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Short communication

A new earwigfly from mid-Cretaceous Burmese amber (Mecoptera: Meropeidae)

Xiangdong Zhao [a, b], Qingqing Zhang [b, c], Edmund A. Jarzembowski [b, d], Lei Chen [a, b, **], Bo Wang [b, e, *]

[a] Shandong University of Science and Technology, Qingdao 266510, PR China
[b] State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, PR China
[c] University of the Chinese Academy of Sciences, Beijing 100049, PR China
[d] Department of Earth Sciences, Natural History Museum, London SW7 5BD, UK
[e] Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Science, Beijing 100101, PR China

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ABSTRACT

A new species of Meropeidae (earwigfly) is described and figured based on an exceptionally well-preserved individual in mid-Cretaceous amber from Myanmar. *Burmomerope clara* Zhao and Wang, sp. nov. is distinguished from the type species *B. eureka* Grimaldi and Engel, 2013 by presence of broader wings with six longitudinal veins in radial sector and seven in medial field, CuA with two terminal branches, and long setae on the anterior margin of the wing. A detailed comparison of the forewings venation in all fossil and extant species is given. The new find is the third fossil species of Meropeidae and also the first fossil female to be described. The female genital structure of *B. clara* sp. nov. is remarkably similar to that of extant species, revealing 100 million years of morphological conservatism, and thus highlighting the antiquity of the group.

1. Introduction

The Meropeidae is one of the smallest families of Mecoptera, comprising only three living species: *Austromerope poultoni* Killington, 1933 from the vicinity of Perth, Western Australia (Killington, 1933; Abbott et al., 2007), *Merope tuber* Newman, 1838 from Maine and Ontario, south to Florida and Alabama, and west to Minnesota, Kansas and Oklahoma (Newman, 1838; Byers, 1973; Dunford et al., 2007) and *Austromerope brasiliensis* Machado, Kawada et Rafael, 2013 from Atlantic forest in the state of Esperito Santo, southeastern Brazil (Machado et al., 2013). The biology of Meropeidae remains poorly known (Schiefer, 2015). The adults commonly live under logs and rocks in the vicinity of streams or springs in forests (Byers, 1973; Maier, 1984; Johnson, 1995; Schiefer, 2015), and probably can stridulate (Sanborne, 1982). The immature stages are still unknown (Machado et al., 2013). The family Meropeidae was thought to be a sister group to all other families of mecopterans (Penny, 1975).

The fossil record of the family is extremely sparse, with only two included species: *Boreomerope antiqua* Novokshonov, 1995 from the Middle Jurassic of Siberia known only from one wing reprint (Novokshonov, 1995) and *Burmomerope eureka* Grimaldi and Engel, 2013 from mid-Cretaceous Burmese amber known from the whole body (Grimaldi and Engel, 2013). In this paper, we describe a new species, *Burmomerope clara* sp. nov., based on a female individual from mid-Cretaceous Burmese amber.

2. Material and methods

The single female is preserved in a small, oblong-ovoid piece of light yellow-orange amber which is from an amber mine located near Noije Bum Village, Tanaing Town, Myanmar (Kania et al., 2015). The piece is 33.2 mm long and 22.1 mm at its maximum width, and the insect is well preserved, with wings and legs almost

* Corresponding author. State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, PR China.
** Corresponding author. Shandong University of Science and Technology, Qingdao 266510, PR China.
E-mail addresses: leichen@nigpas.ac.cn (L. Chen), bowang@nigpas.ac.cn (B. Wang).

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complete, left foreleg damaged, and head and thorax strongly deformed. The age given by U–Pb dating of zircons from the volcanoclastic matrix of the amber is early Cenomanian (98.8 ± 0.6 million years) (Shi et al., 2012), but the geologic age of Burmese amber should be slightly older than the zircon date (Ross, 2015).

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 and a confocal laser scanning microscope (CLSM), the photomicrograph being taken using a CLSM Zeiss LSM710 with ×10 objectives and a laser at 488 nm. In most instances, incident and transmitted light were used simultaneously. All images are digitally stacked photomicrographic composites of approximately 20 individual focal planes obtained using the free software Combine ZP for a better illustration of the 3D structures. The figures were prepared with CorelDraw X3 and Adobe Photoshop CS3. Wings venation used in this paper follows Willmann (1989). All taxonomic acts established in the present work have been registered in ZooBank (see below), together with the electronic publication LSID: urn:lsid:zoobank.org:pub:ECE547A7-EEF5-41E3-9DA4-19754E694C2A.

