Cretaceous Research 109 (2020) 104220

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Short communication

Two new rare wasps (Hymenoptera: Apocrita: Panguidae and Burmusculidae) from mid-Cretaceous amber of Northern Myanmar

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ARTICLE INFO

Article history:
Received 29 April 2019
Received in revised form
8 August 2019
Accepted in revised form 14 August 2019
Available online 22 August 2019

Keywords:
New superfamily
New family
Fossil
Taxonomy

ABSTRACT

A new superfamily Panguoidea superfam. nov. is erected based on one new family, Panguidae fam. nov., with one new genus and species, *Pangu yuangu* gen. et sp. nov. In addition, one new species, *Burmusculus magnus* sp. nov. of Burmusculidae, is also described. Both of these two type specimens are from mid-Cretaceous Myanmar (Burmese) amber. A key to species of Burmusculidae is provided. The new family Panguidae displays a contradictory array of features to further supplement the taxonomic and morphological characters of Apocrita.

(urn:lsid:zoobank.org:pub:42BB16DA-1F8E-40F1-ADA9-0ECF321B8355)

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1. Introduction

Panguidae, the new family based on *Pangu yuangu* gen. et sp. nov. described below, displays a contradictory array of features that provide basis for its new taxonomic attribution. This new family is similar to the undescribed Trigonalidae (?) (NIGP167958) shown in fig. 4 of Zhang et al., 2018b. However, because of the significantly distorted body hindering detailed taxonomic comparison, Zhang et al. did not describe it but tentatively attributed it to Trigonalidae. The well-preserved specimen of *Pangu yuangu* gen. et sp. nov. in amber presents reliable evidence of not-trigonalid affinity, namely, sting-like ovipositor and narrow basal articulation of mid coxa. In contrast, Trigonalidae has ovipositor deeply-reduced and mid coxa with wide basal articulation and elongate mesopostepisternum far overlaying its ventral surface. Narrow mid coxal articulation in *Pangu* gen. nov. makes it impossible to have such elongation of mesopostepisternum, which is an important synapomorphy of Trigonalidae, Megalyridae and Ceraphronoidea s.str. (Rasnitsyn and Zhang, 2010).

Burmusculidae, an extinct family of Pompiloidea, was erected in 2018 by Zhang and Rasnitsyn, based on three well-preserved Myanmar amber species represented by one female and two male holotype specimens (Zhang et al., 2018a). To date, Pompiloidea includes only two families: Pompilidae Latreille, 1804 and Burmusculidae Zhang and Rasnitsyn, 2018. Pompilidae (spider wasps) are a cosmopolitan but predominantly tropical family, containing more than 4000 species in three subfamilies: Ceropalinae, Pepsinae and Pompilinae. The oldest pompilids are from the Eocene as previously proposed (Rodriguez et al., 2015; Waichert et al., 2015). But Burmusculidae from the Cretaceous of Eurasia preserved several characters that can easily distinguish the group from Pompilidae (e.g., the mesopleuron lacking an oblique suture, and the hind wing with cu-a) (Zhang et al., 2018a). Therefore, Burmusculidae as an independent family not only supplements the taxonomic characters of Pompiloidea, but also moves its fossil record back to the mid-Cretaceous.

Herein we describe two new rare wasps: *Burmusculus magnus* sp. nov. of Burmusculidae, and *Pangu yuangu* gen. et sp. nov. of Panguidae fam. nov., based on two well-preserved specimens from the mid-Cretaceous Myanmar (Burmese) amber. The Myanmar amber deposit is located in the Kachin State (Hukawng Valley) of Northern Myanmar, approximately 100 km southwest of the Village of Tanai (Chen et al., 2018; Li et al., 2018b; Lin et al., 2019). An

