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## The first cupedine beetle from Burmese amber (Coleoptera: Cupedidae)



*Le premier vrai cupédide de l'ambre birman (Coleoptera : Cupedidae)*

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### ABSTRACT

A rare archaic beetle, *Mallecupes qingqingae* gen. et sp. n., (Insecta: Coleoptera: Archostemata: Cupedidae) is described from mid-Cretaceous Burmese amber. It shows affinity with *Paracupes* found in South America today and '*Paracupes*' found in North America during the Cretaceous. Archostemata are diverse in Burmese amber.

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### RÉSUMÉ

Un coléoptère rare et archaïque, *Mallecupes qingqingae* gen. et sp. n., (Insecta : coléoptères : Archostemata : Cupedidae) est décrit au Crétacé moyen dans l'ambre birman. Il montre une affinité avec *Paracupes* trouvé en Amérique du Sud aujourd'hui et avec « *Paracupes* » trouvé en Amérique du Nord au Crétacé. Les Archostemata sont divers dans l'ambre birman.

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## 1. Introduction

With some 350,000 described species, beetles (Coleoptera Linnaeus, 1758) are easily the largest order in the animal kingdom: the Cupedina Ponomarenko, 1973, however, is the smallest beetle 'suborder', totaling only about 100 living species, and now commonly split into the smaller suborders Archostemata Kolbe, 1908 and Myxophaga Crowson, 1955 (Beutel et al., 2008; Hörnschemeyer, 2011). Several hundred species of fossil cupedinans have been described from the Permian onwards and archostematans are a notable element of Mesozoic insect faunas, even occurring in places from where they have now vanished, such as southern France and Northwest Europe (Kirejtshuk and Ponomarenko, 2015). Such finds are often preserved as rock fossils (Jarzembowski et al., 2015), but they are now turning up as amber inclusions in Myanmar, also known as Burma (Xia et al., 2015). Archostematans are nevertheless scarce in Burmese amber compared with earlier Cretaceous deposits, such as in the English Weald and northeastern China: this is a little surprising considering the modern association of these beetles with wood, but there may be a size filter involved- or even competition with new terrestrial fauna (Jarzembowski and Wang, 2016). The beetle described below belongs to a rare species, with only three known specimens from some 100,000 inclusions examined. It is nevertheless a typical reticulated beetle, and the first as such to be described from Burmese amber. The reticulated beetles are so-called because of their clathrate elytra (wing cases often showing a lattice pattern) and are the dominant archostematans both at the present day and in the Late Mesozoic, although in the latter they usually belong to an extinct group, the notocupedins (cupedids sensu lato; Jarzembowski et al., 2015; Fig. 1). The extant reticulated beetles (cupedids sensu stricto) are sometimes split into priacmines and cupedines sensu stricto (Lawrence and Ślipiński, 2013). We follow the broader classification used by Kirejtshuk et al. (2010a, see section 4) which also includes various fossil cupedids, especially as we are at the start of a new fauna in Burmese amber.

## 2. Geological setting

Burmese amber (amber from northern Myanmar, burmite) contains the most diverse amberised biota known from the Cretaceous; it has been traded with neighbouring China for nearly two millennia, 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 (Order Coleoptera Linnaeus, 1758) being one of the most diverse, but the majority of species are undescribed. The fossil resin 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  $98.8 \pm 0.6$  m. y.s (Shi et al., 2012); however, a high degree of roundness of the amber and bivalve borings on the surface suggest that it was reworked before deposition



Fig. 1. Photograph of "*Notocupes*" sp., 16 mm long, NIGP AAMA01.  
Fig. 1. Photographie de « *Notocupes* » sp., 16 mm de longueur, NIGP AAMA01.

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 Noiye Bum Village, Tanaing (Tanai) Township (Kania et al., 2015; fig. 1). 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 jewelry trade. This means that larger inclusions about a centimetre in size, such as those described herein, may be partly removed by preparatory polishing although still highly priced.

## 3. Material and methods

The types were examined under an Olympus SZX7 binocular microscope with fibre optics 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. 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 (AA, Amber Archive); LAM, Lingpoge Amber Museum, Shanghai.

#### 4. Systematic palaeontology

Class: Insecta Linnaeus, 1758

Order: Coleoptera Linnaeus, 1758

Suborder: Archostemata Kolbe, 1908

Family: Cupedidae Laporte, 1836 s.l.

