

Short communication

The first Mesozoic Helotidae (Coleoptera: Cucujoidea)

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ABSTRACT

Three new species of Helotidae, *Palaeohelota parva* gen. et sp. nov. from the Lower Cretaceous of Yixian Formation, *Burmahelota pengweii* gen. et sp. nov. and *Metahelotella monochromata* sp. nov. from the Upper Cretaceous of Northern Myanmar are described, with the first taxon representing the oldest fossil record of the family Helotidae. The diversity of Helotidae during the Cretaceous suggests the family originated and diversified at least in the Early Cretaceous. *Laodiscis* Lin, 1971 described in Helotidae from the Paleocene of China is here removed from Helotidae and transferred to Coleoptera, family *incertae sedis*.

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1. Introduction

Helotidae is a small family of Cucujoidea, comprising 5 extant genera and about 100 species or sub-species (Kirejtshuk, 2000; Wegrzynowicz, 2000). Members of this family are found in the tropical and subtropical areas of the Old World except for New Guinea and Australia. Helotidae is currently considered as one of the basal groups of Cucujoidea (Crowson, 1955; Lawrence and Newton, 1995; Leschen et al., 2005), but its phylogenetic placement remains unsettled. Recent molecular analyses of beetles on a larger scale (e.g., Bocak et al., 2014; McKenna et al., 2015; Zhang et al., 2018) recovered Helotidae with weak support as a sister group to Erotylidae and Boganiidae or as a sister group of the clade that includes Protocucujidae and Sphindidae.

Ritsema (1881, 1889, 1905a, 1905b, 1909, 1914, 1915) made a significant contribution to the study of this family, describing most of the species. Wegrzynowicz (2000) provided the first catalogue of the Helotidae, cataloguing 102 species and subspecies in the single recognised genus *Helota*. Kirejtshuk (2000) divided *Helota* into 5 genera *Helota* MacLeay, 1825, *Neohelota* Ohta, 1929, *Afrohelotina* Kirejtshuk, 2000, *Metahelotella* Kirejtshuk, 2000 and *Strophohelota* Kirejtshuk, 2000. Then Lee and Sato (2006), Lee (2007, 2008, 2009a, 2009b, 2010), Lee and Votruba (2011, 2013a, 2013b, 2014) made a

series of revisions of Helotidae, describing 18 new species, and recognising 43 species as junior synonyms. Following recent taxonomic changes listed above, 77 species and subspecies within 5 extant genera are currently recognised in Helotidae.

The record of fossil Helotidae is very rare; only 4 species within 2 genera have been described from the Cenozoic of China (Lin, 1977; Zhang, 1989; Zhang et al., 1994; Wegrzynowicz, 2007). However, only 3 taxa, *Helota senilis* Zhang et al. (1994), *H. palmus* (Zhang, 1989) and *H. zhangii* Wegrzynowicz (2007) can be considered as belonging to Helotidae based on general body characteristics and the presence of the spots on their elytra. Here we describe the first Mesozoic representatives of the family Helotidae based on well preserved inclusions in the Cretaceous Burmese amber and an impression fossil from the Yixian Formation.

2. Materials and methods

The impression fossil described here was collected from the Yixian Formation at Huangbanjigou, Chaomidian Village, Liaoning Province, China (Yang et al., 2015: fig. 1). The age of the fossil locality has been suggested to be early Aptian, Early Cretaceous, ca. 122.8 ± 1.6 by U-Pb SHRIMP dating of zircons (Yang et al., 2007). The amber specimens were derived from amber deposits in Kachin (Hukawng Valley) of Northern Myanmar, approximately 100 km southwest of the Village of Tanai (Dong et al., 2015: fig. 1). The age of the amber deposits was suggested to be earliest Cenomanian, Late Cretaceous (98.79 ± 0.62 Ma) by U-pb zircon dating (Shi et al.,

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2012). All the specimens included in this study are deposited in Capital Normal University (CNU) and Sun Yat-sen University (SYSU).

