

Short communication

Peleserphidae, a new family of basal proctotrupomorphs (Hymenoptera: Proctotrupoidea) from mid-Cretaceous Burmese amber



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ABSTRACT

A new family of basal proctotrupomorph wasps is established based on three new species discovered from mid-Cretaceous Burmese amber and allied to the superfamily Proctotrupoidea. The family Peleserphidae fam. nov. contains two new genera: *Peleserphus* gen. nov. with two new species, the type *P. brachyurus* sp. nov. and *P. genalis* sp. nov., and *Peleproctus* gen. nov. with *P. dolichurus* sp. nov. The new family is interpreted as a specialized close relative of the basal proctotrupomorph family Mesoserphidae.

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1. Introduction

Burmese amber has provided rich information on the history of insects and other non-marine organisms (Rasnitsyn, 1996; Zherikhin and Ross, 2000; Grimaldi et al., 2002; Ross et al., 2010; Rasnitsyn et al., 2016; Guo et al., 2017). In particular, the Hymenoptera assemblage of the Burmese amber currently includes 46 recorded families (Zhang et al., 2017) and 90 described species (75 listed by Guo et al., 2017, plus *Aptenoperissus burmanicus* Rasnitsyn and Poinar, 2017, *Archeofoenus tartaricus* Engel, 2017, *Caloichneumon perrarus* Li, Kopylov, Shih and Ren, 2017, *Curiosivespa striata* Perrard and Carpenter, 2017, *Curiosivespa zigrasi* Perrard and Carpenter, 2017, *Electrofoenops diminuta* Engel, 2017, *Geoscelio mckellari* Engel and Huang, 2017, *Lagenostephanus lii* Li, Rasnitsyn,

Shih and Ren, 2017, *Myanmarina kachin* Zhang and Rasnitsyn, 2017, *Myanmarina lahu* Zhang and Rasnitsyn, 2017, *Myanmarina lisu* Zhang and Rasnitsyn, 2017, *Novichneumon longus* Li, Kopylov, Shih and Ren, 2017, *Phoriostephanus exilis* Engel and Huang, 2017, *Protopespa haxairei* Perrard and Carpenter, 2017, and *Xenodellitha preta* Engel, 2017). Thus, the Burmese amber contains the most diverse of all Cretaceous faunas of Hymenoptera. It also stands out by a high proportion of endemic families, including Aptenoperissidae, Bryopompilidae, Melittosphecidae, Myanmarinidae, and Othniodellithidae (cf. Rasnitsyn et al., 2017; Rodriguez et al., 2016; Poinar and Danforth, 2006; Zhang et al., 2017; Engel et al., 2016, respectively). Yet another endemic family is described in the present paper to include three new species.

2. Material and methods

The present research is based on amber collected from mines in the Hukawng Valley of Kachin State, Myanmar (locality in Kania

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et al., 2015: fig. 1). The rock containing the Burmese amber has been radiometrically dated at 98.79 ± 0.62 Ma (Shi et al., 2012). However, the amber displays clear traces of re-deposition (Ross, 2015) and, therefore, can be older than the enclosing rocks. That is why we informally refer to the amber age as mid-Cretaceous.

The material was studied under a Nikon SMZ-10 R stereomicroscope and a Nikon Optiphot compound microscope with magnifications up to $800\times$ at the State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, and using a Leica M165C stereomicroscope with an attached Leica DFC 420 camera at A.A. Borissiak Paleontological Institute, Russian Academy of Sciences. In most instances, incident and transmitted light were used simultaneously. Helicon Focus Pro was used to z-stack photos to obtain a better depth of focus. Line drawings were prepared based on photographs using image-editing software (CorelDraw X7 and Adobe Photoshop CS6). The specimens are housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS), hence the prefix NIGP in their registration numbers. The morphological nomenclature mostly follows Rasnitsyn (1980). The vein symbols are standard. 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:BB039DE3-78AF-4A7D-9483-790243A30343.

3. Systematic paleontology

Order Hymenoptera Linné, 1758
Suborder Vespina Laicharting, 1781
Superfamily Proctotrupoidea Latreille, 1802
Family Peleserphidae fam. nov.
Type genus *Peleserphus* gen. nov.

