

Myanmarinidae, a new family of basal Apocrita (Hymenoptera: Stephanoidea) from mid-Cretaceous Burmese amber



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ABSTRACT

A new family of basal apocritan wasps is established based on three new species discovered from the mid-Cretaceous Burmese amber and tentatively allied to the superfamily Stephanoidea. The family Myanmarinidae Zhang and Rasnitsyn fam. nov. contains one new genus *Myanmarina* Zhang and Rasnitsyn gen. nov., including three new species: *Myanmarina lisu* Zhang and Rasnitsyn sp. nov., *Myanmarina kachin* Zhang and Rasnitsyn sp. nov. and *Myanmarina lahu* Zhang and Rasnitsyn sp. nov. Comparisons are made between Myanmarinidae and its similar families. Some general remarks are also made about the new family in taxonomy and biology.

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1. Introduction

Burmese amber is currently one of the richest sources of knowledge about the past of insects and some other segments of the non-marine biosphere (Rasnitsyn, 1996; Zherikhin and Ross, 2000; Grimaldi et al., 2002; Ross et al., 2010; Rasnitsyn et al., 2016; Guo et al., 2017). Indeed, the Burmese amber arthropod assemblage accounts for 252 families which is the highest figure among the Cretaceous Lagerstätten (Rasnitsyn et al., 2016; the data by the end of 2013). Years later Ross (2017) lists 356 arthropod families and 481 insect species there, and Guo et al. (2017) cite 73 described species in Hymenoptera. Hymenoptera represents a significant part of the modern and, since the Jurassic, past world biodiversity: the above source counts 30 families, that is, 12 percent of the total arthropod diversity in the Burmese amber. Like other taxa, Hymenoptera displays a number of described (Aptenopressidae, Bryopompilidae, Melittisphoridae, Othniellithidae,

Syspastroxyelidae, cf. Rasnitsyn et al., 2017; Rodriguez et al., 2016; Poinar and Danforth, 2006; Engel et al., 2016a, 2016b, respectively) and undescribed (in preparation) endemic families within the Burmese amber assemblage. Description of one more such family is the objective of the present publication.

2. Material and methods

The present research is based on the amber collected from the amber mines situated in the Hukawng Valley of Kachin State, Myanmar (locality in Kania et al., 2015: fig. 1). The rock containing the Burmese amber was radiometrically dated at 98.79 ± 0.62 Ma (Shi et al., 2012). The date corresponds to the early Cenomanian, that is, the earliest Late Cretaceous. However, the amber displays clear traces of re-deposition (Ross, 2015) and so can be older than enclosing rocks. That is why we prefer to refer to the amber age informally as mid-Cretaceous.

The material was studied under Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope with magnifications up to $800\times$ at the State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and

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Palaeontology, Chinese Academy of Sciences, and using Leica M165C stereomicroscope with a Leica DFC 420 camera at the A.A. Borissiak Paleontological Institute, Russian Academy of Sciences, in Moscow. In most instances, incident and transmitted light were used simultaneously. Helicon Focus Pro $\times 64$ was used to stack photos for better depth of field. The line drawings were prepared based on photographs using image-editing softwares (CorelDraw X7 and Adobe Photoshop CS6). The specimens are housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS). Morphological terminology and symbols to wing vein homology are standard, except that ampersand (&) linking two adjacent vein sections denotes those aligned and forming a seemingly entire vein section. Particularly, 1-RS&1-M means the first (basal) sections of RS and M joining to form a smooth, seemingly entire vein (basal vein in older nomenclature; cf. Fig. 1C). 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:FC26F5AC-E0FF-44CB-B621-C68973E0BEAF.

3. Systematic paleontology

Order Hymenoptera

Suborder Vespina

Superfamily Stephanoidea

Family Myanmarinidae Zhang and Rasnitsyn, fam. nov.

(LCID: urn:lsid:zoobank.org:act:A6499035-F929-449A-8477-63D8BCC80191)

Type genus *Myanmarina* Zhang and Rasnitsyn, gen. nov.