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https://doi.org/10.1016/j.cretres.2019.104220
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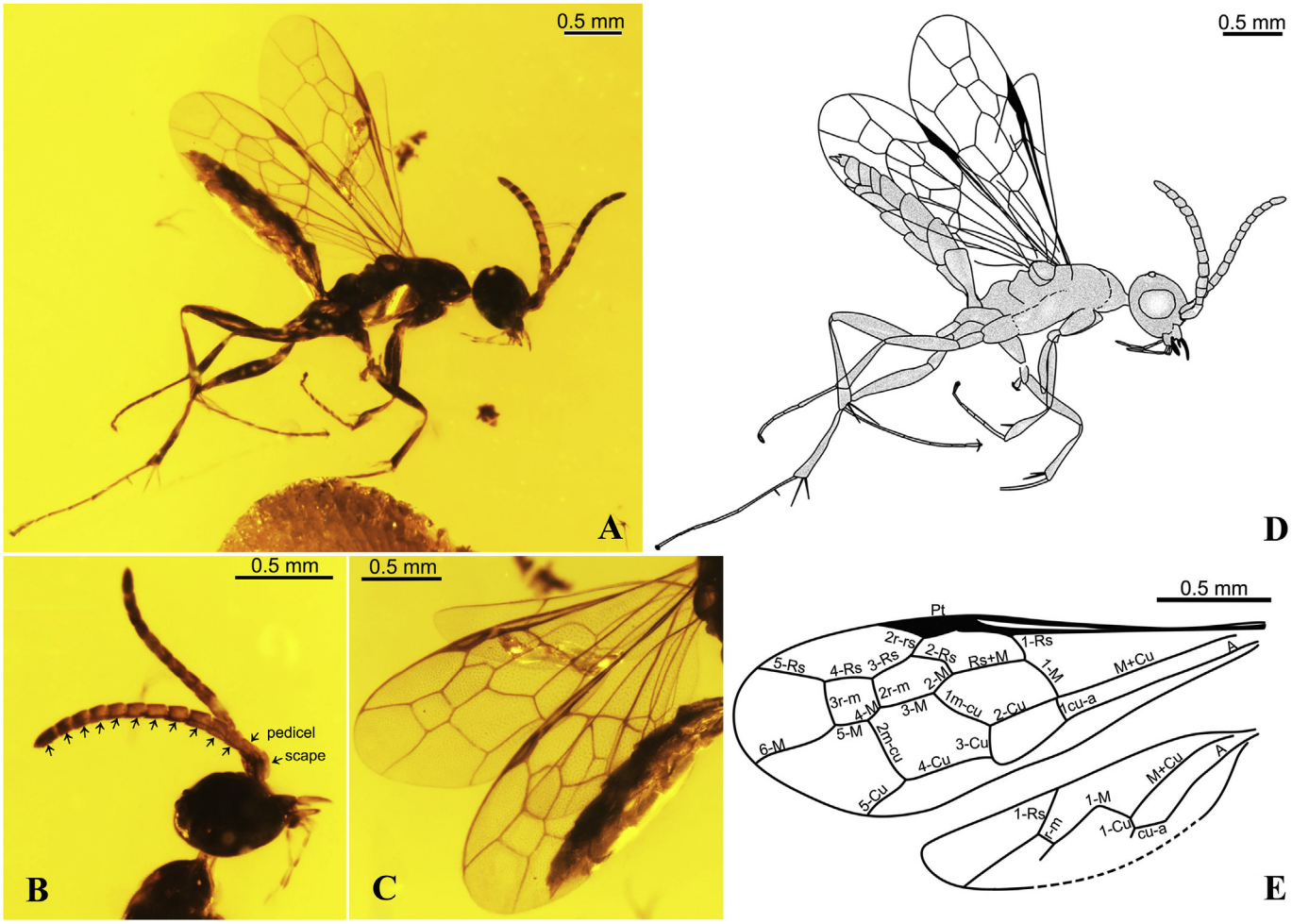


Fig. 1. *Burmusculus magnus* sp. nov. Holotype CNU-HYM-MA-2018105. Photographs (A) habitus, (B) head, (C) wings. Line drawings (D) habitus, (E) wings. Scale bars = 0.5 mm.

earliest Cenomanian (98.79 ± 0.62 Ma) age has been estimated for the Myanmar amber (burmite) (Cruickshank and Ko, 2003; Shi et al., 2012). Recently, a lot of well-preserved hymenopteran fossils have been reported from Myanmar (Burmese) amber (e.g., Evanioidea (Li et al., 2015, 2018a), Pelecinidae (Guo et al., 2016), Stephanioidea (Li et al., 2017a), Ichneumonidae (Li et al., 2017b) and Myanmarinidae (Li et al., 2018; Zhang et al., 2018)).

2. Material and methods

The type fossil specimens described herein are housed in the Key Lab of Insect Evolution and Environmental Changes, in the College of Life Sciences, Capital Normal University in Beijing, China (CNUB; Dong Ren, Curator). The specimens were examined and photographed under a Nikon SMZ 25 dissecting microscope with an attached Nikon DS-Ri2 digital camera system. The figures were drawn using CorelDraw 12.0 and Adobe Photoshop CS5. The venational terminology used here is based on Zhang et al., 2018b, 2018a, with addition of abscissa numbers in front of vein names.