Diagnosis. Female (male unknown). Head big (wider than mesosoma) and prognathous (possibly facultatively so; apomorphy), with mandibles rather weak. Antenna polymerous (16–21 segments) with scape not elongate (about twice as long as wide). Pronotum long medially and wide, with hind margin straight (apomorphy). Forewing venation is similar to that of *Pelecinius* Latr. in RS seemingly long, two-branched, and in cells $1+2r$, $2rm$, $3rm$, $1m-cu$, $2m-cu$ not closed with tubular veins, but with 'RS₂' probably representing displaced M (no other M present, unlike in *Peleciniidae*), $1-RS+M$ and basal $2-RS+M$ lost, $2-RS+M$ basal of $2r-rs$ and $1m-cu$ weak and widely interrupted (all apomorphies), $M+Cu$ and Cu forming strong and straight or somewhat arched vein reaching wing margin (synapomorphy of Proctotrupomorpha, secondarily lost in various subtaxa with reduced wing venation). Hindwing with rm cell closed or open, with few (three) hamuli on small triangular projection. Metasoma with segmentation homonomous except first tergum moderately short but not forming a petiole, and except female hypopygium much enlarged (exceeding half metasoma length and reaching ovipositor sheaths) and acuminate (apomorphy) but not coadapted with tergum to cover metasomal apex. Ovipositor not modified: neither internalized, nor with sheaths transformed into working (intromitting) tool. Cerci unusually long (apomorphy).

Genera included. Two genera described herein.

Remarks. The new family is based on three inclusions, rather poorly preserved due to partial distortion and integument degradation typical of fossil resins of the rumanite type (cf. Zhang et al., 2017). This makes interpretation of the material not at all straightforward. Nevertheless, the observable features are unique in their combination and bear phylogenetic and taxonomic importance. These fossils, therefore, deserve description and further study in spite of their suboptimal state of preservation.

The taxonomic position of these fossils is possible to identify based on the following combination of characters, evaluated under the phylogenetic concept of Rasnitsyn (1988, 2002). The wing venation and, particularly, the long triangular marginal ($3r$) cell combined with straight ($M+Cu$) with no kink at either $1m-cu$ or $2cu-a$ are indicative of Proctotrupoidea (to a lesser extent also of Cynipoidea and Diaprioidea, which differ in having the first metasomal segment modified into a long or short petiolar tube). In fact, the above venation characters represent a synapomorphy of the entire infraorder Proctotrupomorpha, secondarily lost multiple times, mainly in the course of a further venational reduction, within various superfamilies but only rarely in Proctotrupoidea (Rasnitsyn, 1988). Within the superfamily (sensu Rasnitsyn, 1988, i.e. including Mesoserphidae), the external ovipositor with the sheaths retaining their plesiomorphic protective function and not transformed into an intromitting tool (as occurs in Proctotrupidae including *Vanhornia* Crawford) is known only in the extinct family Mesoserphidae and in Roproniidae. However, the latter differ in having a long tubular, modified first metasomal segment. Therefore, we are left with Mesoserphidae—the basal lineage of Proctotrupoidea and, by inference, of Proctotrupomorpha in general (Rasnitsyn, 1988)—as the only possible placement for the fossils under consideration. However, several striking putative apomorphies, not at all characteristic of Mesoserphidae and some of them unique among the entire infraorder Proctotrupomorpha, contradict such a placement. These are:

1. Prognathous head;
2. Pronotum long, with straight hind margin (transversely subquadrate);
3. Forewing with $2-RS+M$ extended beyond $2r-rs$, so that RS and M are forking distal of $2r-rs$, with M resembling 'RS₂' of *Peleciniidae*;
4. Female hypopygium much enlarged;
5. Cercus very long.

These apomorphies make it impossible, at least in our opinion, to include the fossils at hand into Mesoserphidae and, therefore, justify erection of a new family for them.

Genus *Peleserphus* gen. nov.

(LSID: urn:lsid:zoobank.org:act:7FF1BD88-41DA-4477-8A74-CBA99FF3183B)

Type species. *P. brachyurus* sp. nov.

Etymology. The genus name combines the truncated genus names *Pelecinius* and *Mesoserphus*. Gender masculine.

Diagnosis. Head only slightly wider than pronotum. Antenna 16-segmented. Pronotum without subbasal transverse ridge. Forewing with $1m-cu$ partially present. Hindwing without closed cells. Hind tibia distinctly incrassate and somewhat narrowed at apex (indicative of hypertrophied subgenual vibration detector). Ovipositor about 0.2 times as long as metasoma.