Diagnosis. Male (female unknown). Stature elongate, subcylindrical, as in Stephanidae. Body size small (1.5–3 mm). Head subglobose, without crown of teeth around fore ocellus, with big eyes, circular occipital carina and long genal bridge (the space where contralateral genae meet each other between postociput and hypostome). Antenna 11- or 12-segmented, not geniculate, flagellar segments more or less uniform, possibly with elongate (multiporous plate) sensillae. Mandible short, wide, with 2 or, possibly, 3 subequal teeth, with cutting edge subparallel to mandible rotation axis, not distinctly oblique. Maxillary palps with 4 visible segments, apical three ones narrow and elongate. Labial palps not observed, probably much reduced. Mesosoma long and narrow, subcylindrical or somewhat depressed (possibly a preservational distortion), its morphology little known except that the pronotum is short centrally in dorsal view and the mesoscutum long. Propleurae more or less elongate, usually forming a distinct neck. Propodeum elongate, straight in lateral view, with no downward bending towards metasomal articulation. Legs elongate, ordinary; fore tibia with single, thin, arcuate spur. Wings densely pubescent, with comparatively long marginal setae, with venation much reduced. Forewing with tubular veins only in anterobasal part, namely fused C + R up to some 0.6 wing length, M + Cu, strongly oblique basal vein (1-RS&1-M), cu-a, 1-Cu and 1A up to cu-a only (Cu may continue after cu-a as nebulous vein). All distal wing surface free of veins, supported with system of nested radiated folds like in Spathiapterygidae. Hind wing short and very narrow, reaching level of upper end of basal vein (that is, level of 1-RS base), with only C + R tubular and with 3 hamuli. Metasoma linear, with 8 external segments, 1st segment distinctly narrowed basal but details of articulation not clear, male claspers wide and often long, pointing obliquely downward.

Genera included. Type genus only.

Genus *Myanmarina* Zhang and Rasnitsyn, gen. nov.

(LCID: urn:lsid:zoobank.org:act:BB9726BE-39FB-44A5-901A-A7791CFEEC21)

Type species: *Myanmarina lisu* Zhang and Rasnitsyn, sp. nov.

Etymology. From Myanmar, the country where all the three species of the new genus come. Gender feminine.

Diagnosis. As for family because of monotypy.

Species included. Three species.

Myanmarina lisu Zhang and Rasnitsyn, sp. nov.

(LSID: urn:lsid:zoobank.org:act:5AC41744-1151-4846-A7C6-FD58CBE42E3A)

Fig. 1

Derivation of name. After the Lisu, an ethnic group in northern Myanmar where the fossil material was collected. Noun in apposition.

Holotype. Male, NIGP166310 (Fig. 1A–D). Only few part of legs damaged, diagenetic deformation present, with some scattered debris around; small air bubbles distributed around the whole body including the antennae and legs make it difficult to discern the dorsal surface sculpture.

Paratype. Male, NIGP166311 (Fig. 1E–G). One forewing damaged, the other bent; many scattered debris around. Dark body and lots of small bubbles obscuring particular details of the fossil. The type specimens were originally found as syninclusions and subsequently separated for study.

Locality and horizon. Hukawng Valley, Kachin State, Myanmar; lowermost Cenomanian, mid-Cretaceous.

