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Short communication

A new species of the Meropeidae (Insecta: Mecoptera) from mid-Cretaceous Myanmar amber

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ABSTRACT

The Meropeidae (earwigflies) is a small family of Mecoptera with only three extant and three fossil species. In this paper, a new species of Meropeidae *Burmomerope bashkuevi* sp. nov., is described based on an exceptionally well-preserved specimen from mid-Cretaceous Myanmar amber. It can be distinguished from other species mainly by most simplified wing venation, four veins both in radial and medial sectors, massive antenna with wide flagellomeres and very thin and elongated last segments of female abdomen. Our new finding not only represents the fourth species of Mesozoic Meropeidae, but also the third female record of extinct earwigflies, which augments the diversity of Mesozoic earwigflies.

1. Introduction

The mecopteran family Meropeidae (common name: earwigflies) is one of the best-interesting relict groups in Insecta (Grimaldi and Engel, 2013). The most unique feature of this family is the large, pincer-like male genitalia, which resembles the cerci of Dermaptera. The adults are nocturnal, living on the ground, and are capable of stridulation (Sanborne, 1982). Most specimens generally are collected by Malaise (Dunford et al., 2007; Barrows and Flint, 2009) and pitfall traps (Abbott et al., 2007), because of their behavior. Their immature stages are still unknown (Johnson, 1995). Phylogenetic relationships among Meropeidae and other mecopteran related families have been reported. Penny (1975) thought that meropeids were sister group of all other families of Mecoptera. Others suggested that they have close relationship with Eomeropidae, as a different suborder—Protomecoptera (Kaltenbach, 1978) or a sister taxon to Panorpomorpha + Eomeropidae (Grimaldi and Engel, 2005). Ren et al. (2009) suggested that Eomeropidae, Meropeidae and Thaumatomeropidae formed a monophyletic group or together with some families of Panorpomorpha. To understand the phylogenetic relationships within this family were given by Soszyńska-Maj et al. (2017).

Hitherto, the Meropeidae comprising only three living species from southwestern Australia, eastern North America and southeastern Brazil (Killington, 1933; Newman, 1838; Byers, 1973; Dunford et al., 2007; Machado et al., 2013). And only three fossil species have been reported: *Boreomerope antiqua* Novokshonov, 1995 from the Middle Jurassic of Siberia, *Burmomerope eureka* Grimaldi and Engel (2013) (male) and *B. clara* Zhao and Wang (2016) (female) from mid-Cretaceous Myanmar amber (Novokshonov, 1995; Grimaldi and Engel, 2013; Zhao et al., 2016). In addition, Soszyńska-Maj et al. (2017) reported the first male specimen of *B. clara* and assigned the genus *Burmomerope* to a new subfamily Burmomeropeinae Soszyńska-Maj et al., 2017

In this paper, we describe a new species *Burmomerope bashkuevi* sp. nov. from the mid-Cretaceous Myanmar amber. The new finding

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increase our knowledge about diversity of earwigflies in Myanmar amber.

2. Material and methods

2.1. Examined specimen and terminology

The specimen described herein is housed in Nanjing Institute of Geology and Paleontology, Chinese Academy of Science. The insect is completely preserved in an oblong-ovoid piece of light yellow amber from a mid-Cretaceous amber mine located near Noije Bum Village, Tanaing Town, Myanmar (Kania et al., 2015). The mine is rich in flora and fauna, and considered as one of the most diverse amber biota (Ross et al., 2010; Shi et al., 2012; Kania et al., 2015; Yu et al., 2019). The age given by U–Pb dating of zircons from the volcanoclastic matrix of the amber is earliest Cenomanian (98.8 ± 0.6 Ma) (Shi et al., 2012; Ross, 2015). The ammonite *Puzosia* (*Bhimaites*) also supports this age (Yu et al., 2019).

In order to reduce the deformation caused by the differential refractivity, we sandwiched the specimen between two coverslips and filled the space with glycerol. Photographs were taken using a Zeiss Stereo Discovery V16 microscope system. In most instances, incident and transmitted light were used simultaneously. All images are digitally stacked photomicrographic composites of approximately 30 individual focal planes obtained using the free software Helicon. The figures were prepared with CorelDraw X7. The wing venational nomenclature is based on Willmann (1989).