The amber was prepared using a razor table, polished with emery papers with different grain sizes, and finally lustrated with polishing powder. Both specimens were examined under a Leica M205C stereomicroscopes and line drawings were made with the help of a drawing tube attachment, then processing in Adobe Illustrator CS6. Images were taken using a Dun Inc., BK Lab Plus system (<http://www.duninc.com/bk-plus-lab-system.html>); source images were then aligned and stacked in Zerene Stacker and edited in Photoshop CS6. The impression fossil was examined and photographed both dry and under 80% alcohol. Measurements were taken as follows: body length (BL) from anterior margin of clypeus to apex of elytra; head width (HW) across the maximum width (including eyes); pronotal length (PL) along mid line from anterior to posterior margin; pronotal width (PW) across the maximum width; elytra length (EL) along suture, including scutellum; elytral width (EW) across the maximum width of elytra. The morphological terminology of Helotidae employed here is largely based on that of Lawrence et al. (2010).

3. Systematic palaeontology

Order Coleoptera Linnaeus, 1758

Superfamily Cucujoidea Latreille, 1802

Family Helotidae Chapuis, 1876

Palaeohelota gen. nov.

Type species: *Palaeohelota parva* sp. nov.

Etymology. The name is composed of the prefix *Palaeo* (Greek palaios = ancient) and the genus name *Helota*. Gender feminine.

Diagnosis. *Palaeohelota* can be separated from *Helota* and *Neohelota* by the absence of oval spots on elytra and from *Metahelotella* and *Strophohelota* by having distinct costae on elytra. *Palaeohelota* mostly resembles the extant genus *Afrohelotina* in having costate elytra (Kirejtshuk, 2000) but it can be distinguished because of much smaller size (4.3 mm as compared to over 13 mm of extant species), and the elytra without distinct rows of punctures between the costae.

Description. Length about 4.3 mm. Body elongate-oval, dorsal side with distinct punctures visible on head and pronotum, vestiture absent. Head subtriangular with distinct postocular constriction, neck region exposed, but in repose probably deeply inserted into prothorax. Eyes large and laterally protruding. Temples short, about 0.24 times as long as eyes. Frontoclypeal suture absent; anterior margin of frontoclypeus broadly rounded. Mandibles partly visible on dorsal view. Head surface uneven, with moderately dense punctures and granules.

Antennal insertions located closely in front of eyes. Antenna 11 segmented, with distinct and compact 3-segmented antennal club; scape slightly enlarged; antennomere 3 slightly longer than scape; antennomeres 4–8 stout.

Pronotum slightly wider than long, sub-trapezoid with lateral margins weakly constricted posteriorly; posterior margin bisinuate; posterior angles weakly acute; surface with rather dense and coarse punctures and granules. Scutellum small, sub-triangular.

Elytra elongate, lateral margins gradually narrowed posteriorly with subacute apices; elytral disc with distinct costae, not extending to the apical margins; visible striate punctation between costae absent. Legs only partly visible, mostly concealed by the body; protibia appears to be straight and weakly expanding apically; hind coxae broadly separated.

Palaeohelota parva sp. nov.

Fig. 1

Etymology. The species name is derived from the Latin word *parva*, meaning small, referring to the small body size of this species.

Holotype. No. CNU-COL-LB2018001, Dorsal impression only, Lower Cretaceous Yixian Formation, Huangbanjigou, Chaomidian Village, northern China (CNU).

Diagnosis. As for the genus.

Description. Measurements. BL 4.29 mm, HW 0.73 mm, PL 0.81 mm, PW 0.95 mm, EL 2.5 mm, EW 1.23 mm.

Body elongate-oval, about 3.5 times as long as wide; dorsum of head and pronotum with coarse punctures. Head without frontoclypeal suture, postocular constriction distinct with short temples. Antenna 11-segmented with distinct and compact 3-segmented antennal club. Pronotum 0.85 times as long as wide, posterior margins bisinuate. Scutellum small. Elytra about 2.0 times as long as wide; dorsal surface with 3 distinct costae on each, not extending to the apical margins.

Remarks. Prothorax bears longitudinal line or carina in the middle (Fig. 1), extending forward to the head constriction. It is probably not a genuine body structure but a result of taphonomic processes during preservation.

