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A new ommatin beetle (Insecta: Coleoptera) with unusual genitalia from mid-Cretaceous Burmese amber
Ommatin beetle Burmese amber

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ABSTRACT

A new ommatin beetle, *Omma lii* sp. nov. (Insecta: Coleoptera: Archostemata) is described in mid-Cretaceous Burmese amber from northern Myanmar. This is the first species of this Late Triassic-recent genus of archaic beetles to be described from amber inclusions, including genitalia, and is the first unequivocal ommatine cupedid from Burmese amber. Cretaceous *Omma* is considered to belong to the stem group of this now relict Australian genus.

1. Introduction

With some 350,000 described species, beetles (Insecta: Coleoptera) are by far the largest order in the animal kingdom; the Cupedina, however, is the smallest and most archaic beetle suborder, totalling only about 100 living species, and now commonly split into the smaller suborders Archostemata and Myxophaga (Beutel et al., 2008; Hörnschemeyer, 2011). Several hundred fossil species have been described from the Permian onwards and archostematans are notable constituents of Mesozoic insect faunas, even occurring in regions from where they have now vanished (such as Europe; Kirejtshuk and Ponomarenko, 2015). Such finds are usually preserved as adpressions, some exceptionally well preserved as in northeastern China (Jarzembowski et al., 2013a), but they have also been discovered recently as amber inclusions in northern Myanmar (Xia et al., 2015). Archostematans are, nevertheless, scarce in Burmese amber which is surprising considering that most recent archostematans are associated with wood in both active stages (larval and adult) and sometimes the adults visit flowers. The first archostematan in amber to be described from Myanmar, *Stegocoleus caii* Jarzembowski and Wang, 2016, showed affinities with both major extant groups of archostematan beetles (cupedines and ommatines) and an extinct one (brochocoleins). On balance, it was only questionably referred by the authors to the ommatines. Here we describe an archaic beetle from the same deposit which shows affinity with the ommatins or typical ommatines. Opinion is divided as to whether ommatines are a subfamily of cupedids *sensu lato*, the reticulated beetles (Kirejtshuk and Ponomarenko, 2015), or a separate family (a clade with the tetraphalerins: Beutel et al., 2008), whereas brochocoleins are currently considered to be the sister group of crown-group ommatines (Tan et al., 2012). For consistency with Jarzembowski et al. (2013a,b), we consider cupedids and ommatines in the broad sense, the former including this subfamily and latter including tetraphalerins and brochocoleins, as well as ommatins, as tribes.

The beetles described below belong to an uncommon species, less than ten examples being known from over 100,000 inclusions examined, dispersed over several collections. Extant ommatins are also rare insects, now only found in Australia unlike in the Mesozoic when they were more widespread (Soriano and Delclòs, 2006) and are considered a relict group of 'living fossils' (Lawrence and Ślipiński, 2013). No 'Tertiary' ommatins have yet been described.

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2. Geological setting

Burmese amber (amber from northern Myanmar, burmite) contains the most diverse biota in amber (fossil resin) known from the Cretaceous; it has been traded with neighbouring China for nearly two millenia, but no scientific research on the insect inclusions was undertaken there until recently (Wang et al., 2015). All the major divisions of extant insects (orders) are represented, beetles being one of the most diverse, but the majority of species are undescribed. The amber has been dated stratigraphically and radiometrically from late Albian to early Cenomanian in the present century (Cruickshank and Ko, 2003; Ross et al., 2010). U–Pb dating of zircons from the volcanoclastic matrix gave a maximum age of 98.8 ± 0.6 mys (Shi et al., 2012); however, a high degree of roundness of the amber and bivalve borings (*Gastrochaenolites*) on the surface suggest that it was reworked before deposition and we therefore consider the age as circa 100 Ma.

Amber has been found in several districts of Myanmar, but the current supply is from Myitkyina District, Kachin State, in the Hukawng Valley of northern Myanmar; an active mine is located near Noije Bum Village, Tanaing (Tanai) Township (Kania et al., 2015: fig. 1; Fig. S1). Another source of amber has been discovered recently in central Burma, but no insect inclusions are reported yet unlike in the Hukawng Valley (Sun et al., 2015). By law, Burmese amber can only be sourced and worked by local people, despite being in a war zone, and is prepared for the foreign jewellery trade. This means that larger inclusions over half a centimetre in size, such as those described herein, may be partly removed by preparatory polishing (although are still highly priced). Such damage, coupled with a degree of natural deformation, means that multiple specimens are best examined for study purposes.