2.2. Measurements and abbreviations

Measurements were finished using a Zeiss Stereo Discovery V16 microscope system. The vein abbreviations are as follows: Sc, subcosta; R, radius; Rs, radial sector; M, media; Cu, cubitus; A, anal vein.

3. Systematic paleontology

Order Mecoptera Packard, 1886
Family Meropeidae Handlirsch, 1906

Subfamily Burmomeropeinae Soszyńska-Maj et al., 2017
Type genus *Burmomerope* Grimaldi and Engel, 2013

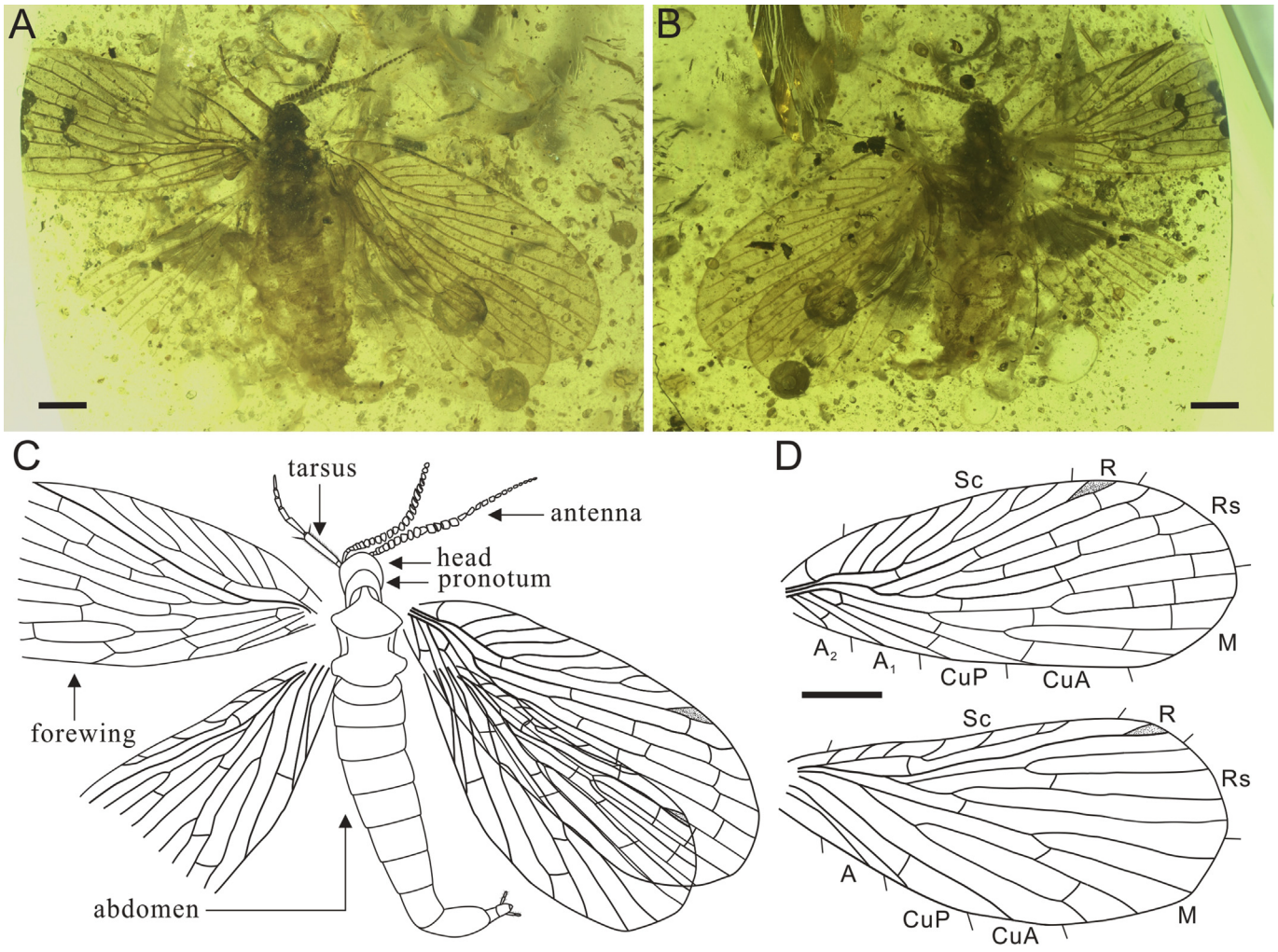

Fig. 1. *Burmomerope bashkuevi* sp. nov., NIGP173192, female. A, microphotograph in dorsal view. B, microphotograph in ventral view. C, line drawing of the body. D, line drawings of wing, forewing (above) and hindwing (below). Scale bars, 2 mm.