Metahelotella Kirejtshuk, 2000

Type species: *Helota semifulva* Ritsema (1881)

Diagnosis. This genus can be identified by the following characters (Kirejtshuk, 2000): elytra smooth, without oval smooth spots; pronotum narrowing both anteriorly and posteriorly with deeply bisinuate base, surface with relatively sparse and regular fine punctures; elytra with regular longitudinal rows of moderately dense punctures. Pronotum and elytra of this genus almost always bear metallic lustre, similar to *Helota* and *Neohelota* (Kirejtshuk, 2000).

Metahelotella monochromata sp. nov.

Fig. 2

Etymology. The species name is derived from the Latin “*monochromata*” meaning one colour, referring to the uniformly metallic olivaceous surface of the new species.

Holotype. No. CNU-COL-MA-0016; lowermost Cenomanian, Hukawng Valley, northern Myanmar (CNU).

Diagnosis. This species can be distinguished from most of the extant species except for *M. marthae* (Ritsema) by its unicolor body (Lee, 2009b). *M. monochromata* can be separated from *M. marthae* by much smaller and broader body with elytra only 1.73 times longer than wide compared to 2.13 times longer than wide in *M. marthae*. Also, the fossil species bears more acute posterior pronotal angles. *Description.* Measurements. BL 4.78 mm, HW 1.05 mm, PL 1.4 mm, PW 1.55 mm, EL 2.83 mm, EW 1.65 mm.

Body weakly convex without distinct vestiture on dorsal side, uniformly metallic olivaceous with dense microsculpture. Head weakly transverse, sub-triangular with distinct postocular constriction; temples 0.14 times as long as eyes. Eyes large and laterally protruding, distorted by preservation with left eye dorsally appears much bigger than right one. Frontoclypeal suture absent; clypeus narrowly rounded apically bearing setae anteriorly. Mandibles apically bidentate. Frons between eyes shallowly concave bearing sparse deep punctures. Maxillary palps only partly visible on ventral side with terminal palpomere narrowly elongate. Antennal insertions concealed from above, close in front of eyes. Antenna 11-segmented with distinct 3-segmented antennal club,