3. Material and method

The specimens were examined under an Olympus SZX7 binocular microscope with fibreoptics and top and bottom illumination; they were photographed with a Zeiss Axiocam 506 digital camera with Combine ZP software mounted on a Zeiss AX10 Zoom.v16 binocular microscope. Drawings were prepared from both photographs and specimens by hand (EAJ). Only standard degreasing and wetting were undertaken during examination to prevent further damage to specimens; glycerine under a cover slip was applied temporarily to reduce surface interference. For morphology, we follow the terminology in Jarzembowski et al., 2013a; Fig. S2). Drawing conventions are: solid line, distinct margin; dashed, indistinct or damaged; dashed-and-dotted, folded; dotted, extrapolated. The abbreviations used are NIGP and NIGPAS, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences; HAM, Huxuan Amber Museum, Jinan. The publication LSID is: urn:lsid:zoobank.org:pub:D18D604D-451D-4267-9543-F313F9951B54.

4. Systematic palaeontology

Class INSECTA Linnaeus, 1758
Order COLEOPTERA Linnaeus, 1758
Suborder ARCHOSTEMATA Kolbe, 1908
Family CUPEDIDAE Laporte, 1836 s.l
Subfamily OMMATINAE Sharp & Muir, 1912
Tribe OMMATINI Sharp & Muir, 1912

Genus *Omma* Newman, 1839
Type species: *Omma stanleyi* Newman, 1839 by original designation; recent, Australia.

Diagnosis. Ommatine beetles possessing: small or medium-size, moderately long elytra with comparatively well-developed tuberculation and discernible reticulation due to external cell development; epileuron with moderately wide rim widening slightly anteriorly; disc with distinct longitudinal rows of window cells.
Remarks. The diagnosis has been emended to complement that of the fossil sister genus *Cionocoleus* Ren, 1995 which is readily distinguished by its more elongate, larger form and lack of reticulation (Jarzembowski, 2013a).

Omma lii sp. nov.
(urn:lsid:zoobank.org:act:637B830A-3EF8-4F06-9A83-5BD014EC5E10). Figs 1–4

Derivation of name. After Mr Jun Li (Jinan), collector.
Holotype. NIGP 164898, beetle body in tumbled and polished amber cabochon.
Paratypes. NIGP 164899, 164900; HAM LJ16001; horizon and locality as holotype.
Locality and horizon. Mine near Noije Bum Village, Tanaing Township, Myitkyina District, Kachin State, Myanmar, 26° 15′ N., 96° 33′ E.; unnamed horizon, mid Cretaceous, upper Albian or lower Cenomanian.
Other material. Possibly a figured specimen (Xia et al., 2015: 103, upper right).
Diagnosis. Small Cretaceous species of *Omma* similar in size to recent *Omma rutherfordi* Lawrence, 1999 (about six to less than eight mm long), but differing in its shorter antennae and palps, distinct temples, stouter body (2.4 times long as wide compared with 3.9 in *O. rutherfordi*) and male genitalia (aedeagus with spiny rather than smooth parameres).
Description. Small black beetle, 5.6–7.6 mm long (from anterior end of mandibles to posterior end of folded elytra), 1.8–3.2 mm wide (across folded elytra), holotype with maximum dimensions (Fig. 1A). Body flattened (dorsoventrally); hirsute, covered with small setae and elongate scales, latter especially on posterior ends of elytra (Fig. 2). Cuticle generally distinctly tuberculate (Fig. 1B).

Head with well-developed neck (constriction at rear); temples rounded, shorter than eyes, latter prominent, elongate and rounded laterally. Antennae short, not extending beyond posterior edge of prothorax, 11-segmented, filiform, inserted on side of head; 3rd antennal segment elongate (longer than 2nd and 4th), 11th spindle-shaped. Labrum broad, fronto-clypeal area behind it slightly depressed. Mandibles arched forward with three vertical teeth, only two visible dorsoventrally (Fig. 3, cf. S3A). On underside of head, gular sutures not well developed; last maxillary segment widened, but not extending beyond labrum.

Thorax. Pronotum broader than long with rounded corners and edges, wider than head, narrower than abdomen, slightly raised laterally in top view. Pronotopleural suture long. Procoxae large, rounded, contiguous on posterior edge of prothorax. Profemur thickened anteriorly and extending beyond edge of abdomen; protibia thinner, shorter and spurred; protarsus shorter than protibia, not lobed. Mesoscutellum small. Mesocoxae large, rounded and adjacent. Mesofemur long, slightly curved and extending beyond edge of body and longer than spurred mesotibia; latter about length of mesotarsus with elongated first and last segments. Metaventrite broad, trapezoidal with cross sutures. Metatrochantin broad, spindle-shaped. Metacoxa very large, subtriangular; Metatrochanter small, triangular. Metafemur broad, nearly as long as metatibia, not extending beyond edge of body; metatarsus longer and thinner with very elongated segments.