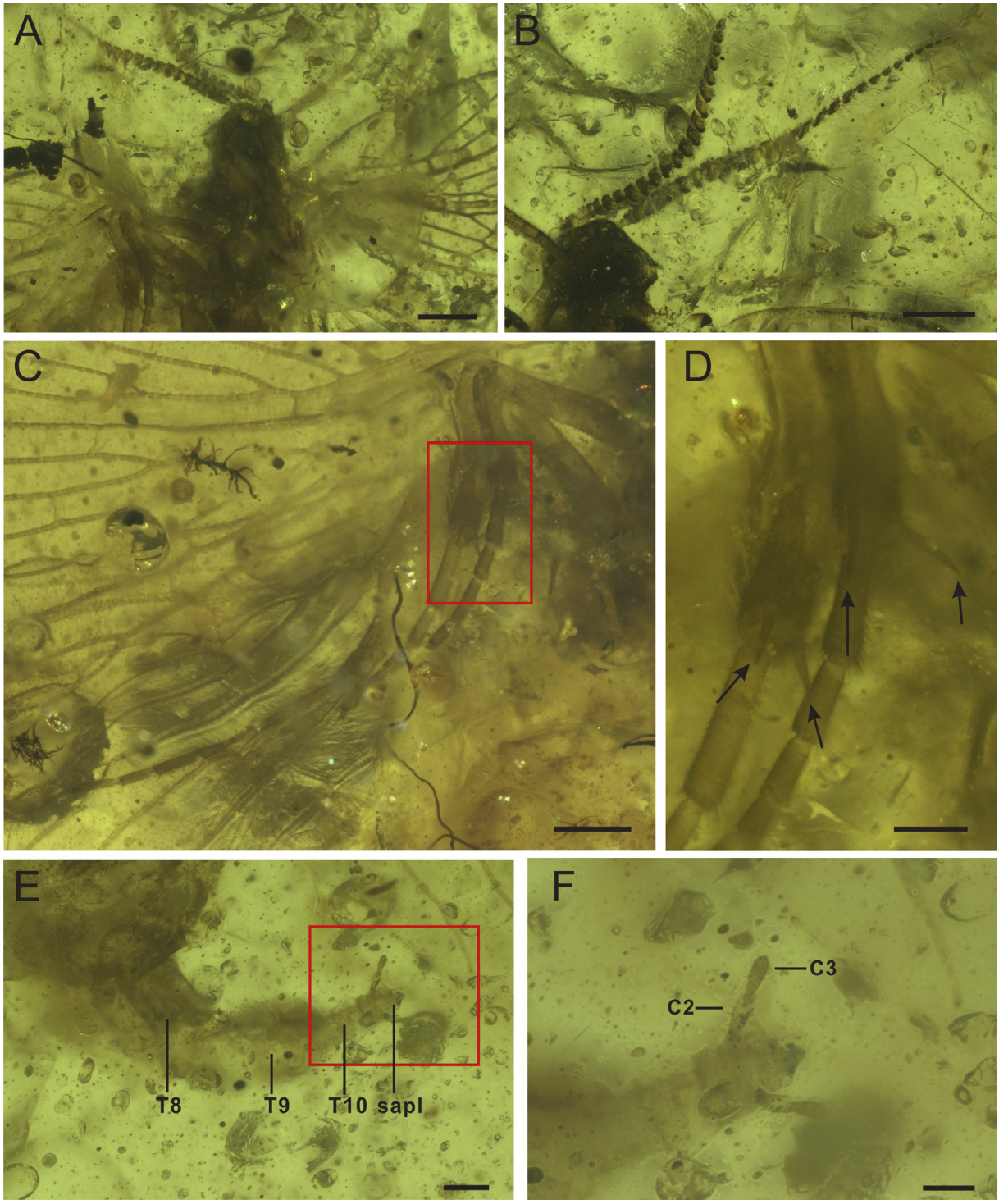

Fig. 2. Microphotographs of the holotype of *Burmomerope bashkuevi* sp. nov., NIGP173192. A, head. B, antennae. C, left legs. D, tibia with long apical spurs, enlarged from C. E, female genital segments. F, female postgenital segments, enlarged from E. Scale bars, 1 mm in A and B, 0.5 mm in C, 0.2 mm in E, 0.1 mm in D and F.

Type species *Burmomerope eureka* Grimaldi and Engel (2013)

Included species *Burmomerope eureka* Grimaldi and Engel (2013); *Burmomerope clara* Zhao and Wang (2016).

Burmomerope bashkuevi sp. nov.
(urn:lsid:zoobank.org:act:EB45CD5C-6275-43B5–B8B6–13C450A298ED).

(Figs. 1–2).

Diagnosis. Most simplified wing venation, four veins both in radial and medial sectors, Rs_3 and Rs_4 forking at one third of wing length, a little proximal to the forking of Rs_1 and Rs_2, CuA simple; massive antenna with wide flagellomeres and very thin and elongated last segments of female abdomen.

Etymology. The specific name is in honour of Dr. Alexei Bashkuev for his contribution to the study of fossil scorpionflies.

Holotype. NIGP173192, a female with partially preserved body and wings, housed in a permanent curatorial repository at Nanjing Institute of Geology and Paleontology, Chinese Academy of Science.

Locality and horizon. Myanmar amber, from deposits near the Tanai Village in the Hukawng Valley of northern Myanmar, lowermost Cenomanian, Upper Cretaceous (98.8 ± 0.6 Ma).