Subfamily: Cupedinae Laporte, 1836 s.l.

Remarks. The extant (crown group) cupedids s.s. or Cupedinae s.l. are sometimes divided into priacmines/priacmins and cupedines/cupedins (Lawrence and Ślipiński, 2013), the former division having apparently branched earlier, but is not necessarily natural (paraphyletic according to Hörschemeyer, 2010a). This division has been rejected by Kirejtshuk et al. (2010a) because it is based on a morphological trend (towards longer antennae, with basal approximation, and pronounced head protuberances) which suffers from exceptions. It must be observed, however, that the majority of Cretaceous species are ‘priacmines’ – whereas Cenozoic ones are cupedines (Kirejtshuk and Ponomarenko, 2015). A third group, the mesocupedines/mesocupedins, is recognised for Mesozoic fossils (Tan and Ren, 2009), but the fossils described below cannot be referred to it because they clearly show abutting abdominal ventrites, as in the crown group [‘priacmines’ + cupedines].

Genus *Mallecupes* nov.

Type species: *Mallecupes qingqingae* sp. n. by monotypy; Cretaceous, Myanmar.

Etymology. From the latin malleus (referring to the hammer-shaped head) and *Cupes* (typical genus), masculine.

Diagnosis. Slender fossil cupedid nearly one centimetre long with fairly long and narrow antennae and tarsi; forward-directed head protuberances immediately posterior to the antennal insertions; no posterior head tubercles; two subapical mandibular teeth; head wider than long, hammer-shaped; protruding, globular eyes with transverse diameter of eyes about half of distance between them; temples rounded, gula elongated; pronotum subquadrate, wider than long, anterior angles slightly produced and blunted apically; elytra wider than pronotum, parallel-sided with ten rows of maculated window punctures, small and round in rows 1–9 (two shown in Fig. 6) and large and ovoid in row 10 (but not transverse: Fig. 2). Hindwing with third median cell (2M, cubital auct.) well developed with posterior cubital connection (Fig. 7B).

Remarks. The monobasic new genus shares with the extant genus *Paracupes* Kolbe, 1898 the generic autapomorphy of forward-directed head protuberances immediately behind the antennal insertions (Fig. 3B) coupled with a lack of posterior protuberances (Hörschemeyer, 2009). It also shares this feature with Upper Cretaceous (Turonian) *Paracupes svitkoi* Lubkin, 2003. The latter species is only known from a fusainised head capsule, and its generic attribution has been questioned, despite the fossil being relatively well preserved, suggesting a new genus (Kirejtshuk and Ponomarenko, 2015 contra Hörschemeyer, 2010b). This is supported by the mandibular teeth of the Turonian ‘*Paracupes*’ being more serrated than in recent *Paracupes* (*P. brasiliensis* Kolbe, 1898 + *P. ascius* Neboiss, 1989) and *Mallecupes*. The

head is wider than long in recent *Paracupes*, ‘*Paracupes*’ and *Mallecupes*. In the last, however, it is hammer-shaped with relatively protruding globular eyes (Fig. 5A, D), which are more inset in recent *Paracupes* (Fig. 5B, C) and elongate in ‘*Paracupes*’, the latter with a smaller, rounded head (Fig. 5E). The gula of *Mallecupes* is elongate as in *P. ascius* (although the head is domed in the latter) and not short and nearly wide as long as in *P. brasiliensis* and ‘*Paracupes*’ (Fig. 5B, C; Lubkin, 2003): a comparison of other body characters awaits the discovery of new fossil material. Nevertheless, the pronotum and elytra of *Mallecupes* resemble those of modern *Paracupes* (cf. Neboiss, 1989), although the antennae are fairly long with curved first antennal segments (scapi) and hindwing venation is better developed (cf. Vulcano and Pereira, 1975).

*Mallecupes qingqingae* gen. et sp. nov.

(Figs. 2, 3, 4A, B, 5A, D, 6, 7A, B)

Etymology. Named after Ms Qingqing Zhang (NIGPAS), palaeontologist.

Locus typicus and stratum typicum. Burmese amber, unnamed horizon, mid-Cretaceous, Late Albian or Early Cenomanian; mine near Noije Bum Village, Tanaing Township, Myitkyina District, Kachin State, Myanmar, 26° 15' N., 96° 33' E.