Elytron overlapping hindbody; base slightly curved, humerus (shoulder) rounded; apex bluntly pointed; anterior (outer) margin curved and anterior part of disc strongly inclined with step-like

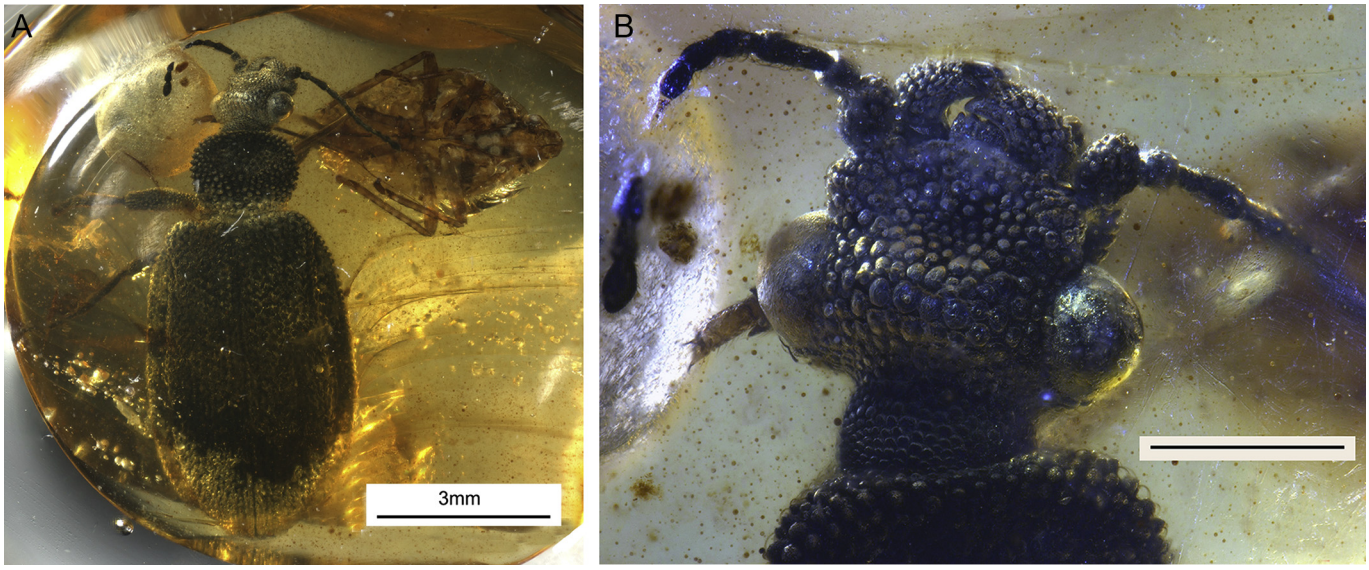

Fig. 1. *Omma lii* sp. nov., photographs of holotype (immersed in glycerine) in A, dorsal view and B, close-up of head to show tuberculation. Scale 1 mm (B). (The brown insect (top right, A) is a plant-hopper nymph (fulgoroid homopteran) characteristic of Burmese amber.)

