Another possible hypothesis is that bifid anterior prosternal angle may be a plesiomorphic character in the Cupedidae, and *Furcicupes* may be a archaic relative of *Rhipsideigma*. The new genus was assigned to the tribe Priacmini mainly based on the length of antennae and size of eyes, but *Rhipsideigma*, which was separated from the genus *Cupes* by Neboiss (1984), belongs to the tribe Cupedini. Many members of the tribe Priacmini were found from Late Jurassic Kazakhstan and Early Cretaceous Mongolia, Siberia and Spain (Sorinao and Delclòs 2006); however, up to now, no fossil species of the tribe Cupedini have been reported. The present fossil records indicate an earlier origin for the tribe Priacmini than for Cupedini. Thus, the new genus may be one of the intergradations between the relatively primitive tribe Priacmini and the more advanced tribe Cupedini.

In addition, all known species of Cupedidae show nine or 10 regular rows of punctures on the elytron (Ponomarenko 1969; Neboiss 1984), whereas *Furcicupes* gen. nov. has only eight rows of punctures. Due to the abundance of cupedids in the Mesozoic, the new genus with only eight rows of punctures on the elytron might appear as a special type at that epoch, but declined through the Cretaceous and subsequently died out. However, this is a preliminary view as further fossil specimens are required to provide more evidence.

## Acknowledgements

We are grateful to Dr Shih Chung-Kun from College of Life Sciences, Capital Normal University, for his editing of our manuscript. We express our gratitude to one anonymous reviewer for his critical review of the manuscript. This research is supported by the National Natural Science Foundation of China (Nos. 30025006, 30370184, 30430100), Beijing Natural Science Foundation Program (No. 5032003), Scientific Research Key Program (KZ200410028013) and PHR Project of Beijing Municipal Commission of Education.

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