Description. NIGP166310. Head subglobose; ocelli small, well separated from compound eyes; compound eyes prominent, berry-like in appearance. Antenna 11-segmented, inserted moderately low on head, densely covered with fine setae; scape relatively straight; pedicel almost as long as scape; first flagellomere extremely long, thinner than pedicel basally and becoming gradually thicker; second about as long as scape and pedicel combined; third and fourth slightly longer than second and fifth, remaining ones shorter than fifth but still more than twice as long as wide, apicalmost flagellomere rounded. Maxillary palps almost as long as head height, with three apical segments long and thin, basal visible segment probably short. Mesosoma imbricate, long-column-shaped and wider than high; pronotum short, mesoscutum long with indistinct (possibly percurrent) notauli. Legs long with respect to body length and covered with minute setae; tibial spur formula 1-1-1; basitarsomeres almost as long as remainder of corresponding tarsomeres together; all femora shorter than their tibia, and hind femur slightly swollen. Length ratio of tarsomeres in all legs (similar in all congeners) ca. 10:5:3–3.5:1.5–1.7:2–2.5 (precise measurements often difficult because of imperfect preservation state and improper position of legs in amber). Forewing longer than metasoma, spatulate, with well-defined marginal fringe, fringe setae longest along hind margin (possibly also along wing apex which is obscured), moderate along veins on fore margin, growing shorter toward anterior preapical margin; membrane with dense and comparatively long setae all over surface distal of venation, with basal (1rm) and subbasal (1cua) cells naked; C + R reaching maximum wing width (0.64 wing length); M + Cu faded in basal third, branching in wing basal 0.2, 1-RS&1-M thickest vein, reaching C + R at 0.33 wing length, cu-a aligned with 1A, meeting Cu distinctly distal of M + Cu apex; free Cu long, nebulous, subparallel to wing hind margin, continuing into weak fold; five stronger folds running fan-like toward wing margin anterior of Cu. Hind wing very narrow, some 0.4 as long as forewing, with fringe of moderately long setae along all visible hind margin and apex and with 3 hamuli present. Metasoma narrow, about as long as head and mesosoma combined, and wider than high, with segments difficult to discern; first segment trapezoid, elongate, following apparently shorter;