Species included. Type species *Peleserphus brachyurus* sp. nov. and *P. genalis* sp. nov.

Peleserphus brachyurus sp. nov.

(LSID: urn:lsid:zoobank.org:act:A1623076-1A1F-4907-8BF9-B91901A4A977)

Fig. 1

Etymology. *Brachyurus* is the Greek for short-tailed.

Holotype. NIGP166459. Nearly complete except one antenna and some leg parts missing; partially deformed, with integuments degraded and some parts, particularly on the right body side (mesosoma, metasomal base, and several flagellar segments, marked with asterisks in Fig. 1), flattened and variably expanded.

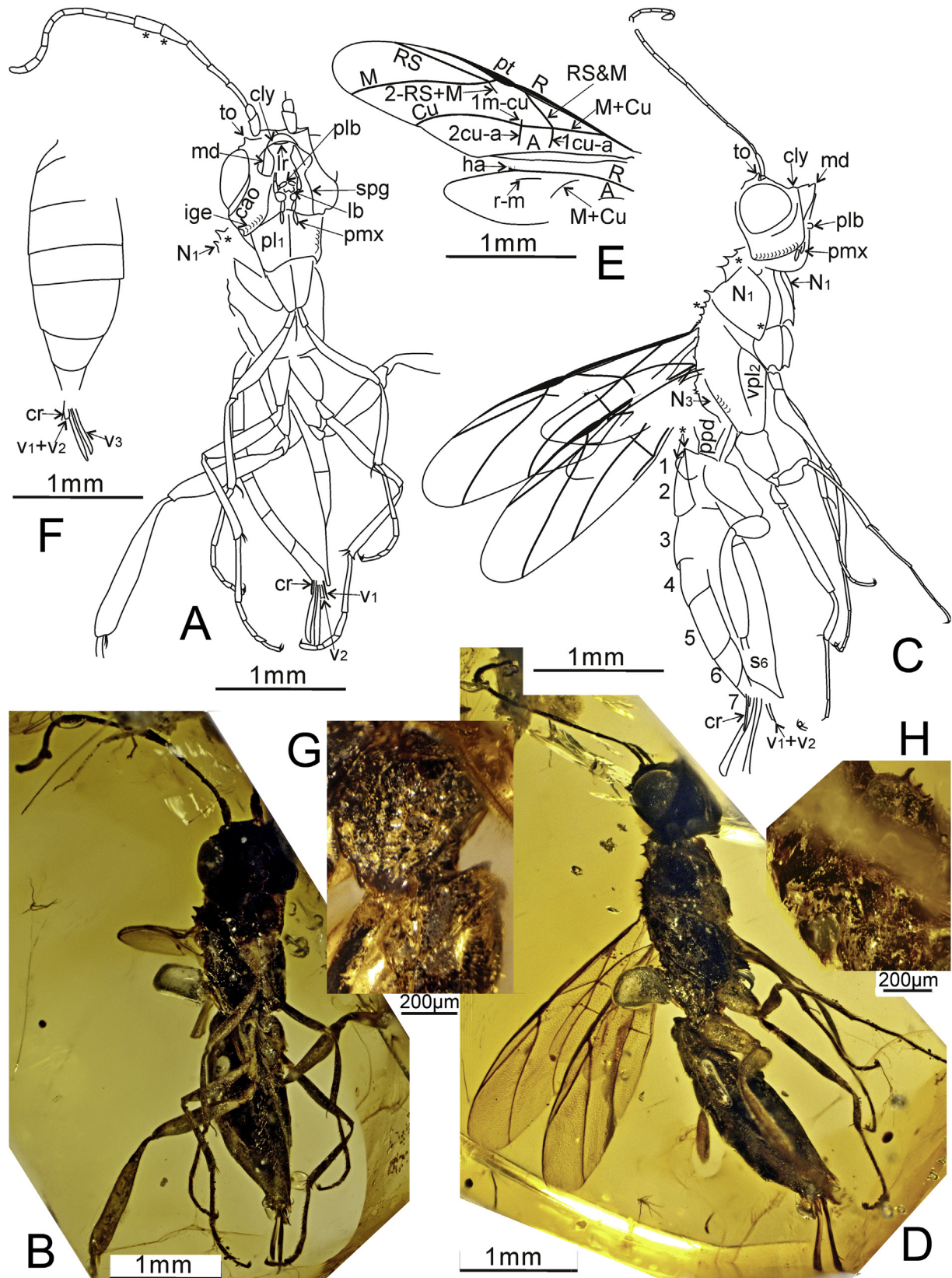


Fig. 1. *Peleserphus brachyurus* sp. nov. Holotype NIGP166459. A, B. Ventral view. C, D. Lateral view. E. Wing venation showing vein homology (vein names standard). F. Metasoma, dorsal view. G. Propodeum and metasomal base, lateral view, showing comparatively intact first metasomal segment. H. Mesosoma, lateral view, partial, showing comparatively intact mesonotal spines. Symbols: cao – adocular carina, cly – clypeus, cr – cercus, ha – hamuli, ige – genal groove, md – mandible, lb – labial lobes, lr – labrum, pl₁ – propleuron, N₁ – pronotum, plb – labial palp, pmx – maxillary palp, pld – propodeum, s₆ – terminal metasomal sternum (in female), to – extension of torulus (antennal attaching sclerite), v₁ – ventral stylet of ovipositor, v₂ – dorsal stylet of ovipositor, v₃ – ovipositor sheath, vpl₂ – mesoventropleuron, 1 through 7 – metasomal terga, * – asterisk marking particularly strong deformation (compression and stretching).

The amber piece is transparent, with some scattered debris and bubbles, polished as a semi-circular pillar about 10 mm in diameter and about 4 mm high.

Locality and Horizon. Hukawng Valley, Kachin State, Myanmar; lowermost Cenomanian or uppermost Albian, mid-Cretaceous.

Diagnosis. Head with temple wide, genae widely separated, mandibles sharp, triangular, and notched dorsally. Mesonotum with conspicuous, partly bent spines. Forewing length, 2.5 mm.

Description. Body dark brown except legs pale. Head transverse, broad, eyes large, oval; antennae attached to pair of adjacent lobes elevated above short, subvertical clypeus; mandibles sharp, triangular, with cutting edge subparallel to mandible rotational axis; labial palp 2-segmented, short, with terminal segment longer than wide; maxillary palp 5-segmented; genal