Material. Holotype, NIGP 157008, Paratype, NIGP 164791, beetle bodies in tumbled and polished amber cabochons. Other material, figured specimen (Xia et al., 2015, Lingpoge Amber Museum, Shanghai) (Fig. 4B, 6).

Diagnosis. As for genus.

Remarks. *M. qingqingae* differs from Lower Cretaceous ‘priacmines’ in possessing antennal insertions closer than the diameter of the eyes (Tan and Ren, 2009). Recent *Paracupes* has exceptionally long first antennal segments

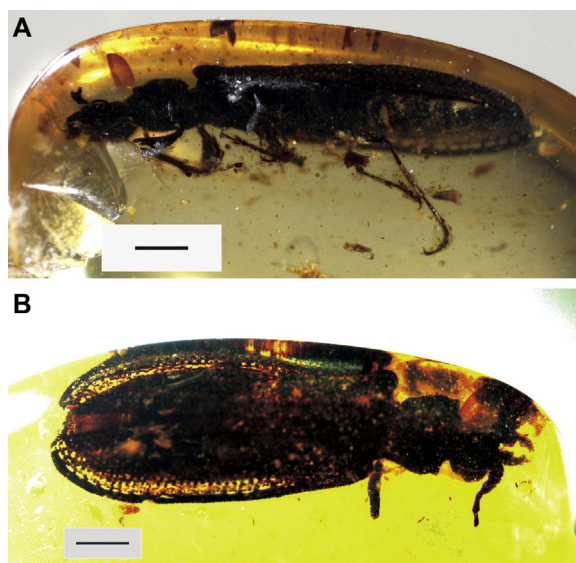
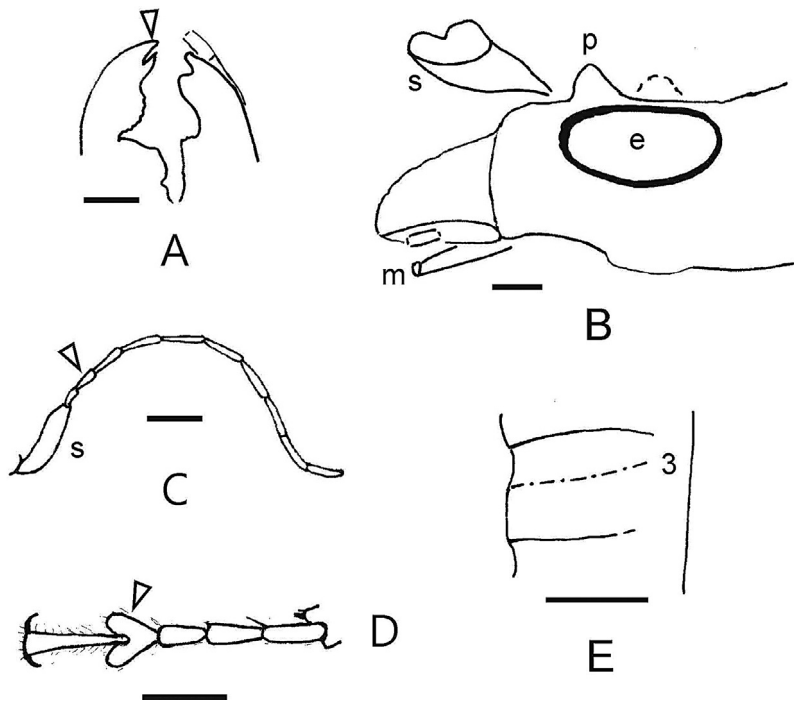


Fig. 2. Photograph of *Mallecupes qingqingae* gen. et sp. n., holotype NIGP157008: A: ventrolateral view; B: dorsal view (scale bar = 1 mm).

Fig. 2. Photographie de *Mallecupes qingqingae* gen. et sp. n., holotype NIGP 157008 : A : vue ventrale-latérale ; B : vue dorsale (barre d'échelle = 1 mm).