3. Systematic palaeontology

Order Mecoptera Packard, 1886
Family Meropeidae Handlirsch, 1906

Genus *Burmomerope* Grimaldi and Engel, 2013

Burmomerope clara Zhao and Wang, sp. nov.
(urn:lsid:zoobank.org:act:AE15A479-3A9A-4E8A-9896-A8FD5AA9634C)
Figs. 1–3

Etymology. Specific epithet is from Latin *clara*, in reference to the excellent preservation of the wings.
Holotype. NIGP164028; housed in the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences.
Locality and horizon. Noije Bum Village, Tanaing Town, northern Myanmar; lowermost Cenomanian, mid-Cretaceous.

Diagnosis. Distinguished from *Burmomerope eureka* by presence of broader wings with more longitudinal veins in radial sector and medial field (five and six in *B. eureka*, six and seven in *B. clara*), CuA with two terminal branches, and long setae on the anterior margin of the wing.
Description. Body length 5.95 mm; thorax length 1.73 mm, approximately half of abdomen length; abdomen length 3.52 mm. **Head**: length 0.7 mm, width 0.55 mm, approximately 0.5 × greatest width of thorax. Ocelli invisible; compound eye well preserved, large and round, surface conforming to contour of head capsule. Rostrum invisible. Antennal length 2.5 mm, antenna thickest in middle, scape and pedicel invisible; flagellum with 23 flagellomeres, flagellomeres bead shaped, with short, fine hairs, largest flagellomere length 0.12 mm. **Thorax**: pronotum cylindrical, with slight median ridge; longer than head capsule, width approximately equal to that of head capsule; mesothorax with broad, apically pointed projections, laterally just over forewing bases; meso- and metathoraces well separated, detailed features of metathoraces invisible. Legs: very slender; hind legs distinctly longer than fore and mid legs, tibial spur formula 2, 2, 1. Length: profemur 0.89 mm, protibia 0.82 mm, protarsus 1.2 mm; mesofemur 0.94 mm, mesotibia 1.08 mm, mesotarsus 1.25 mm; metafemur 1.43 mm, metatibia 1.89 mm, metatarsus 1.68 mm; basitarsomeres longer than other tarsomeres, pretarsal claw well developed, empodium pad-like. **Wings**: slightly longer than whole length of body, pterostigma invisible; bases of wings very narrow, apices broadly rounded; with long setae on the anterior margin. Forewing length 6.4 mm, width 2.88 mm; hindwing length 6.08 mm, width 2.6 mm; forewing with 27 terminal veins (meeting wing margin), 37 crossveins; Sc 4.48 mm long, with 7 terminal branches; R simple and straight; Rs branching from R in basal 0.12 of length of R, with 5 deep forks (6 terminal branches), base stronger than other wing veins; M with 6 deep forks (7 terminal branches); CuA with one fork (2 terminal branches); CuP without branches/forks; A1 and A2 without branches, A2 subparallel to A1. Hindwing with 21 terminal veins (meeting wing margin), 27 crossveins; Sc with 5 apical/terminal branches; R simple and straight; Rs with 6 terminal branches; M with 7 terminal branches; CuA and CuP without branches; A absent. **Abdomen**: slender, length 3.5 mm, with 11