groove narrow. Antenna 16-segmented, torulus visible, scape about twice as long as pedicel, pedicel narrower than scape and longer than wide; flagellum filiform, with segments of nearly uniform width, densely covered with fine setae, first flagellomere as long as pedicel and scape combined, remaining flagellomeres gradually becoming shorter towards apex but at least twice as long as wide, terminal flagellomere rounded, longer than penultimate one, with group of long setae. Mesosoma slightly narrower than head, pronotum long; pronotum, mesonotum, and mesoscutellum of about equal length; mesotergum and pronotum with numerous spines; ventral end of left mesopleuron also with 4–5 spines visible; metanotum short; propodeum narrowed apically and coarsely reticulate. Legs of ordinary shape, fore- and midcoxae subequal in length, about twice as long as wide and more than half as long as hind coxa; trochanters cylindrical, longer than wide; foreleg with tibia as long as femur, and 1 tibial spur simple and arched; midleg with femur longer than tibia; hindleg with tibia longer and thicker than femur; mid- and hind-leg with 2 apical tibial spurs. Forewing with pterostigma long and gradually narrowed distally, issuing 2r-rs at its midlength; basal vein (RS&M, Fig. 1E) straight, connected to R before pterostigma; 2r-rs slightly longer than pterostigma width; Rs straight and reaching anterior wing margin well before wing apex, making cell 3r narrow and elongate; 2-RS+M distinct, light-colored and short; remnant 1m-cu short and connected with 2cu-a; M slightly arched; Cu distinct and subparallel to M; M and Cu reaching outer wing margin; A distinguishable; 1cu-a interstitial and 2cu-a straight, both not reaching posterior wing margin, separated from one another by distance greater than length of 2cu-a. Hindwing with 2 or 3 hamuli, without closed cells visible, with two veins (M and Cu?) lacking bases, about 0.3 times as long as hindwing and almost reaching outer wing margin. Metasoma 7-segmented and apparently raised up at junction with propodeum, widest at posterior edge of third segment; first segment short and apical one triangular, all others uniform in general shape and size, almost equally long, quadrangular with angles rounded; sixth sternum extremely long. Ovipositor with sheaths moderately long, extending beyond abdomen apex, stylet broken off.