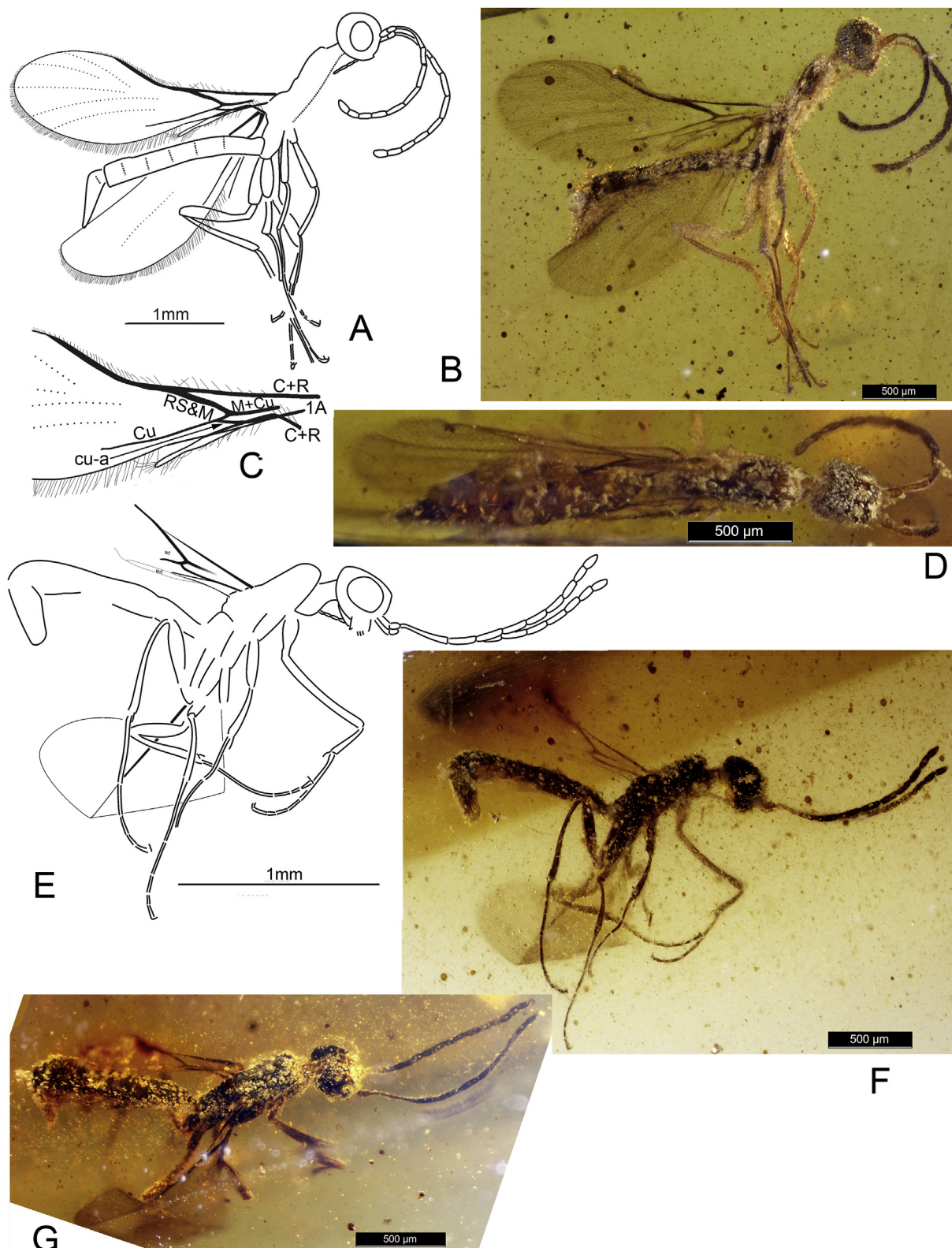


Fig. 1. *Myanmarina lisu* sp. nov. A–D. Holotype NIGP166310, E–G. Paratype NIGP166311. A, B, E, F. Photomicrographs and reconstructions of habitus in side views. C. Wing base with indication of vein nomenclature (standard). D. Dorsal view. G. Dorsolateral view.

claspers wide and long, triangular in side view, otherwise genitalia not visible.

NIGP166311, providing additional characters such as: mandible possibly tridentate, maxillary palps narrow and long; fore leg with

coxa long ovate, trochanter small, tibia with inner row of setae; mid and hind coxa almost as long as femur.

Measurements. NIGP166310. Total body length, 2.7 mm; head length, 0.3 mm, width, 0.4 mm; mesosomal length, 1.0 mm;

metasomal length, 1.4 mm; antennal length, 1.4 mm; forewing length, 1.9 mm, width, 0.7 mm; hindwing length 0.7 mm.

NIGP166311. Total body length, 2.3 mm; head length, 0.3 mm, width, 0.3 mm; mesosomal length, 0.7 mm; metasomal length, 1.3 mm; antennal length, 1.3 mm; forewing length, 1.38 mm, width, ca. 0.6–0.65 mm; hindwing length 0.55 mm.

Remarks. The species differs from all congeners in having antennae distinctly thickened apically, hind coxae and genital claspers very long. It is noteworthy that high size variability is present in the species, with forewing length differing in almost 1.4 times between two males available.

Myanmarina kachin Zhang and Rasnitsyn, sp. nov.

(LSID: urn:lsid:zoobank.org:act:148831C2-8910-4229-8E5E-4F36DC8F465D)

Fig. 2

Derivation of name. After the Kachin, an ethnic group in northern Myanmar where the fossil material comes. Noun in apposition.

Holotype. Male, NIGP166309. Nearly complete with diagenetic deformation, with antennae and hind legs partly damaged; amber inner layer surface light brown; the surface sculpture not discernible.

Locality and horizon. Hukawng Valley, Kachin State, Myanmar; lowermost Cenomanian, mid-Cretaceous.

Description. Body dark brown to black. Head subglobose. Eyes not easily recognizable. Antenna inserted moderately low on head, slightly widened apically, 11-segmented; scape slightly expanded ventrally, about twice the length of pedicel; pedicel small, slightly longer than wide; first flagellomere thin and extremely long, arched softly and becoming thicker apically; flagellomeres 2–5 similar in size and shape, about half as long as first and slightly thinner in both ends than middle part; flagellomeres 6–8 shorter and broader, flagellomere 9 almost as long as 8 and slightly pointed at apex. Maxillary palps as visible as long as head high, with 4 segments visible, apical three narrow and elongate, first visible segment much thicker and probably short. Mesosoma sub-cylindrical with reticulated surface (possibly because of cuticle degradation), narrow and more than 3 times as long as wide. Pronotum short and mesoscutum long; propodeum elongate, straight in lateral view, with no downward bending towards metasomal articulation. Legs long and thin on the whole, coxa long and moderately stout; trochanter thin; tarsomere length as in type species. Protibial spur simple and curved. Fore and mid legs with femur cylindrical and shorter than tibia; tibia expanded apically. Fore basitarsus as long as tibia; mid basitarsus longer than tibia. Hind legs with femur slightly swollen; tibia longer than femur, with single tibial spur. Forewing hyaline with moderately dense setation, with short fringe along hind margin (possibly also along wing apex which is obscured). Venation incompletely visible, with fused C + R long, about 3/5 length of wing; 1-Rs&1-M strongly oblique, very thick, connecting to C + R near its midlength; nested forking folds present distal of preserved veins, with hind fold apparently continuing into nebulos free Cu. Hind wing short and very narrow, with 3 hamuli present. Metasoma linear, longer than mesosoma, with segment boundaries difficult to identify precisely. Claspers wide and short, other details of genitalia invisible.