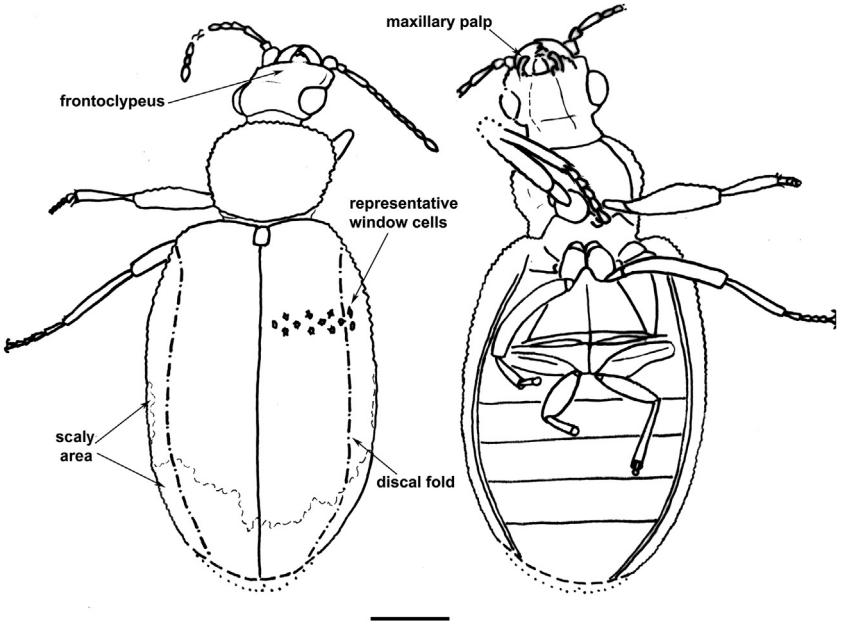

Fig. 2. *Omma lii* sp. nov., holotype, drawings of dorsal (left) and ventral (right) views. Scale bar 1 mm.

Fig. 3. *Omma lii* sp. nov., photograph of paratype NIGP 164899 in brown Burmese amber displaying mandibles (jaws) in ventral view. Scale bar 1 mm.

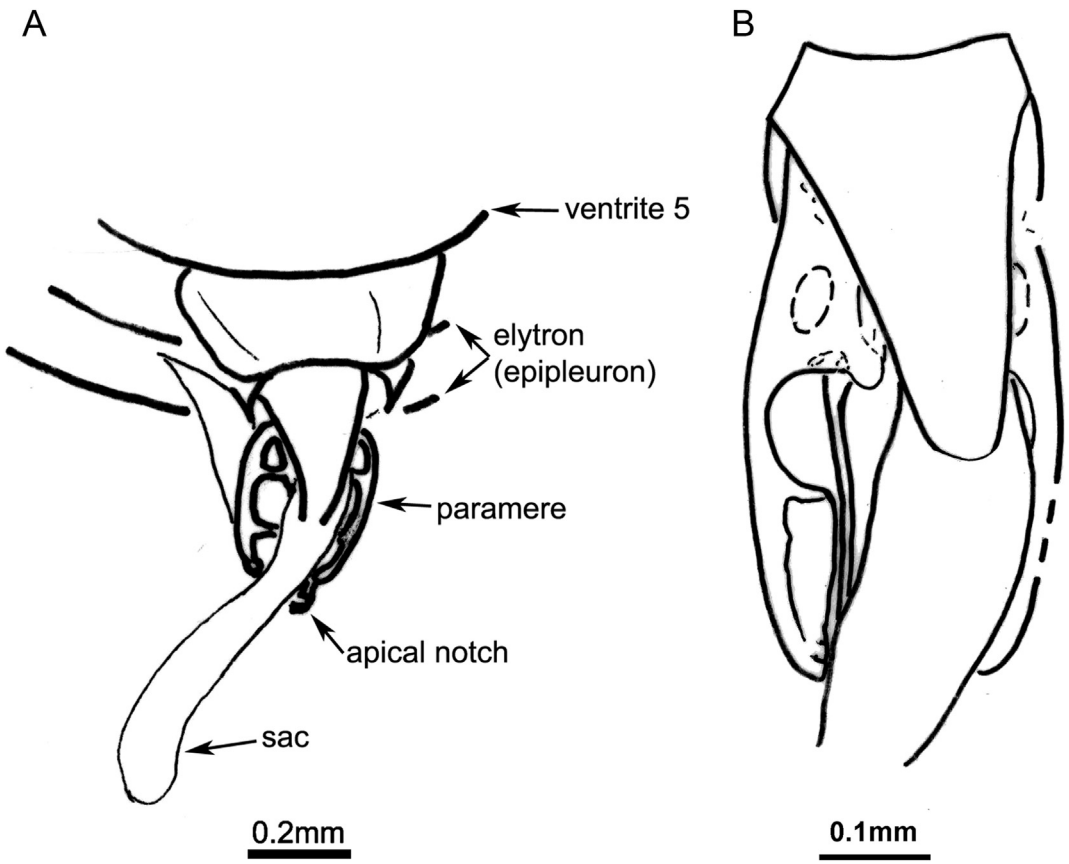

Fig. 4. *Omma lii* sp. nov., paratype NIGP 164900, drawing of male genitalia, ventral view (A), including trilobate aedeagus (below triangular sternite IX), setae omitted in (B).

fold; epipleural rim moderately wide, narrowing slightly posteriorly; seven distinct rows of small window cells (appearing stellate due to overlapping tubercles) on disc and one adjacent to epipleural rim with intervening rows obscured by discal fold (but with space for two more rows).