3. Systematic paleontology

Order Hymenoptera Linnaeus, 1758
Suborder Apocrita Gerstaecker, 1867
Superfamily Pompiloidea Latreille, 1804
Family Burmusculidae Zhang and Rasnitsyn, 2018
Genus *Burmusculus* Zhang and Rasnitsyn, 2018
Type species *Burmusculus nuwae* Zhang and Rasnitsyn, 2018

Burmusculus magnus Li, Rasnitsyn, Shih & Ren sp. nov.
(Fig. 1).
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Etymology. The specific name is derived from the Latin word 'magnus' meaning big, referring to the forewing with cells 2rm and 3rm broad and 2rm much bigger than 3rm.
Diagnosis. Antenna 13-segmented with stout flagellomeres. Forewing with cell 2rm and 3rm broad, 2rm distinctly longer than 3rm; 2-Rs longer than 1-Rs and strongly bent; 1cu-a slightly postfurcal. Hind wing with 1-Cu much shorter than cu-a.
Type material. Holotype, Male, CNU-HYM-MA-2018105, specimen well-preserved, but head and mesosoma much darker than rest of body, which increases the difficulty of observation.
Locality and horizon. Hukawng Valley, Kachin State, northern Myanmar; mid-Cretaceous (lower Cenomanian).
Description. Small body size, 3.53 mm long, dark brown to black. Head rounded, 0.52 mm long × 0.51 mm high in lateral view. Antenna 13-segmented, with scape distinctly longer than pedicel; flagellum long, but with every segment stout and nearly equal in width from base to apex. Mandible thin, bidentate, labrum long and narrow, tongue-like; maxillary palp long, with 4 segments elongated.

Mesosoma 1.25 mm long and 0.53 mm high in lateral view. Legs elongated, with hind legs longer and wider than fore- and mid-legs, all legs almost straight; tibial spurs 1:2:2; tarsus pentamerous, with first segment distinctly longer than others. Metasoma 1.76 mm long, formed of eight rounded discernible segments, with first metasomal segment gradually broadening posteriad and distinctly narrowed at base, second and third metasomal segments distinctly broader than first, remaining segments gradually shorter and narrower than former. Gonostylus visible in metasomal apex.

Wings hyaline with abundant microtrichia, forewing 2.47 mm long, 0.83 mm wide (greatest width). Pterostigma long and narrow, 0.4 mm long and 0.1 mm wide; 1-M (0.23 mm) 1.6 times as long as 1-Rs (0.14 mm); 1-Rs inclined toward wing base, meeting R far from base of pterostigma; 2r-rs short and straight, forming acute angle with 2-Rs, meeting pterostigma slightly beyond its midlength; 2-Rs (0.22 mm) much longer than 1-Rs and 2r-rs, with distinct bend one-third of way to 2-Rs apex; both 2r-m and 3r-m nearly straight, and 3r-m (0.20 mm) longer than 2r-m (0.13 mm); cells bordered by 2r-m and 3r-m broad, and 2r-m distinctly longer than 3r-m; 2-M, 3-M and 1m-cu forming Y-shaped junction, 3-M (0.26 mm) 2.2 times as long as 2-M (0.12 mm); 1cu-a (0.10 mm) slightly postfurcal, reaching A; A complete and extending to wing base. Hind wing 1.66 mm long, 0.50 mm greatest width, with 1-Rs distinctly longer than r-m, 1-M strongly bent, 1-Cu (0.05 mm) much shorter than cu-a (0.14 mm), A complete and extended to wing base.

Key to all species of *Burmusculus* Zhang and Rasnitsyn, 2018

1. Forewing with 1cu-a antefurcal……..
   ……. *B. nuwae* Zhang and Rasnitsyn, 2018
   Forewing with 1cu-a intersititial or postfurcal……..2
2. Forewing with 1cu-a interstitial…….
   ……*B. fuxii* Zhang and Rasnitsyn, 2018
   Forewing with 1cu-a postfurcal……3
3. Forewing with 2-Rs short and straight, cell 2rm shorter than 3rm, 2r-rs forming right angle with 2- Rs……
   ……. *B. shennongii* Zhang and Rasnitsyn, 2018
   Forewing with 2-Rs long and strongly bent, cell 2rm longer than 3rm, 2r-rs forming acute angle with 2-Rs……
   ……*B. magnus* Li, Rasnitsyn, Shih & Ren sp. nov.