Measurements. NIGP166309. Total body length, 3.2 mm; head length, 0.4 mm, width, 0.2 mm; mesosomal length, 1.2 mm; metasomal length, 1.6 mm; antennal length, 1.5 mm; forewing length, 1.8 mm, width, 0.7 mm.

Remarks. The species differs from all congeners by its larger size and the hind femur comparatively short and rather stout (instead of long and at most slightly swollen in both *M. lisu* and *M. lahu*).

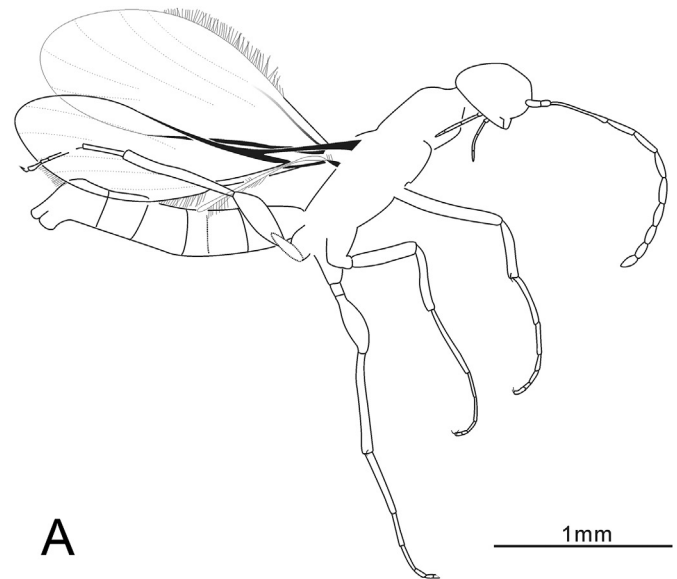


Fig. 2. *Myanmarina kachin* sp. nov., holotype NIGP166311. Reconstruction (A) and photomicrograph (B) of habitus in side view.

Myanmarina lahu Zhang and Rasnitsyn, sp. nov.

(LSID: urn:lsid:zoobank.org:act:ECC6AE11-5B6C-4306-9ECB-BE229F17BCE1)

Fig. 3

Derivation of name. After the Lahu, an ethnic group in northern Myanmar where the fossil material was discovered. Noun in apposition.

Holotype. Male, NIGP166312 (Fig. 3A–D). Nearly complete fossil missing only one wing apex, deformed in many respects; amber color faint yellow and not well transparent, inner surface deep yellow colored; many scattered debris around; surface sculpture and many details of morphology of holotype are difficult to see and interpret correctly because of diagenetic deformations as well as deep dark color.

Paratype. Male, NIGP166313 (Fig. 3E–F). Head and part of legs damaged, lots of scattered debris and some filaments around; amber not well transparent, dark body and lots of small bubbles obscuring particular details of the fossil.