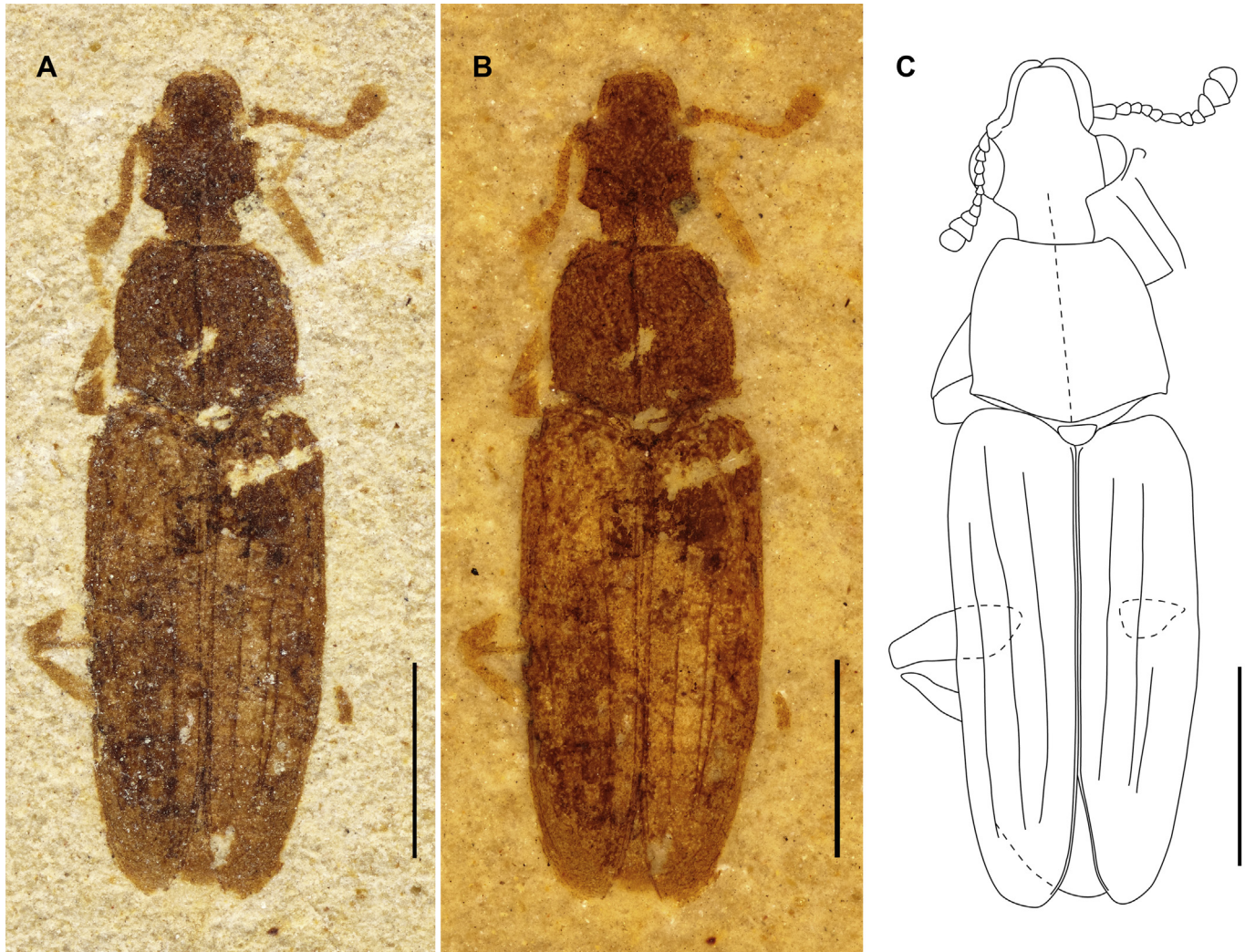


Fig. 1. *Palaeohelota parva* gen. et sp. nov., CNU-COL-LB2018001, Holotype; A. dorsal habitus, dry; B. dorsal habitus, wet; C. interpretative illustration of dorsal habitus. Lower Cretaceous Yixian Formation, Huangbanjigou, northern China. Scale bars: 1 mm.

scape slightly enlarged, pedicel stout and distinctly shorter than antennomere 3. Ventral side with distinct subantennal grooves, extending below eyes; gular surface covered with sparse and long bristles.

Prothorax sub-trapezoid, about 0.9 times as long as wide, moderately convex; lateral margins slightly arcuate and weakly constricted before posterior margin; lateral carinae complete; posterior angles short and acute; posterior margin bisinuate with complete bead. Procoxal cavities circular and widely separated, externally closed; protrochantins concealed. Prosternal process long and broad, about 0.8 times as long as the anterior portion of prosternum, apex broadly truncate and slightly expanded, covered with dense and long setae mainly apically. Mesocoxal cavities circular and widely separated, laterally open to mesepimeron; metacoxal cavities slightly transverse, widely separated and laterally extend to elytra. Mesoventrite flat, metaventrite with distinct discrimen and transverse suture, both shiny and covered with dense and erect setae on central areas. Meso-metaventral junction in straight line. Scutellum small with apex narrowly rounded.

Elytra 1.72 times as long as wide, lateral margins gradually narrowing posteriorly with rounded apex; basal margin raised and forming short humeral tooth; disc with complete sutural stria and 3 incomplete rows of punctures in lateral area, median part smooth

and shiny; sparse setae visible on lateral areas. Epipleuron distinct at base, gradually narrowing posteriorly and absent before apex.

Abdomen with 5 ventrites; first ventrite longest, remaining ventrites subequal in length; surfaces smooth, shiny and sparsely setose. Legs very long with femora slightly dilated, tibiae slender, weakly expanded apically; front tibia strongly expanded and bend, bearing dense setae in apical fourth; trochanters and inner edges of front tibiae covered with dense and distinct setae. Tarsi 5-segmented with the first 4 segments short, tarsomere 5 much longer with a pair of symmetrical claws; tarsomeres 1–3 with dense and long setal brushes underneath, front tarsomeres 1–3 laterally expanded and very densely setose.