Abdomen with coplanar ventrites and widest opposite 2nd ventrite; 1st and 5th ventrites longer than others, 5th c. 0.3 times longer than 4th (penultimate). Aedeagus trilobed, median lobe elongate, lateral lobes spinose in structure with slightly notched tip and mesal area (Fig. 4).

Remarks. The NIGPAS amber collection also contains a beetle resembling a small *O. lii* but with slight posterior pronotal angles, and another even smaller form with more clavate antennae. We propose to describe these separately, but in the meantime they indicate that several species may have coexisted in the amber forest like alongside earlier Jurassic water bodies as suggested by adpression fossils (Ponomarenko, 1968).

5. Comparison

Two species of *Omma* have been described from the Cretaceous (both Lower Cretaceous): *Omma sibiricum* Ponomarenko, 1966 from Russia and *Omma antennatum* Ponomarenko, 1997 from Mongolia. The former is distinctly larger (20 mm long) than the amber fossils falling only in the size range of the largest living species, *O. stanleyi* (13–25 mm); it also differs in its longer pronotum and ventrite 5 plus claviform profemur. *O. antennatum* is also larger (11.5 mm long) than the amber fossils, differing morphologically from them in possessing a longer metasternum and ventrite 5, shorter and thicker femora, smaller tubercles, and a broad pronotum with a straight anterior edge (loc. cit.). The amber fossils are of similar size to extant *O. rutherfordi* males (6–7.2 mm long) and small *O. mastersi* (7–11 mm). The former species, however, is much more slender, with longer antennae and indistinct temples (Lawrence, 1999: fig. 1). The latter species has slightly shorter antennae and a little longer body (2.8 times longer than wide). Both also possess long palps. Moreover, the uniquely preserved fossil aedeagus lacks the smooth parameres of extant *Omma* species (Fig. S3B), despite a slightly notched apex (Fig. 4A). In fact, apart from this emargination which is characteristically well developed in modern *Omma* (loc. cit.), the parameres resemble the comparatively spiny cupedine form (Neboiss, 1984; Fig. S4). We therefore propose a new mid-Cretaceous species, currently the smallest fossil member of this genus. Kirejtshuk et al. (2016) consider the cupedines to be the sister group of the ommatines plus three other cupedomorph families including extant crowsoniellids: the latter also possess spinose genitalia, so the Burmese amber discovery is perhaps not surprising.

6. Conclusion

That the *Omma* lineage separated prior to the Cretaceous is supported by the occurrence of *Cionocoleus* in the Upper Jurassic (Jarzembowski, 2013a). The former genus is indeed reported as extending back to the Late Triassic, although Crowson (1962) qualified this claim by saying 'it is of course unlikely that an Early Jurassic fossil will be strictly congeneric with a recent species of Coleoptera'. It may therefore be significant that Middle Jurassic *Omma daxishanense* Cai and Huang, in press is distinguished by its

broad, tetraphalerin-like temples which are unlike the Burmese amber fossils. Ponomarenko (1966) also remarked that Early Cretaceous *Omma*, whilst showing greater morphological similarity to extant *Omma* than Late Triassic/Early Jurassic beetles, probably still represented a stem group. The same is suggested by the cupedine-like genitalia of *O. lii* sp. nov. (section 5). The *Omma*-like genus *Ommamima* Ponomarenko, 1964 from the Upper Jurassic of Kazakhstan may be another comparatively small (8.3–5 mm long) stem form. It differs from *O. lii* sp. nov. in its smaller eyes and prominent temples plus longer ventrite 5. Although later synonymised with *Omma* after morphological comparison by Ponomarenko (1969), this action might need to be reconsidered in the light of the new amber finds. Unfortunately, well-preserved genitalia are not available in Jurassic *Omma* for critical comparison, even if these are all larger species (>8–31 mm long, pers. tally) and therefore more readily preserved in sedimentary strata. As an ommatin, *O. lii* sp. nov. is nevertheless less enigmatic than its contemporary *Stegocoleus caii* with has a cupedine-like foreleg architecture (non-contiguous procoxae, Fig. S5) as well as ommatine (brochocolein and tetraphalerin-like) features (expanded epipleura and antennal grooves: Jarzembowski and Wang, 2016). In addition to these species, a true cupedine is also known from Burmese amber inclusions: albeit not showing affinity with cupedins, it confirms that the two major lineages of extant archostematans are represented (Jarzembowski et al., in press).

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.cretres.2016.10.010.