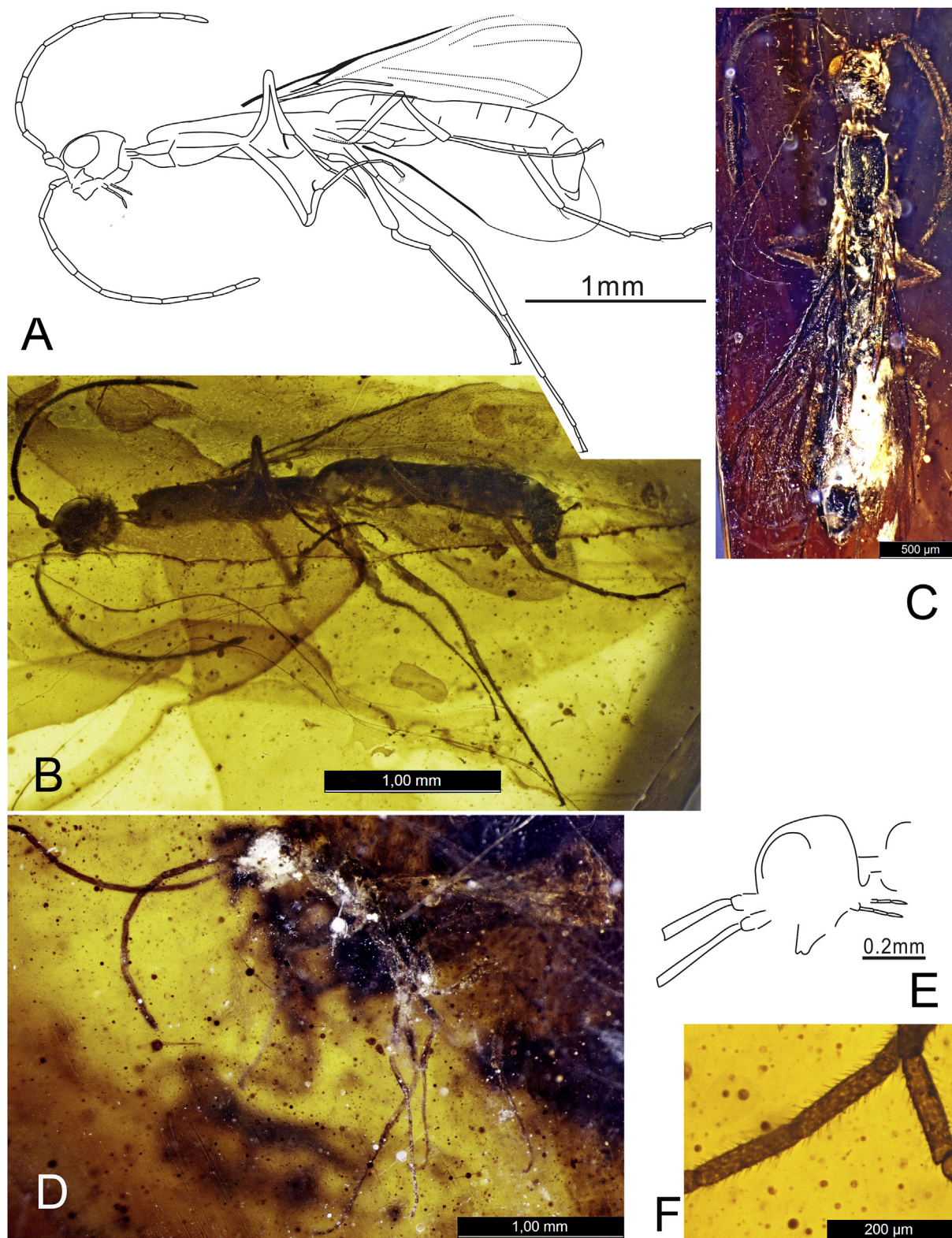


Fig. 3. *Myanmarina lahu* sp. nov. A–D. Holotype NIGP166312, E–F. Paratype NIGP166313. A, B. Oblique ventral view. C. Dorsal view. D. Forewing. E. Head. F. Flagellar segments showing possible multiporous plate sensilla (slit-like foramina among circular ones).

The type specimens were originally found as syninclusions and separated subsequently.

Locality and horizon. Hukawng Valley, Kachin State, Myanmar; lowermost Cenomanian, mid-Cretaceous.