***Burmahelota* gen. nov.**

Type species: *Burmahelota pengweii* sp. nov.

Etymology. The generic name is derived from Burma, the former name of Myanmar, and *Helota*, referring to the origin of the described amber fossil. Gender feminine.

Diagnosis. This genus is most similar to *Helota* and *Neohelota* in having 4 oval isolated and smooth spots on elytra, but it can be easily distinguished from both these genera by the absence of striate punctations on elytra.

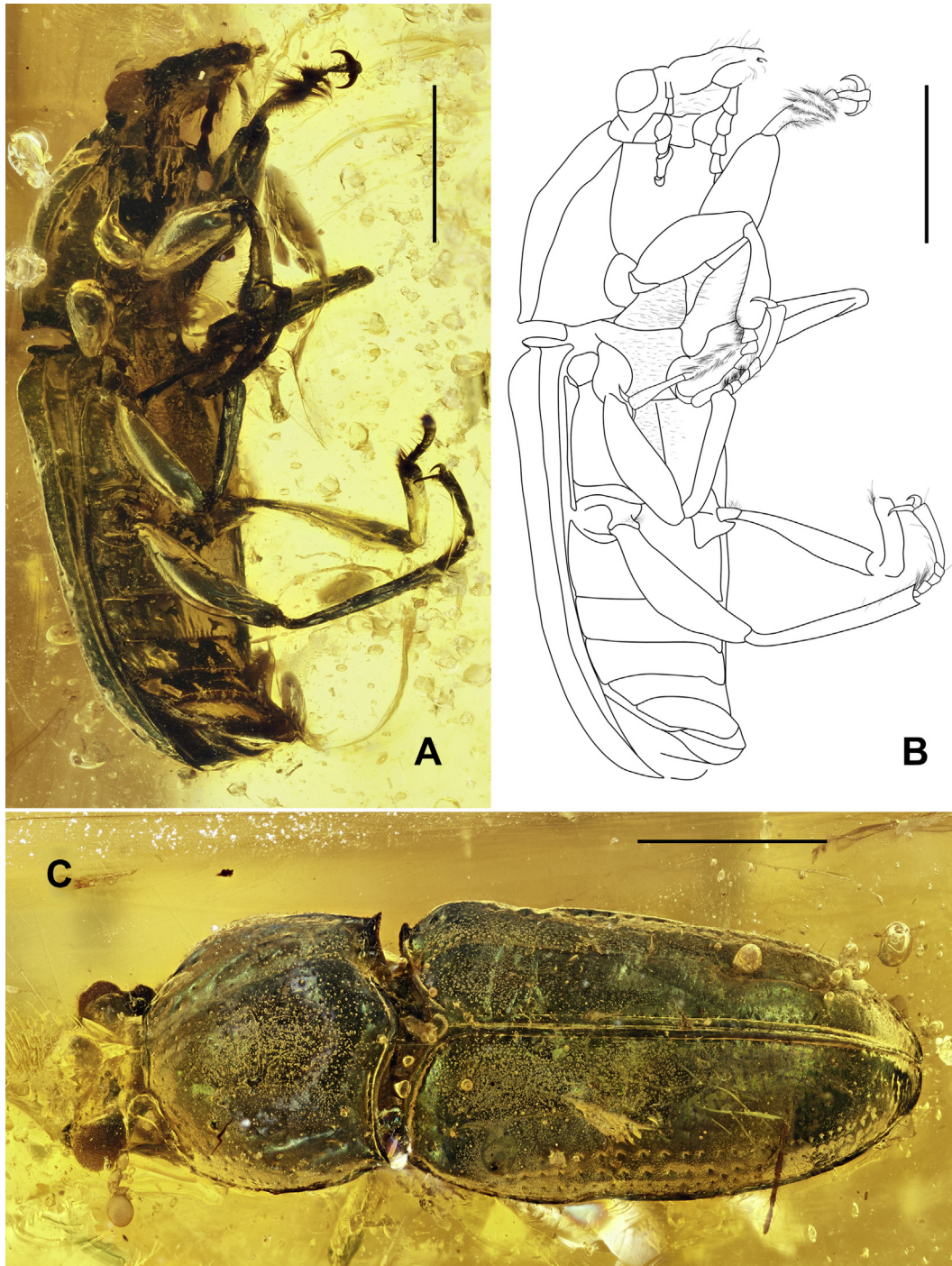


Fig. 2. *Metahelotella monochromata* sp. nov., CNU-COL-MA-0016, Holotype; A, lateroventral habitus; B, interpretative illustration of lateroventral habitus; C, dorsal habitus. Lowermost Cenomanian, Hukawng Valley, northern Myanmar. Scale bars: 1 mm.

Description. Length 2.34 mm. Body weakly convex, dorsal surface nearly smooth with distinct metallic lustre, covered with sparse and long setae.

Head with prominent postocular constriction; temples absent. Eyes large and dorsally and laterally protruding. Frontoclypeal suture absent; clypeus broadly rounded apically; mandibles broad, unidentate apically; maxillary palps with the terminal palpomere elongate and fusiform. Antennal insertions concealed from above, close in front of eyes. Antenna 11-segmented with distinct and

compact 3-segmented club; scape enlarged, pedicel slightly enlarged, antennomere 3 weakly elongate; antennal club covered with dense setae, especially on apex of antennomere 11. Dorsal side shiny, coarsely and sparsely punctured. Ventral side with sub-antennal grooves not extending below eyes.

Prothorax about as long as wide; pronotal disc moderately convex, coarsely and sparsely punctured; lateral margins arcuate and constricted in front of posterior margin; anterior angles broadly rounded, posterior angles short and acute; posterior margin deeply bisinuate with complete bead. Procoxal cavities