Superfamily Panguoidea Li, Rasnitsyn, Shih & Ren **superfam. nov.**
Type family Panguidae Li, Rasnitsyn, Shih & Ren **fam. nov.**

Diagnosis. Antenna oligomerous (12-segments where known). Mandibles symmetrical. Pronotum long centrally, reaching tegulae, with hind margin weakly arcuate, not fixed onto mesonotum. Mesonotum with notauli distinct, medial longitudinal suture or line absent. Mesopleuron with no longitudinal or oblique suture. Metapostnotum wide ribbon-like, propodeum moderately short. Mesococoxal articulation to mesosoma narrow (like in Pompilidae). Wings with complete venation (standard of Aculeata) except that hind wing with M lacking free end and streamlined with r-m, and A

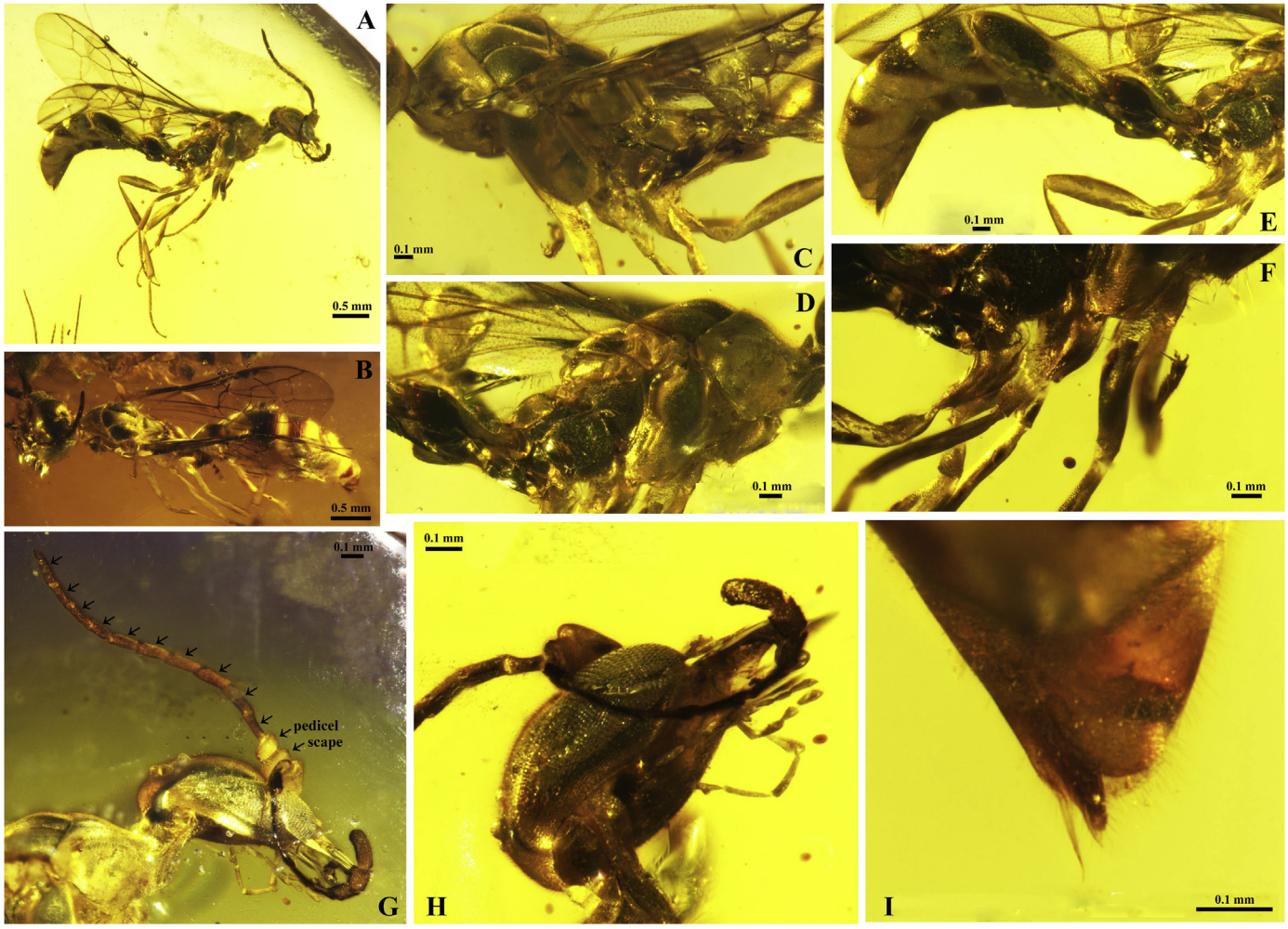


Fig. 2. *Pangu yuangu* gen. et sp. nov. Holotype CNU-HYM-MA-2018106. Photographs (A, B) habitus, (C, D) mesosoma, (E) metasoma, (F) coxae, (G, H) head, (I) apex of metasoma. Scale bars = 0.5 mm (A–B), 0.1 mm (C–I).

equally lacking free end. Hind wing with no jugal lobe and with no margin incision delimiting anal lobe. Metasoma with external 7 terga and 6 sterna and with ovipositor internalized except the very apices of sheaths and sting.