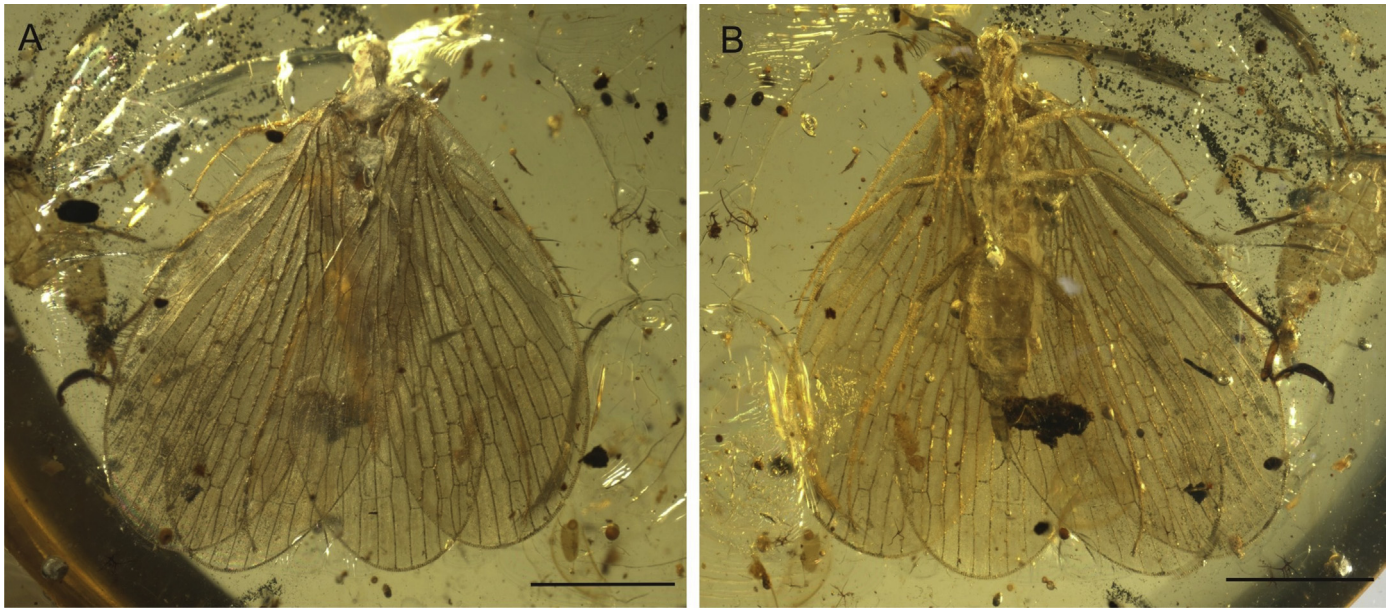

Fig. 1. *Burmomerope clara* sp. nov., NIGP164028, female. A, microphotograph in dorsal view (scale bar = 2 mm). B, microphotograph in ventral view (scale bar = 2 mm).