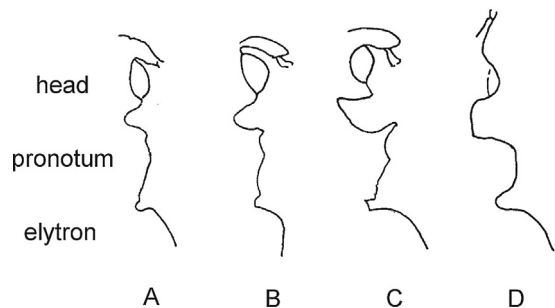


**Fig. 3.** Interpretative drawings of morphological details, holotype: A: dorsal view of mandibles (arrow pointing to teeth); B: lateral view of head, e, eye, m, maxillary palp, p, protuberance, s, scape; C: dorsal view of left antenna (arrow pointing to third antennomere); D: dorsal view of left mesotarsus (arrow pointing to bilobed tarsomere); E: third abdominal ventrite (profile on left) (scale bars A, B = 0.2 mm, C–E = 0.5 mm).

**Fig. 3.** Dessins interprétatifs de détails morphologiques, holotype : A : vue dorsale de mandibules (la flèche pointant vers les dents) ; B : vue latérale de tête, e, oeil, m, palpe maxillaire, p, protubérance, s, premier antennomère ; C : vue dorsale d'antenne gauche (la flèche pointant vers le tiers de l'antennomère) ; D : vue dorsale de mésotarse gauche (la flèche pointant vers le tarsomère bilobé) ; E : troisième sternite de l'abdomen (profil gauche) (barres d'échelle A, B = 0,2 mm, C–E = 0,5 mm).

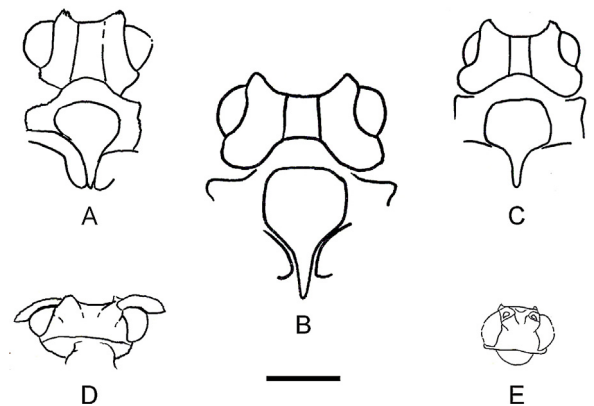
(scapi) which extend beyond the eyes as is seen in the fossils described herein (*M. qingqingae*); in the latter, though, they are curved and not straight (e.g. Fig. 2B). Curved long scapi are also present in the controversial Early Cretaceous *Ovatocupes* Tan and Ren, 2006 from northeastern China which has been considered both a cupedin and a notocupedin on gross morphology (Kirejtshuk et al., 2010b). It does, however, imply homoplasy (convergence) in this

feature, but the cupedin affinity of the Burmese fossils is supported by the presence of a prosternal process, bilobed tarsi, long antennae inserted dorsally, short third antennal segment and abutting abdominal ventrites as in the crown



**Fig. 4.** Identification profiles (right side, antenna-elytron) of Burmese amber cupedines: A: *Mallecupes qingqingae* gen. et sp. n., holotype; B: *M. qingqingae* figured (Xia et al., 2015; LAM 15.104b); C: *M. sp. n.* (loc. cit.; NIGP 164792); D: '*Cupes*' sp. (loc. cit.; LAM 15.103a) (scale bar = 1 mm).

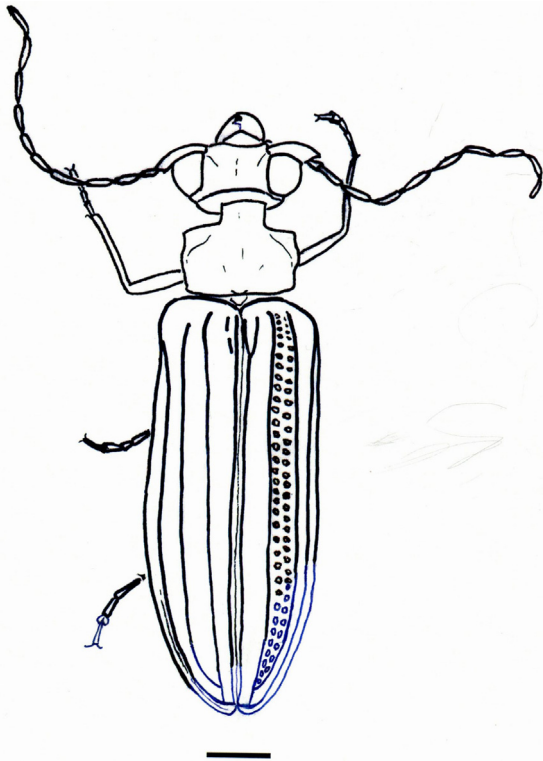
**Fig. 4.** Profils d'identification (côté droit, antenne-élytre) de cupédines de l'ambre birman : A : *Mallecupes qingqingae* gen. et sp. n., holotype ; B : *M. qingqingae* illustré (Xia et al., 2015 ; LAM 15.104b) ; C : *M. sp. n.* (loc. cit. ; NIGP 164792) ; D : '*Cupes*' sp. (loc. cit. ; LAM 15.103a) (barre d'échelle = 1 mm).