Families included. Type only

Remarks. The new family described below displays a contradictory array of features that makes its taxonomic attribution far from straightforward. A combination of internalized, apparently sting-like ovipositor, comparatively complete wing venation, mesonotum with no traces of median longitudinal suture and simple 12-segmented antenna suggest Aculeata. However, hind wing with free end of M lost and with junction of M and r-m smooth is not known in Aculeata and characteristic of only Trigonalidae and Megalyridae (particularly of Cleistogastrinae that preserved these veins). The fossil similar to the one described below but unfortunately not described yet (Zhang et al., 2018b, fig. 4) has been tentatively attributes to Trigonalidae there. The attribution was problematic because of poor preservation state obscuring many important characters, as well as elongate symmetrical mandibles and 12-segmented antenna. The present fossil with well-preservation presents reliable evidence of not-trigonalid affinities of *Pangu* gen. nov., namely, sting-like ovipositor and narrow basal articulation of mid coxa. In contrast, Trigonalidae have ovipositor deeply reduced, mid coxa with wide basal articulation and elongate mesopostepisternum far overlaying its ventral surface. Narrow midcoxal articulation in *Pangu* gen. nov. makes it impossible to have such elongation of mesopostepisternum, which is an important synapomorphy of Trigonalidae, Megalyridae and Cerapheronoidea s.str. (cf. Rasnitsyn and Zhang, 2010, for details).

The above characters leave us with Aculeata as a harbor for the new family. However, it cannot be accommodated to any existing superfamilies for the following reasons. The female amber specimen has 7 external metasomal terga like in Chrysidoidea whilst in the remaining aculeates (termed Aculeata s.str.) have the 7th tergum internalized and deeply transformed. Furthermore, the characters available in fossil Chrysidoidea are synapomorphic in the loss of 3r-m and 2m-cu cross-veins, and to include Panguidae there will result in the loss of its only synapomorphy. That is why we decide to create a new superfamily Panguoidea superfam. nov. to attribute the new family of Panguidae fam. nov.

Family **Panguidae** Li, Rasnitsyn, Shih & Ren fam. nov.
Type genus *Pangu* Li, Rasnitsyn, Shih & Ren gen. nov.

Diagnosis. As for the superfamily because of monotypy.
Genera included. Type only.

Pangu Li, Rasnitsyn, Shih & Ren gen. nov.

Etymology. The generic name is 'pangu', a person who created the universe in Chinese mythology.
Type species. Pangu yuangu Li, Rasnitsyn, Shih & Ren sp. nov.
Diagnosis. As for the family because of monotypy.
Species included. Type species and undescribed specimen figured and discussed by Zhang et al., 2018b: p. 741–742, fig. 4), both from the mid-Cretaceous Burmese amber.

Pangu yuangu Li, Rasnitsyn, Shih & Ren sp. nov.
(Figs. 2, 3).
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Etymology. The specific name is Chinese words 'yuangu' meaning ancient or earliest time.