Description. NIGP166312. Specimen dark brown to black. Head subglobose, longer than high. Eyes berry-like, moderately large, reaching mandibular base; ocelli indistinguishable. Antenna inserted low on head, below eye midheight, 12-segmented; scape ventrally slightly expanded, about twice the length of pedicel;

flagellomeres densely covered with thin setae, with first three antennal segments pale compared to remainders; first one moderately long, thinner than pedicel basally, second to sixth as long as first, seventh to tenth slightly shorter than sixth, apical one rounded. Mandible narrowed apically. Maxillary palps some half as long as head high, with three apical segments long and thin. Mesosoma very long, wider than height. Pronotum extremely short centrally, hardly visible in dorsal view; propleurae elongate forming distinct neck; mesoscutum long; propodeum elongate and straight. Legs long with respect to body length and covered with minute setae; coxa long, trochanters small; fore and mid femora longer than respective tibia, hind femur slightly swollen and shorter than tibia; tarsomere length ratio as in type species. Forewing as preserved similar to that in other congeners. Hindwing short with membrane, without wing venation apart from C + R, and with three hamuli present. Metasoma long and narrow, with 8 external tergites, second longest, eighth shortest. Claspers wide and short, other parts of genitalia not visible.

Specimen NIGP166313 not well visible, very small, head big, mandible narrowed apically, distinctly with two subequal teeth, hind coxa and femur long. Flagellomeres possibly with multiporous plate sensilla (Fig. 3F).

Measurements. NIGP166312. Total body length, 2.9 mm; head length, 0.4 mm, width, 0.3 mm; mesosomal length, 1.1 mm; metasomal length, 1.7 mm; antennal length, 1.8 mm; forewing length, 1.9 mm; hind wing length ca. 0.65 mm.

NIGP166313. Head length, 0.3 mm; mesosomal length, 0.85 mm; antennal length, 1.7 mm.

Remarks. The species differs from all congeners in having the antenna 12-segmented, the first flagellomere hardly 1.5 times as long as apical one and the maxillary palps short (antenna 11-segmented with the first flagellomere several times as long the apical one, and maxillary palp long in both *M. lisu* and *M. lahu*).

4. Discussion

The present fossils are imperfectly preserved, and therefore they are insufficiently known in morphology. However, the morphological characters known from these specimens are distinctive enough so as to warrant description of the fossils as a family of their own. Accommodation of the new family in the wasp tree is not straightforward as well. Its distinctive similarity to the Spathiopterygidae in wing morphology cannot be inherited because of too different organization of propodeum and metasoma. In Spathiopterygidae, the first metasomal segment is transformed into a petiole and attached low on the propodeum at the end of the backward slope of the latter. In combination with other features scrutinized by Engel et al. (2013), this is clearly indicative of Diaprioidea. In contrast, propodeum of the new family is straight in side view lacking a posterior slope, and hence a real constriction is absent between the propodeum and the metasoma. This character state is characteristic of Stephanidae and extinct families Ephialtidae and Aptenoperissidae, that is, of the superfamily Stephanoidea (Rasnitsyn and Zhang, 2010; Rasnitsyn et al., 2017; Zhang et al., submitted). That is why we attribute Myanmarinidae to Stephanoidea, at least until a sound contradictory information appears.

Myanmarinidae can be easily differentiated from all three other families of Stephanoidea in their small size, 11-segmented antenna and particularly in their specific mode of reduction of the wing venation: particularly with two incompletely separated basalmost cells margined with thick veins within the basal third of wing's

length, with no other closed cells, and with distinctly radially folded outer wing membrane. Unlike the new family, Ephialtidae and male Aptenoperissidae (Zhang et al., submitted) always have more complete venation (female apterous), and Stephanidae have venation varying from complete to strongly reduced but never displaying deep differentiation between the wing base and the remainder wing blade.

5. Concluding remarks

The biology of the new family could be very tentatively inferred from the general appearance of the available fossils. Their long and narrow body and comparatively big and movable head are suggestive of insects parasitizing hidden, probably xylobiotic preys. This agrees additionally with the proposed taxonomic position of Myanmarinidae, because Stephanidae are known to develop at expense of xylophagous beetles (Achterberg, 2002), and Ephialtidae are hypothesized to behave similarly (Rasnitsyn, 1980). The distinct variation of the body size within the males of *M. lisu* sp. nov. is compatible with the hypothesis as well.

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