ovate and broadly separated, externally closed; prothoracanth concealed. Prosternal process long and broad, about 0.8 times as long as the anterior portion of prosternum, apical margin almost truncate. Mesocoxal cavities small and ovate, widely separated from each other, laterally open to mesepimeron; metacoxal cavities slightly transverse, widely separated, laterally extend to elytra. Mesoventrite small and flat, metaventrite with complete discrimen; meso-metaventral junction in straight line. Scutellum very small and ovate.

Elytra moderately elongate; humeral projection very small and sharp; lateral margins completely visible dorsally, gradually narrowing posteriorly with 3 sharp indentations in apical third, each bearing stiff seta. Each elytron with 3 basal pits connecting to complete sutural stria and 2 large pale oval spots (Fig.); surface nearly smooth with apparent microsculpture; epipleuron incomplete, broad at base and absent before apex.

Abdomen with 5 ventrites, all coarsely punctured, first ventrite much longer than remaining segments. Legs with femora slightly dilated, tibiae weakly expanded apically. Tarsi 5-segmented with basal 4 tarsomeres short, tarsomere 5 very long with a pair of large claws; empodium visible between claws, bisetose; fore legs with basal 2 tarsomeres slightly expanded and covered with dense setae

underneath, apex of front tibiae covered with dense setae along inner sides.

***Burmahelota pengweii* sp. nov.**

Fig. 3

Etymology. This species is named after Mr. Wei Peng, the original owner of this amber specimen, who provided it for our research.

Holotype. No. SYS-ENAM0006; lowermost Cenomanian, Hukawng Valley, northern Myanmar (SYSU, donated by Mr. Wei Peng).

Diagnosis. As for the genus.

Description. Measurements. BL 2.34 mm; HW 0.51 mm; PL 0.72 mm; PW 0.72 mm; EL 1.28 mm; EW 0.72 mm.