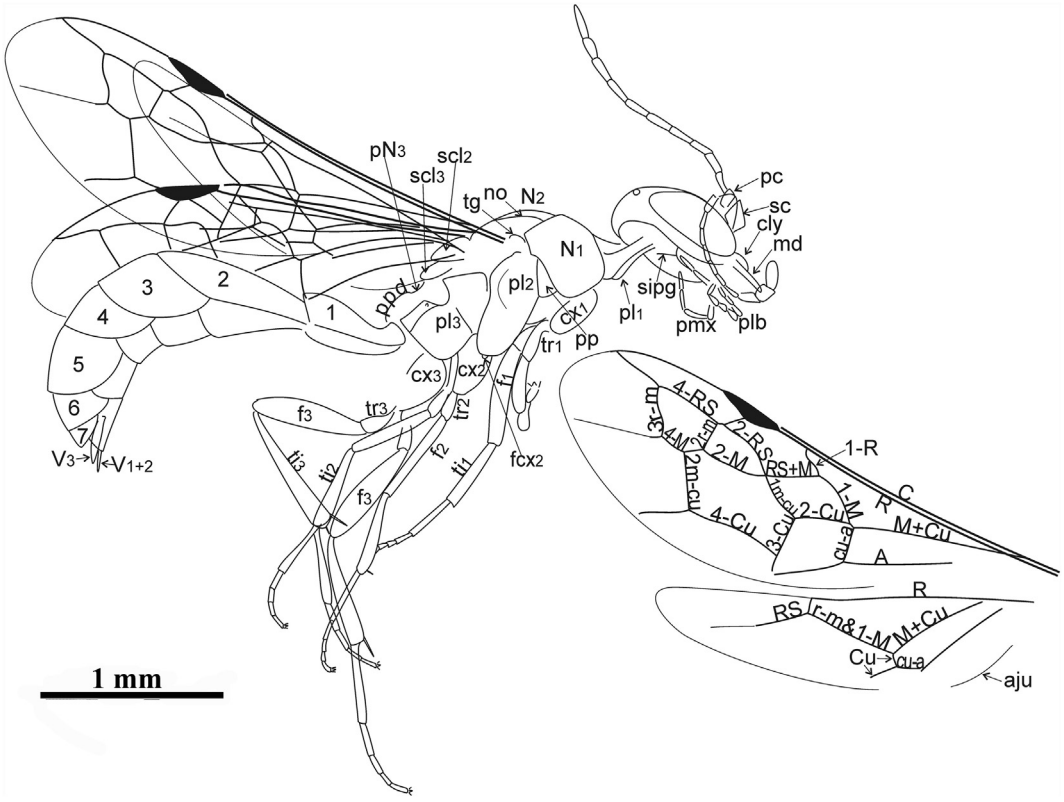


Fig. 3. *Pangu yuangu* gen. et sp. nov. Holotype CNU-HYM-MA-2018106. Line drawings of general appearance and wing venation. cly, clypeus; cx_1, cx_2, cx_3, pro-, meso-, and metacoxa; f_1, f_2, f_3, pro-, meso- and metafemur; fcx_2, proximal articulatory foramen of mesocoxa; md, mandible; no, notaulus; N_1, N_2, pro- and mesonotum; pc, pedicel; plb, labial palp; pmx, maxillary palp; pl_1, pl_2, pl_3, pro-, meso- and metapleuron; pN_3, metapostnotum; ppd, propodeum; sc, scape; scl_2, scl_3, meso- and metascutellum; tg, tegula; ti_1, ti_2, ti_3, pro-, meso- and metatibia; tr_1, tr_2, tr_3, pro-, meso- and metatrochanter; V_{1+2}, ovipositor (sting); V_3, ovipositor sheath; 1–7, metasomal terga. Scale bars = 1 mm.

Diagnosis. Unlike the above-mentioned undescribed specimen, body elongate, scape and pedicel thick (both wider than half eye width), forewing with 4-Rs longer than 2-M, metasomal segments 1 and especially 2 longer than high.

Type material. Holotype, Female, CNU-HYM-MA-2018106, well-preserved.

Locality and horizon. Hukawng Village, Kachin State, Northern Myanmar; mid-Cretaceous (lower Cenomanian).

Description. Small body size, 4.43 mm long. Head and flagellum dark, scape, pedicel and palps pale. Mesosoma dark, pronotum paler. Legs including coxae infuscate. Pterostigma dark. Metasoma with terga 1 and 2 dark, pale basally (widely so in tergum 2), terga 3–7 pale, 3–5 ones with dark subbasal transverse spot narrowing lateral, 6 infuscate apical, sterna pale, 3–5 ones dark basally. Ovipositor sheath dark.

Head ovate, 0.67 mm long × 0.29 mm height in lateral view. Eye elongate ovate, near twice as long as wide, reaching mandibular base or nearly so, almost reaching hind head margin in side view. Ocelli not enlarged, in acute triangle, lateral ones more than twice as distant from eye as from each other. Temples narrow, ribbon-like. Clypeus moderately emarginated and thick medio-ventrally. Occipital carina narrower lamelliform medio-dorsally, its ventral (anterior) branches subparallel and very wide apart, leaving postgenal bridge wide and moderately long and mouth cavity comparatively short (but both are not as short as those in the undescribed species where these structures are particularly well preserved). Structure of mandible not known. Maxillary palp with 5 visible elongate segments, labial one with 4 less elongate segments growing wider apical, with 4th widely rounded apical (presence of a short basal segment cannot be excluded for either palp). Antenna 12-segmented, with scape and pedicel much inflated (each wider than half eye width), scape slightly elongate, with obliquely truncate apex, pedicel strictly transverse. Flagellar segments of subequal length, 1st to a lesser extent narrow, following of standard width, some 2.5 times as long as wide except apical one longer and subacute (flagellar segments are flattened diagenetically and may look different depending on aspect, so the above description is highly tentative).