Description. Body length 6.71 mm; thorax length 2.15 mm, approximately half of abdomen length; abdomen length 4.56 mm. Amber slightly damaged, with some bubbles inside.

Head (Fig. 2A). Length 0.73 mm, width 0.59 mm, width ca. 0.43 × greatest width of thorax. Compound eye large and round, ocelli invisible, surface conforming to contour of head capsule. The outline of the head is clear; Rostrum present, well-developed, length 0.93 mm, ca. 1.57 × that of head capsule, width 0.27 mm; Antennal length 2.77 mm, widest in the middle, scape and pedicel invisible, flagellum with 27 flagellomeres, length of middle flagellum equal to width, basal flagellomeres columned, apex flagellomeres bead-shaped (Fig. 2B); each flagellomere with short, fine setae, largest flagellomere length 0.11 mm, smallest flagellomere length 0.05 mm.

Thorax. pronotum cylindrical, with slight median ridge, longer than head capsule, width 0.6 mm. Mesothorax with broad, apically pointed projections, length slightly longer than head capsule, width approximately equal to that of head capsule. Meso- and metathoraces well separated.

Legs. Very slender (Fig. 2C); hind legs distinctly longer than fore- and mid-legs. Length: profemur 0.97 mm, protibia 0.65 mm, protarsus 1.01 mm; mesofemur 1.25 mm, mesotibia 0.99 mm, mesotarsus 1.20 mm; metafemur 1.69 mm, metatibia 1.48 mm, metatarsus 1.68 mm; tibia of each leg with long apical spur (Fig. 2D), apical spur length approximately 0.1 × tibia's. Basitarsomeres longer than other tarsomeres.