**Fig. 5.** Head of A: *Mallecupes qingqingae* gen. et sp. n.; B: *Paracupes brasiliensis*; C: *Paracupes ascius*; D: *M. qingqingae*; E: '*Paracupes*' svitkoi (A–C: ventral views, A: LAM 15.104b, B and C based on Neboiss, 1989; D, E: dorsal views, D based on Xia et al., 2015, E based on Lubkin, 2003) (scale bar = 1 mm).

**Fig. 5.** Tête et prothorax de A : *Mallecupes qingqingae* gen. et sp. n. ; B : *Paracupes brasiliensis* ; C : *Paracupes ascius* ; D : *M. qingqingae* ; E : '*Paracupes*' svitkoi (A–C : vues ventrales, A : LAM 15.104b, B et C basé sur Neboiss, 1989 ; D, E : vues dorsales, D basé sur Xia et al., 2015, E basé sur Lubkin, 2003) (barre d'échelle = 1 mm).





**Fig. 6.** Habitus of *Mallecupes qingqingae* gen. et sp. nov. based on paratype NIGP 164791 (blue) and LAM 15.104b (cells representative) (scale bar = 1 mm).

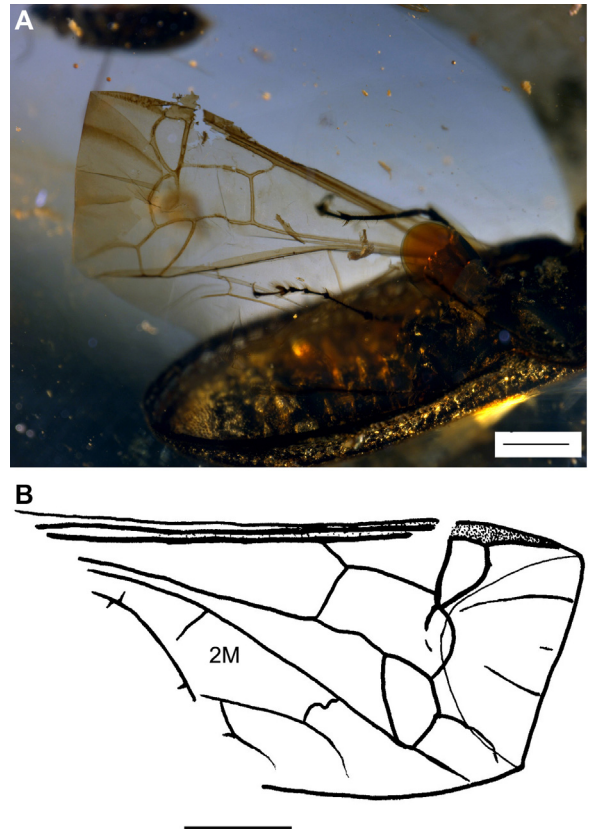
**Fig. 6.** Habitus de *Mallecupes qingqingae* gen. et sp. nov. basé sur les paratypes NIGP 164791 (bleu) et LAM 15.104b (cellules représentatives) (barre d'échelle = 1 mm).

group (Fig. 3B–E). The North American '*P. svitkoi*' is unusual in being tridentate.