Mesosoma 1.38 mm long and 0.66 mm height in lateral view. Pronotum plate-like, 0.35 mm long × 0.42 mm height in lateral view, not differentiated into dorsal and declivous parts, with hind margin gently emarginated, posterolateral lobes reaching tegula, slightly angular both above and below it, lower lobe widely rounded. Propleura moderately elongate, otherwise insufficiently visible. Mesonotum with notauli well impressed, diverging anterior, well distant and almost reaching transverse line behind, adlateral lines thin, long, medial longitudinal line or sutura absent, prescutellar depression rather long, scutellum narrow, convex. Mesopleuron 0.55 mm long and 0.31 mm height, with no suture or line visible except distinct triangular prepectus adjacent to posterior pronotal margin. Metanotum rather long below and behind mesoscutellum in side view (unfortunately not clearly visible from above), metapostnotum rather long trough-like. Propodeum short, largely irregular reticulate-rugose. Legs of medium length (hind femur, tibia and tarsus combined 0.75× as long as forewing), thin

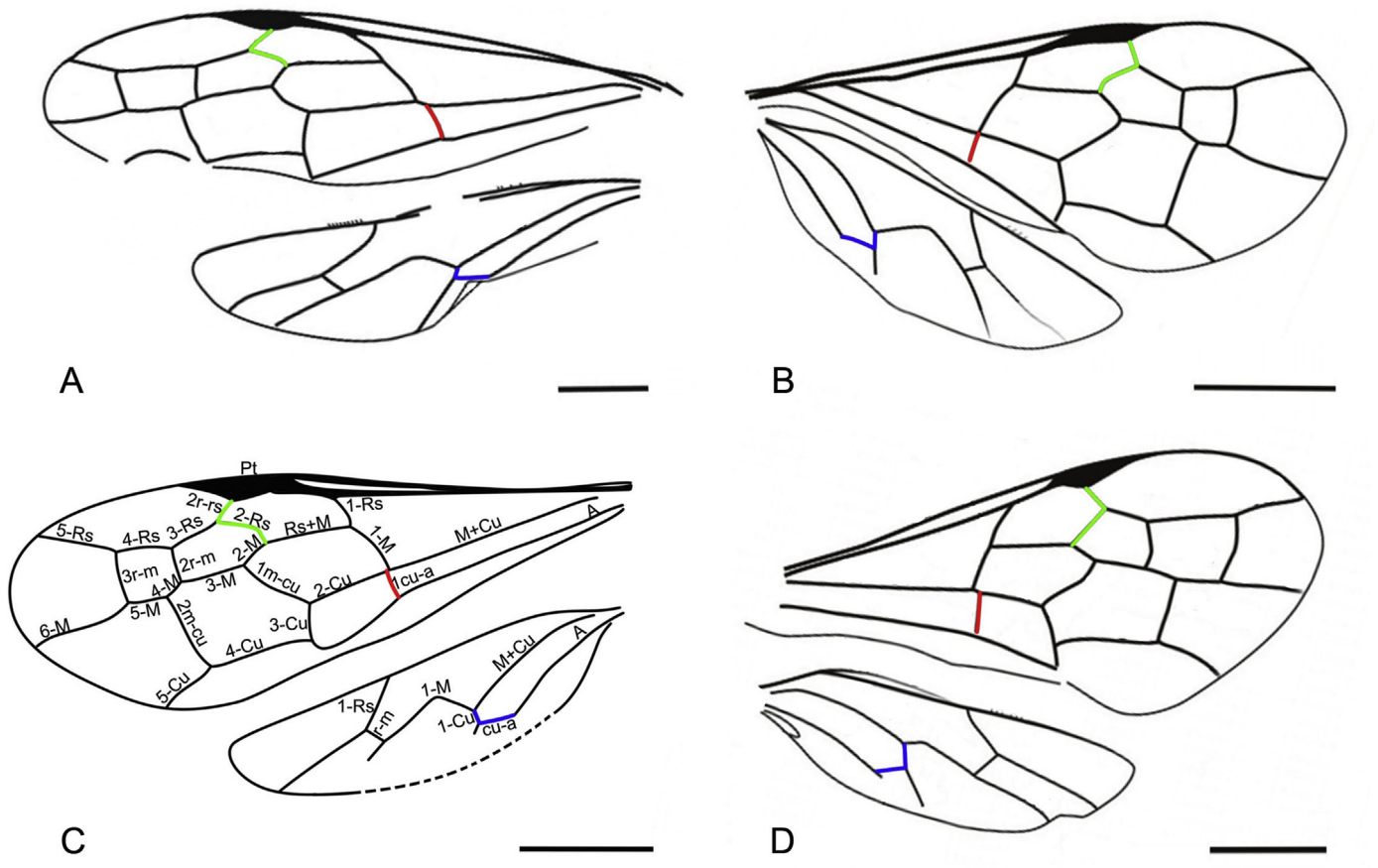


Fig. 4. Line drawings of wings of four species in Burmusculidae. (A) *Burmusculus nuwae*, (B) *Burmusculus fuxii*, (C) *Burmusculus magnus* sp. nov., (D) *Burmusculus shennongii*. Scale bars = 1 mm.