Wings (Fig. 1D). Slightly longer than whole length of body, larger than the body, pterostigma distinct; base of wings slightly narrow, apices broadly rounded. Forewing length 6.34 mm, width 2.60 mm; length/width ratio 2.43: 1. Without sparse, short, fine setulae on longitudinal veins, with rich venation. Sc no longer than middle of the wing, but straight. Forewing with 22 terminal veins, 21 crossveins. Sc 0.61 × wing length, with 7 terminal branches, base of R very strong and R nearly along 5.11 mm length. R slightly curve, base thickest, with two apical branch. Rs branching from R in basal 1/10th of length of R, Rs with 3 deep forks (4 terminal branches), Rs_3 and Rs_4 forking at 1/3rd of wing length, a little earlier than the fork of Rs_1 and Rs_2; M with 3 deep forks (4 terminal branches), M_3 and M_4 forking at the middle of wing; CuA and CuP without branches/forks; CuA and CuP single, 3.71 mm long and 2.21 mm long, respectively; A_1 length 0.67 mm, A_2 length 1.33 mm, very short. Hind wing length 5.78 mm, width 2.50 mm; Sc with 7 terminal branches; R simple and straight; Rs and M with 4 terminal branches; CuA and CuP without branches/forks, A simple.

Female abdomen. Slender (Fig. 2E), length 4.89 mm, with 11 visible segments, slightly curved, genitalia well preserved, segment IV (the most thickest segment) 0.65 mm long, width 1.63 mm; segment X length 0.27 mm, segment XI 0.24 mm; first segment of cerci shielded by subanal plate, segments II and III of cerci clearly visible, large size, segment II length 0.11 mm, slender and cylindrical; segment III length 0.10 mm, tapering to rounded apex, with sparse setae (Fig. 2F). Segments VIII-IX much thinner and elongated than previous ones. Male unknown.

4. Discussion

Since the type species of *Burmomerope* Grimaldi and Engel, 2013 was reported from Myanmar amber, totally six specimens of this genus have been found from the same locality one after another (Grimaldi and Engel, 2013; Xia et al., 2015; Zhao et al., 2016; Soszyńska-Maj et al., 2017). Based on these materials, Soszyńska-Maj et al. (2017) assigned all specimens to the new subfamily Boreomeropeinae. Our new species, *B. bashkuevi* sp. nov., represents the seventh specimen and the third species of this genus, which also shows the diversity of earwigflies. New species can be assigned ot *Burmomerope* by these features: long rostrum, large pronotum, and slender legs; Sc with seven branches, many fewer crossveins in R and M fields veins, CuA and CuP single (Grimaldi and Engel, 2013; Zhao et al., 2016; Soszyńska-Maj et al., 2017).

Burmomerope bashkuevi sp. nov. can be distinguished from other species by massive basal flagellomeres, bead-shaped apex flagellomeres and slender abdomen; presence of four longitudinal veins in Rs and M (Grimaldi and Engel, 2013; Zhao et al., 2016; Soszyńska-Maj et al., 2017). *Burmomerope bashkuevi* sp. nov. bearing pterostigma in the end of R, which is different from the sole male specimen of the type species *B. eureka*, but similar to the female specimen of *B. clara*. This character does not have gender differences, due to the same difference applies to female in *B. calra* (Zhao et al., 2016; Soszyńska-Maj et al., 2017). More differences from *B. clara*. is that setae on the anterior margin absent and CuA branch single in *B. bashkuevi* (Zhao et al., 2016).

According to the result of phylogenetic analysis by Soszyńska-Maj et al. (2017), the divergent of extant and extinct Meropeidae from common ancestor was before the Middle Jurassic. Mordern Meropeidae are restricted to temperate areas, but the fossils from Myanmar amber indicate that they can be found in humid tropical forest during the mid Mesozoic (*Fig. 5* in Soszyńska-Maj et al., 2017). It is hypothesized that like Mesozoic tropical snakeflies (Grimaldi and Engel, 2005), these tropical Meropeidae were probably not already adapted for colder climates after the mid-Cretaceous global warming (Hay and Flögel, 2012). Consequently, significant extinction in the family has left the cold-adapted groups in the three distant temperate habitats.

5. Conclusion

A new species of Meropeidae, *Burmomerope bashkuevi* sp. nov., is established based on a well-preserved specimen from mid-Cretaceous Myanmar amber. It is distinctly different from other species in that most simplified wing venation, four veins both in radial and medial sectors, massive antenna with wide flagellomeres and very thin and elongated last segments of female abdomen. Our finding enhances our understanding of the palaeogeographic distribution and diversification of Cretaceous earwigflies.

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