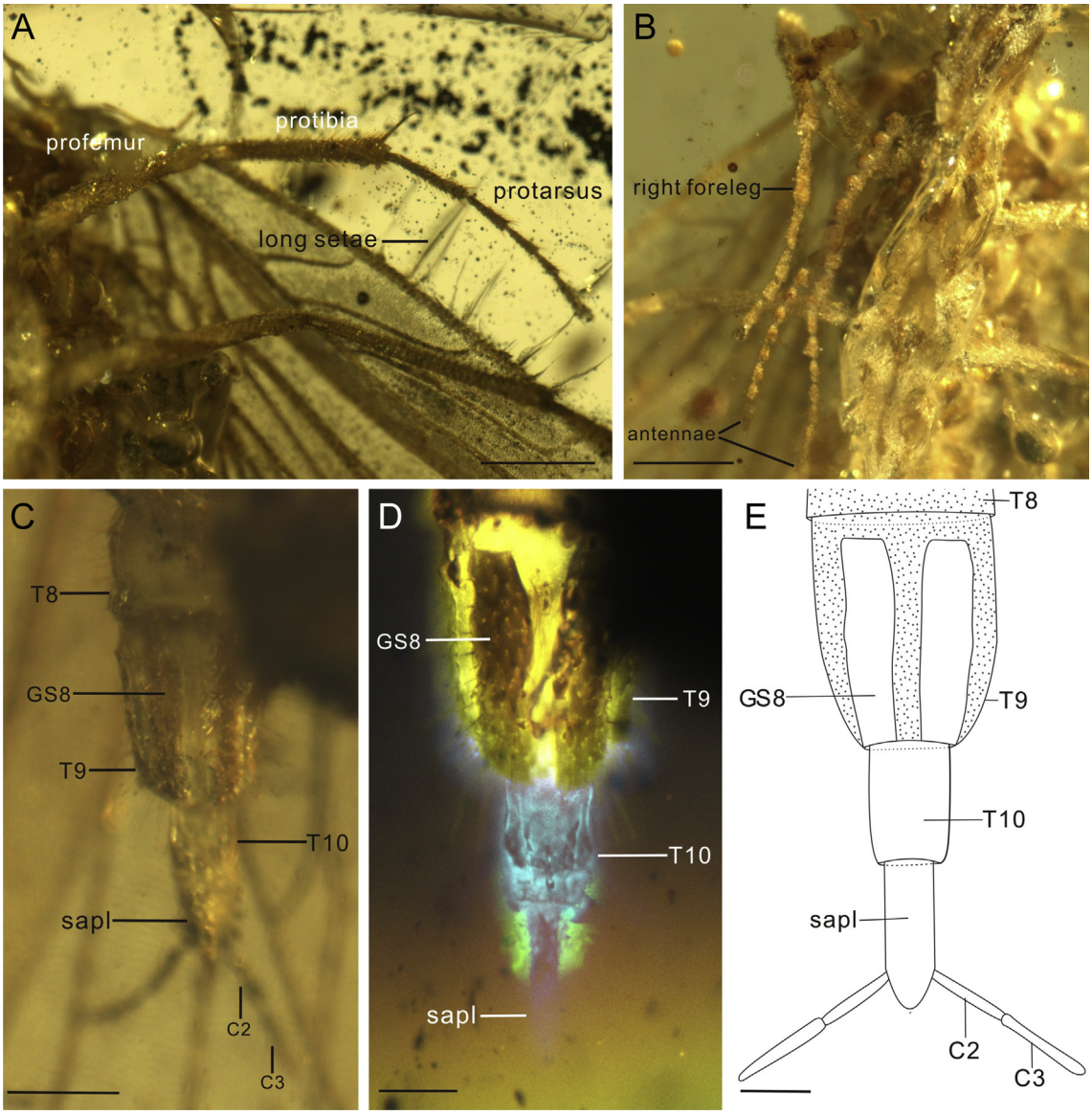

Fig. 2. Microphotographs of the holotype of *Burmomerope clara* sp. nov., NIGP164028. A, microphotograph of left foreleg (scale bar = 0.5 mm). B, microphotograph of antennae (scale bar = 0.5 mm). C, microphotograph of female genital and postgenital segments (scale bar = 0.2 mm). D, microphotograph of female genital and postgenital segments taken by CLSM (scale bar = 0.1 mm). E, line drawings of female genital and postgenital segments (scale bar = 0.1 mm). T8–T10, tergites of segments 8–10; Cl–C3, 1–3 segments of cerci; GS8, gonocoxosternites of segment 8; sapl, subanal plate.

visible segments, segment 3 (thickest segment) 0.98 mm long, width 2.03 mm; gonocoxosternites of segment 8 represented by two ventrally situated, slightly curved, sclerotized plates lying below tergite 9, with a small number of setae; a well developed subanal plate and segment 1 of cerci shielded by subanal plate. Segments 2 and 3 of cerci clearly visible; segment 2 length 0.15 mm, slender and cylindrical; segment 3 length 0.13 mm, tapering to rounded apex.

4. Discussion

The genus *Burmomerope* with the type species *B. eureka* was erected based on a male specimen from Burmese amber (Grimaldi and Engel, 2013). Our examination of some private collections shows that there is no distinct gender variation in wing venation of *B. eureka*. For example, the wing venation of a male and female both preserved in one amber piece show a high degree of uniformity (Xia et al., 2015, p. 123) as in extant species (Dunford et al., 2007). The new species belongs to the genus *Burmomerope* based on its pronotum being partially cylindrical instead of shield-like, forewing with 13 terminal branches and 34 crossveins in radial sector and medial field (Table 1; Fig. 4). *B. clara* can be distinguished from *B. eureka* by presence of broader wings with more longitudinal veins in radial sector and medial field (five and six in *B. eureka*, six and seven in *B. clara*), by CuA with two terminal branches, and by long setae on the anterior margin of the wing (Fig. 5). The new specimen is the first fossil female meropeid to be figured and described and preserves the external morphology of the female genital and postgenital segments. The gonocoxosternites of segment 8 are represented by two ventrally situated, slightly curved, sclerotized plates lying below tergite 9 that are remarkably similar to those of *Austromerope poultoni*, revealing 100 million years of morphological conservatism in female genital structures (Smithers, 1988). The