(hind femur 4.3× as long as wide), with coxae big, mid one narrow at basal articulation, hind basitarsus about as long as remaining tarsomeres combined, 4th one elongate, claws simple, arolium small. Mid and hind tibia with 2 spurs each.

Forewing 2.71 mm long, 0.89 mm greatest width, with costal space narrow, distinct throughout. Pterostigma wide, with 2r-rs behind its midlength. 1-Rs (0.18 mm) shorter than 1-M (0.28 mm), sinuate, 1-M somewhat bent, meeting 1-RS at angle. 2r-rs (0.10 mm) straight, oblique, slightly longer than pterostigmal width. Cells 2rm and 1mcu contacting by a point (no 2-Rs+M present). 2-Rs (0.34 mm) smoothly bent, with no 1r-rs rudiment. 2r-m (0.15 mm) subvertical, 3r-m (0.27 mm) slightly sinuate, reclival and much longer than 2r-m. 3-Rs very short, 4-Rs longer than 5-Rs and 2-M. Cell 3r narrow, with acute apex. 1m-cu subequal and subparallel to 1-M, 2m-cu entering cell 3rm before its midlength. M and Cu with long free apices. 1cu-a (0.21 mm) antefurcal. Cell 2cua slightly longer and wider than 1mcu. Hind wing 1.93 mm long, 0.47 mm greatest width, with undifferentiated anojugal lobe delimited with weak notch of wing margin. 1-RS (0.08 mm) slightly proclival, subequal to 1-Cu, r-m & 1-M very long (0.55 mm) and almost straight, cu-a (0.17 mm) reclival and much longer than 1-Cu. Free apex long in RS, short in Cu and absent in M and A.

Metasoma 2.45 mm long, elongate, highest slightly behind midlength, first and second segments about 1.5 times as long as high, widening backward, following higher than long. Visible length of terga 1 through 7 are 0.55, 0.78, 0.45, 0.33, 0.35, 0.25 and 0.06 mm, respectively. Hypopygium incised apically. Ovipositor sheath tapering toward narrow apex.

4. Concluding remarks

Panguidae, as a new family described here, shares some characters of Aculeata and Trigonalidae and Megalyridae. As aforementioned in detailed remarks, we are sure that Panguidae not only enriches the hymenopteran fauna of mid-Cretaceous Myanmar (Burmese) amber, but also sheds light to a new way for studying the relationships among groups of Apocrita pending more new amber specimens to be found.

Furthermore, the discovery of *Burmusculus magnus* sp. nov. in Burmusculidae not only supplements the taxonomic and morphological characters of this family but also indicates several interspecific diagnostic differences. The wings of *Burmusculus magnus* sp. nov. as well as the other three previously reported species of Burmusculidae are compared in Fig. 4:

(1) Three states exist for forewing 1cu-a position relative to 1-M exist: 1cu-a antefurcal (*B. nuwae*), interstitial (*B. fuxii*), and postfurcal (*B. shennongii* and *B. magnus*).
(2) Three states exist for forewings with respect to 2-Rs and 2r-rs: 2-Rs bent and forming acute angle with 2r-rs (*B. nuwae, B. magnus*), 2-Rs bent and forming right angle with 2r-rs (*B. fuxii*), and 2-Rs straight and forming right angle with 2r-rs (*B. shennongii*).
(3) Two states exist for hind wings with respect to 1-Cu and cu-a: 1-Cu distinctly shorter than cu-a (*B. magnus, B. fuxii, B. nuwae*), or 1-Cu as long as cu-a (*B. shennongii*).

Acknowledgements

We appreciate valuable comments and constructive suggestion on our manuscript from the anonymous reviewers. This research is supported by the Scientific Research Start-up Funds for Openly Recruited Doctors (2017RCZX-27), the National Natural Science Foundation of China (No. 31730087, 41688103), Program for Changjiang Scholars and Innovative Research Team in University (IRT17R75), and Project of High-level Teachers in Beijing Municipal Universities (IDHT20180518).

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