Body elongate-ovate, about 3.3 times as long as wide; dorsum with sparse and coarse punctures on head and pronotum, vestiture of moderately long setae. Head slightly transverse and subtriangular, postocular constriction distinct but without prominent temple; frontoclypeal suture absent. Antenna 11-segmented with distinct and compact 3-segmented antennal club. Pronotum about as long as wide, posterior margin deeply bisinuate, posterior angles short and acute. Procoxae broadly separated with concealed prothoracanthins; procoxal cavities externally closed; posterior margin of

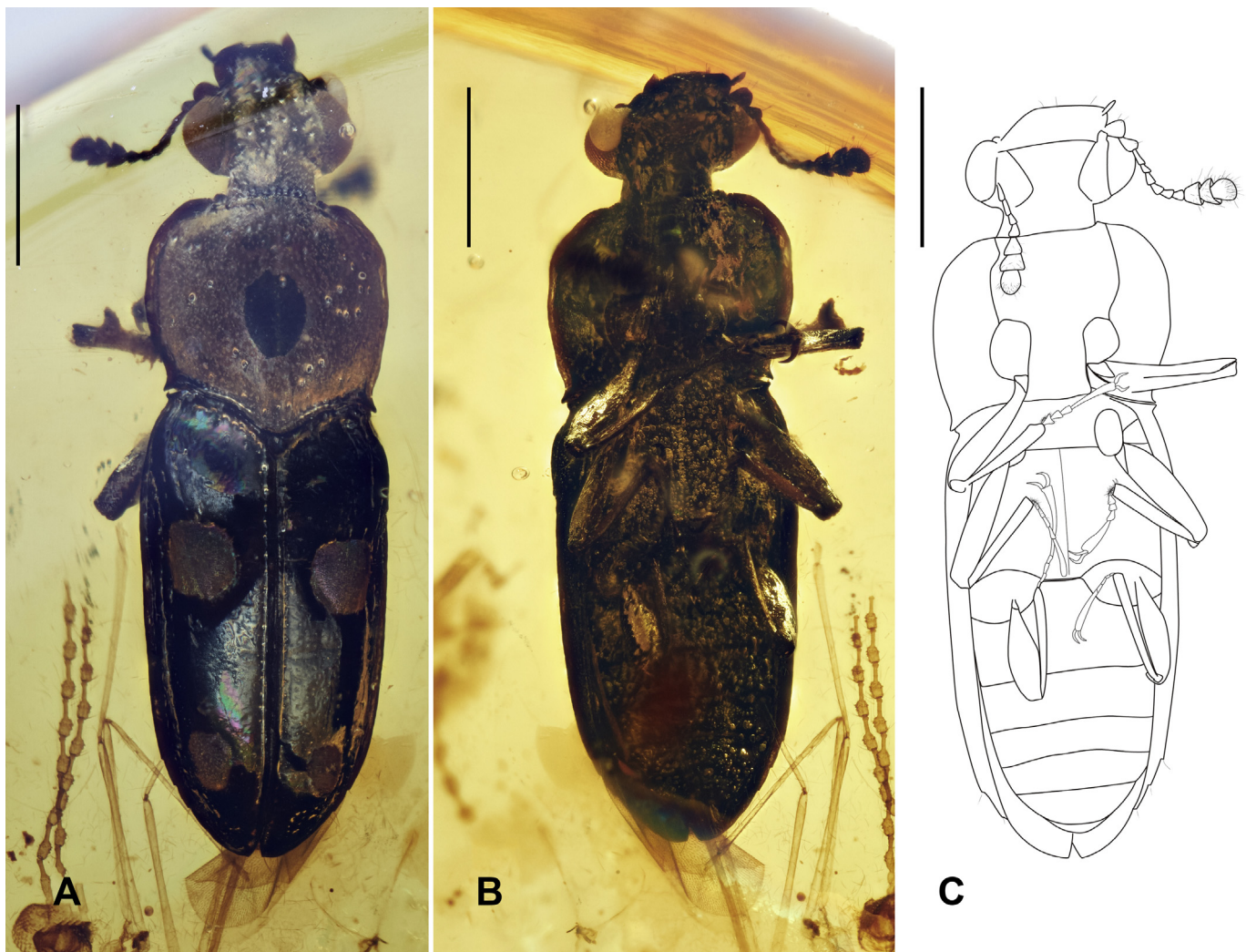


Fig. 3. *Burmahelota pengweii* gen. et sp. nov., SYS-ENAM0006, Holotype; A. dorsal habitus; B. ventral habitus; C. interpretative illustration of ventral habitus. Lowermost Cenomanian, Hukawng Valley, northern Myanmar. Scale bars: 0.5 mm.