**Description.** Small cupedine, 2.2–3.0 mm wide, 7.8–9.2 mm long (including mandibles, Fig. 3A); body elongate (length: width ratio > 3:1), flattened, and hirsute (covered with small setae/scales), spines and spurs developed locally. Cuticle blackened and tuberculate. Head short and broad with bulging eyes, rounded laterally; anterior protuberances present, directed forward above antennal bases; temples rounded, narrower than eyes. Neck short and narrower than head. Antennae long, inserted on top of head, reaching mid length of body, 11-segmented, filiform: scape exceptionally long, curved; third antennomere slightly shorter than fourth and not elongate. Mandible well developed, curved anteriorly, with two acute, subapical teeth and ridge behind them. Maxillae long, palps extending beyond mandibles. Gula short and broad, straight-sided.

Prothorax subrectangular, broader than long, slightly narrower than head, much narrower than hindbody. Pronotum laterally depressed but not ridged medially with bifid anterior angles, latter blunted, rounded.

Legs. Tarsomere 4 bilobed underneath; tarsomere 5 simple. Procoxae large, completely separated by prosteral process. Profemur stout, extending beyond edge of



**Fig. 7.** Hindwing of *Mallecupes qingqingae* gen. et sp. nov., paratype NIGP 164791: A: photograph; B: interpretative drawing (scale bar = 1 mm).

**Fig. 7.** Aile postérieure de *Mallecupes qingqingae* gen et sp. nov., paratype NIGP 164791 : A : photographie ; B : dessin interprétatif (barre d'échelle = 1 mm).

prothorax and scape. Protibia spurred and thinner than profemur but of comparable length. Protarsus thinner than protibia and somewhat shorter; metatibia, however, longer than metafemur and metatarsus longer than metatibia, the latter with an elongate first tarsomere. Metacoxae very large.

Pterothorax weakly waisted, metaventricle narrowed, metatrochantins spindle-shaped, not wide. Elytra elongate, overlapping hindbody, shoulders rectangular, apices rounded with well developed suture; disc comparatively flat with traces of longitudinal venation (evidently second anal and cubital veins) and about five double rows of small cells; outer edge of disc stepped with prominent row of large maculated window cells on lower incline and narrow epipleural rim, the latter only ornamented with tubercles.

Abdomen elongate, apex acute, rounded; ventrite 5 nearly twice as long as ventrite 4, first not divided, shorter than fifth; all ventrites abutting and markedly depressed anteriorly.

**Remarks.** The holotype is on the edge of a medium-size, chipped cabochon with parallel resin flows with some debris inclusions; the beetle is partly polished away, the antennae especially have been damaged (as well as the maxillae, but these are visible on the paratype). The

prothorax is, however, naturally partly detached from the pterothorax. The antennae are undamaged on the Xia figured specimen, but the distal end of the abdomen has been polished off as well as a metatarsus which, however, are preserved on the paratype (Fig. 6, blue); the Xia specimen is accompanied by a psocid inclusion in a larger and darker piece of amber.

The exposed metatrochantins are a diagnostic archostematan plesiomorphy, but the presence of a prosternal process on the proventrite is a long established probable apomorphy of cupedids sensu stricto (Ponomarenko, 1969): it is well displayed on the Xia specimen.

Bifid spines on the anterior pronotal angles are developed to a varying degree in the Burmese fossil *Mallecupes*, suggesting that at least two species are represented (Fig. 4A–C). They are also seen in extant cupedines s.s. (i.e. non ‘priacmines’), so could be homoplastic, but their development can be consistent throughout a genus (Neboiss, 1984). For the present, we include the holotype, paratype and the Xia specimen with rounded temples and anterior pronotal angles in *Mallecupes qingqingae* gen. et sp. n. The second species will be the subject of a further paper, and we anticipate more finds with the new interest in Burmese amber, which could well provide additional details, such as ventral sutures and terminalia.

## 5. Conclusion

The new Burmese genus, coupled with North American ‘*Paracupes*’, adds to the diversity of non-typical, ‘priacmine’ cupedines in the mid-Upper Cretaceous of Laurasia. Today, the so-called ‘priacmine’ genera are Neotropical-Nearctic, but in the Cretaceous are Laurasian, predating barriers like the expansion of the North Atlantic Ocean and Cretaceous sea level maxima (Batten, 2011, text-fig. 15.3). Their low number and species diversity, however, do not necessarily indicate that they were already relict some hundred million years ago. There are at least eleven other archostematan species present in Burmese amber at time of writing, representing both main groups living today, as well as distinctly fossil forms (personal tally of undescribed material). The current interest in mining and collecting Burmese amber suggests that this number is likely to increase in the near future.

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