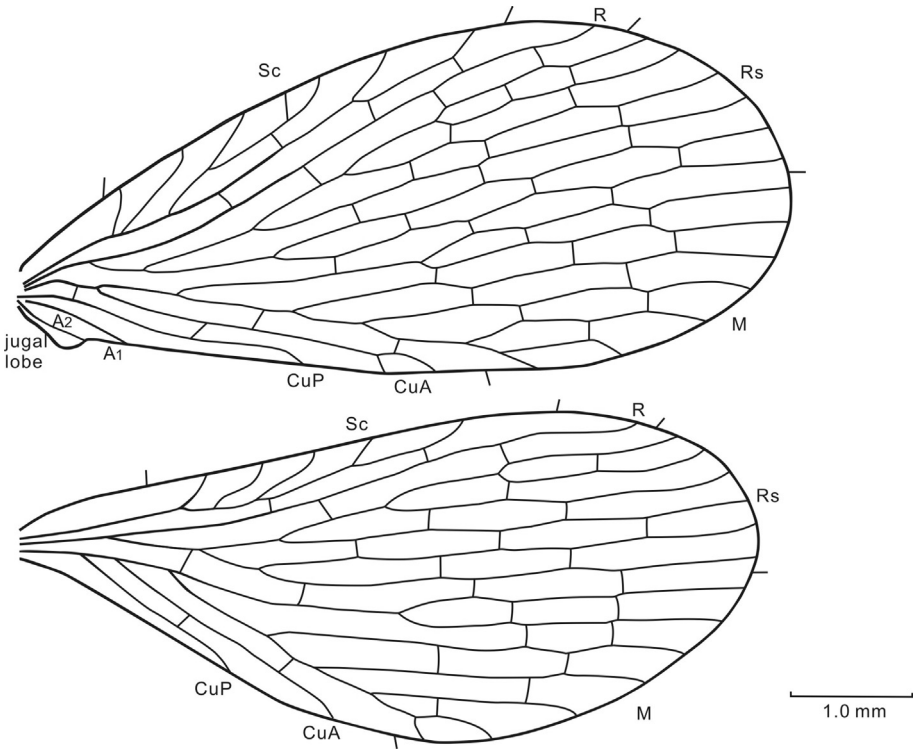

Fig. 3. Line drawings of wing of *Burmomerope clara* sp. nov. Forewing (above) and hindwing (below).

Table 1
A detailed comparison of forewings in all fossil and extant species.

	Burmomerope clara	*Burmomerope eureka*	*Boreomerope antiqua*	*Austromerope poultoni*	*Austromerope brasiliensis*	*Merope tuber*
Sc	7 terminal branches, 1 crossvein	7 terminal branches, no crossvein	8 terminal branches, 14 crossveins	20 terminal branches, more than 30 crossveins	8 terminal branches, 49 crossveins	14 terminal branches, 8 crossveins
Rs	6 terminal branches	5 terminal branches	6 terminal branches	12 terminal branches	11 terminal branches	5 terminal branches
M	7 terminal branches	6 terminal branches	5 terminal branches	8 terminal branches	9 terminal branches	6 terminal branches
CuA	2 terminal branches	simple	simple	simple	simple	simple