prosternal process truncate. Scutellum small. Elytra about 1.8 times as long as wide, lateral margins with 3 sharp indentations in apical third, each bearing stiff seta; dorsal surfaces with 4 pale ovate spots but without seriate punctures. Meso- and metacoxae broadly separated; mesocoxal cavities laterally open to mesepimeron; meso- and metaventral conjunction simple, forming straight line; discrimen on metaventrite complete. Abdomen with 5 free ventrites, ratio of the length of each ventrite as follows: 4.0 : 1.5 : 1.2 : 1.0 : 1.0. Fore legs with basal 2 tarsomeres slightly expanded, bearing dense setae underneath.

4. Discussion

All fossil taxa described here share the elongate body shape, the large and distinctly protruding eyes and the subtrapezoid fronto-clypeus, which are consistent with the characters of this distinctive family. The placement of *Palaeohelota*, the first compression fossil specimen attributed to the family Helotidae is well established based on the distinct postocular constriction, 11-segmented antennae with a distinct, compact, 3-segmented antennal club, the pronotum with a bisinuate posterior margin and widely separated metacoxal cavities. The placement of the amber fossils is further supported by the broadly separated pro- and mesocoxal cavities and externally closed procoxal cavities.

Helotidae can be divided into 2 groups, with *Helota* and *Neohelota* species having 2 pairs of pale spots on the elytra which are absent in the remaining genera. *Burmahelota pengweii* resembles *Helota* and *Neohelota* in having elytral spots but is recognised as a new genus due to the absence of seriate punctures or tubercles on the elytra, which are always present in the extant taxa of these genera (Kirejstshuk, 2000). The sharp lateral indentations in the sub-apical area of the elytra in *Burmahelota* resemble similar structures observed in males of some extant species of *Neohelota* (Lee & Votruba, 2011).

The placement of the Burmese amber *Metahelotella monochromata* in that genus is supported by the overall smooth dorsal surface with regular metallic lustre, the elytra with several rows of moderately dense punctures, and the pronotum narrowed both anteriorly and posteriorly with a deeply bisinuate base. The punctures on the central areas of the elytra and pronotum are indistinct, which may be a result of the preservation or poor visibility of these surfaces in the amber.

The single known Mesozoic impression fossil of the Helotidae from the Yixian formation is here classified in the new genus *Palaeohelota*, based on the distinctly developed, but apically incomplete elytral costae not accompanied by seriate punctures as found in *Afrohelotina* (Kirejstshuk, 2000).

Laodiscis Lin (Lin, 1977) was described from the Early Paleogene of China under the family Helotidae. Examination of the original paper in Chinese revealed that the author mismatched the Chinese family name with the Latin family name, causing wrong attribution of the fossil to a family. Lin described the genus *Laodiscis* under the family “沼甲科” with Helotidae next to it; but the Chinese name refers to Scirtidae, which used to be called Helodidae. The description of the genus *Laodiscis* with the head concealed under the pronotum, the narrowly separated pro- and mesocoxae and aquatic habits does not match Helotidae, and *Laodiscis* is here transferred to Coleoptera, family *incertae sedis*, pending examination of the type specimen.

5. Concluding remarks

The discovery of the Helotidae from Yixian Formation represents the oldest record of the family so far, backdating the earliest known occurrence of Helotidae from the Miocene

(20.43–15.97 Ma) to the Aptian, Early Cretaceous (ca. 122.8 ± 1.6 Ma). Two Burmese amber inclusions attributed to the genera *Metahelotella* and *Burmahelota* reflect an already strong diversification of the family during the Cretaceous period, which together with the Yixian *Palaeohelota* suggests that Helotidae originated at least in the Early Cretaceous.

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