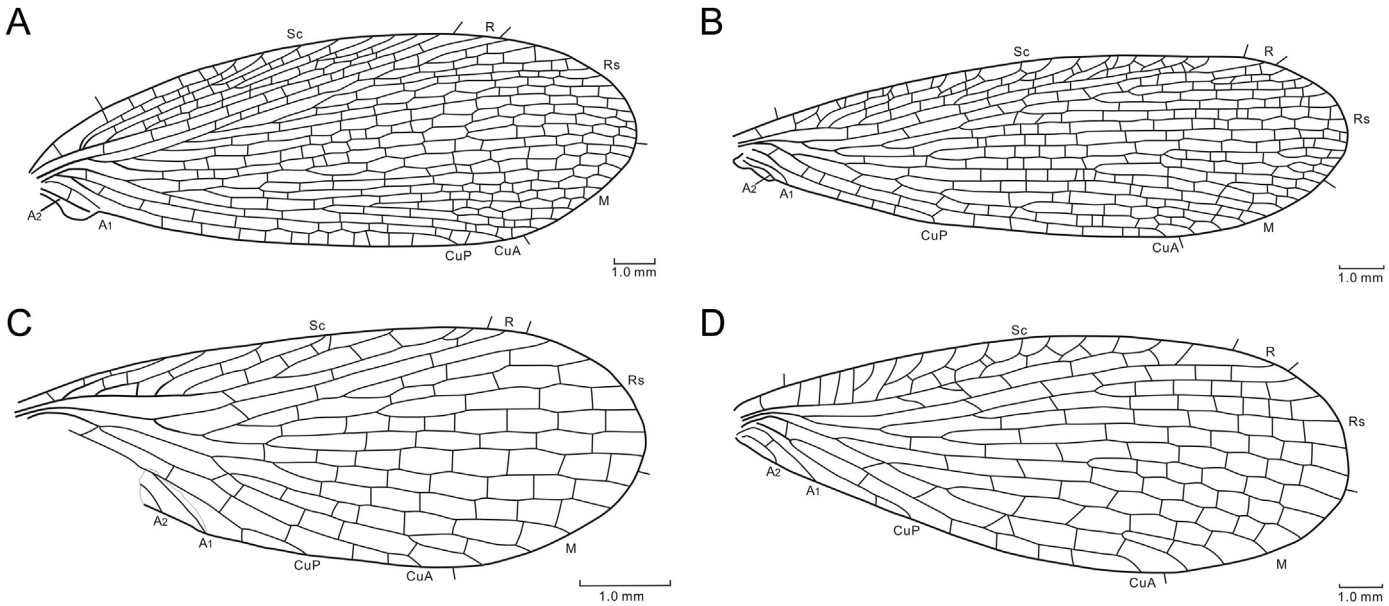

Fig. 4. The wings venation of the other extant/fossil species. A, forewing of *Austromerope brasiliensis* from Machado et al. (2013). B, forewing of *Austromerope poultoni* from Willmann (1989). C, forewing or hindwing of *Boreomerope antiqua* from Novokshonov (1995). D, forewing of *Merope tuber* from Willmann (1979).

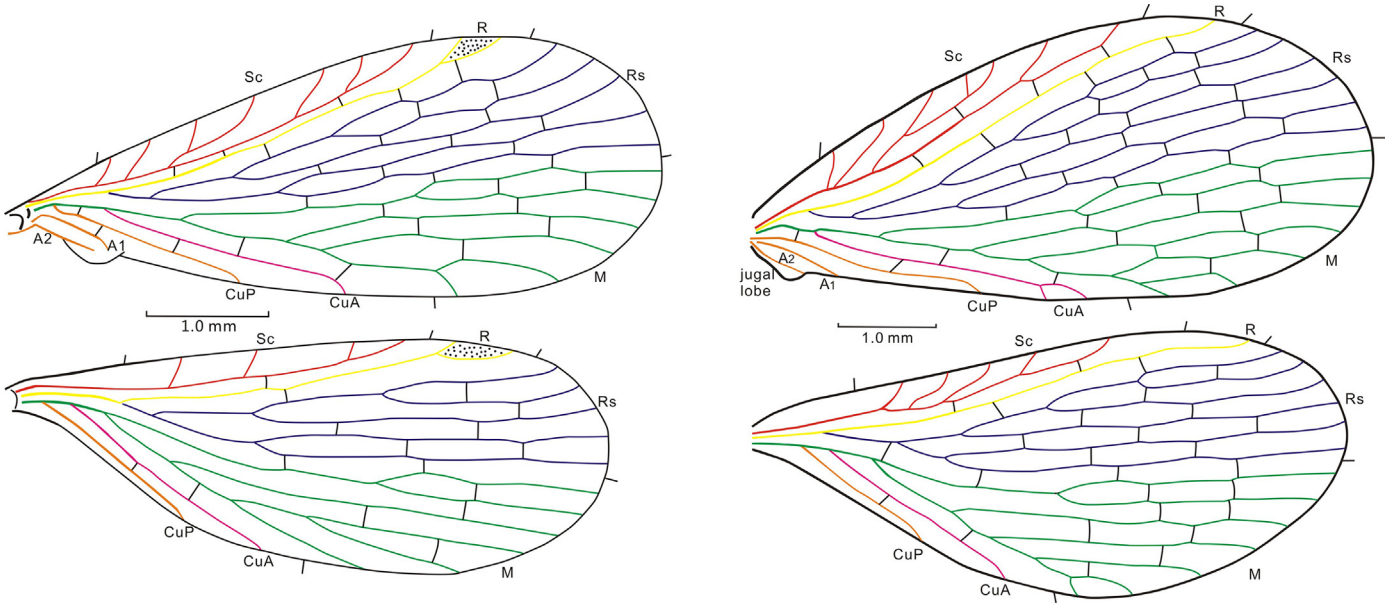

Fig. 5. Line drawings of wing venation of *Burmomerope eureka* (left) *and B. clara* (right). Forewing (above) and hindwing (below).

only difference is that *B. clara* has longer tergites of segment 10 (T10) and the subanal plate (Fig. 2C–E).

5. Concluding remarks

A new species of Meropeidae, *Burmomerope clara* sp. nov., is described from mid-Cretaceous Burmese amber. It represents not only the third fossil species of Meropeidae, but also the first fossil female earwigfly to be figured and described. The female genital structure of *B. clara* is remarkably similar to that of extant species, revealing 100 million years of morphological conservatism, thus highlighting the antiquity of the group. Our find augments the diversity of Mesozoic earwigflies, and enhances our understanding of the early evolution and diversification of earwigflies.

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