Measurements. Total body length, 3.6 mm; head length, 0.8 mm, width, 0.9 mm; mesosomal length, 1.6 mm; metasomal length, 2.0 mm; antennal length, 2.6 mm; forewing length, 2.5 mm; hindwing length, 1.3 mm, width, 0.4 mm; ovipositor sheath length, 0.6 mm.

Peleserphus genalis sp. nov.

(LSID: urn:lsid:zoobank.org:act:9AD1EE19-5D8A-4A4C-8C79-61F6FF7520C4)

Fig. 2

Etymology. Species name refers to the short genal bridge characteristic of the species,

Holotype. NIGP166460. Amber piece preserving an almost complete female wasp with some scattered debris around; partly clouded, with the mesosoma and most of the metasoma especially obscured with air bubbles; polished as a subquadrate cabochon, 15 by 10 mm, about 2 mm high. The degraded integuments, dark body color, and squashed deformation make the surface sculpture difficult to discern; the deformation particularly strongly affects the head, antennae, and legs, with the eye cuticle being almost completely decayed and most of the legs strongly distorted.

Locality and Horizon. Hukawng Valley, Kachin State, Myanmar; lowermost Cenomanian or uppermost Albian, mid-Cretaceous.

Diagnosis. Head with temple narrow, genae meeting medially to form short genal bridge, mandibles small but not short, parallel-sided, with oblique sinuate cutting edge, not notched dorsally. Mesonotum with spines short and not numerous. Forewing longer than 4 mm.

Description. Body dark brown, except antennae and legs. Head medium-sized, longer than wide, with eyes large and almost reaching posterior head margin. Maxillary palps thin and long, 5-segmented; labial palps short, with 2 segments visible. Mandible moderately narrow, with cutting edge subparallel to mandibular rotational axis; hypostomal carina distinguishable; other mouthparts poorly preserved. Antennae thin, nearly as long as metasoma, segments of nearly uniform width; scape straight, about as wide as pedicel and as long as first flagellomere; pedicel small and subquadrate, as wide as first flagellomere; flagellomeres 1–5 thin in dorsal view, 6–9 nearly three times as long as wide, shorter than first; remaining ones gradually becoming shorter but each at least twice as long as wide; terminal rounded apically, 1.5 times as long as penultimate one. Mesosoma narrower than head, squashed dorsoventrally. Pronotum long, 0.2 times as long as mesosoma, with several spines discernable on lateral margin; mesonotum and mesoscutellum quadrangular with slightly rounded angles; mesonotum and mesoscutellum not flat, with jagged edge visible; metanotum not distinguishable but probably short; propodeum triangular; structures of lateral and ventral mesosoma insufficiently preserved. Legs deformed, particularly mid- and hind pairs, hind femur and tibia thickened; fore- and mid-coxae subequal in length, smaller than hind coxa; tibiae apparently as long as respective femora; fore- and mid-tibiae with only one apical spur, simple and acute; basitarsus as long as remaining segments, segment 4 shortest; claws symmetrical, acute, and moderately bent. Forewing and hindwing venation as in type species. Forewing with 2-RS+M short but connected to 1m-cu as weak, nebulous vestige; hindwing venation reduced. Metasoma fusiform with 7 visible segments, first segment short, second longer than first, all others poorly visible because of deformation, terminal one with straight posterior edge. Ovipositor long but hidden in metasoma for most of its length, with stylets originating before or near metasoma midlength, with sheaths thin, rodlike, 0.2 times as long as forewing. Cercus thin, rodlike, unusually long (almost half as long as ovipositor sheaths), conspicuously setose apically.

Measurements. Total body length, 8.4 mm; head length, 1.6 mm, width, 1.3 mm; mesosomal length, 2.9 mm; metasomal length, 4.1 mm; antennal length, 4.0 mm; forewing length, 4.2 mm, width, 1.5 mm; hindwing length, 2.6 mm, width, 0.9 mm; ovipositor length, 2.5 mm; sheath length, 0.8 mm.

Remarks. This specimen differs from the type species by its distinctly larger body size and other characters summarized in the diagnosis above.

Genus *Peleproctus* gen. nov.

(LCID: urn:lsid:zoobank.org:act:DDF5F918-F7DF-4C16-BC6C-5474B072A1E3)

Type species. *P. dolichurus* sp. nov.

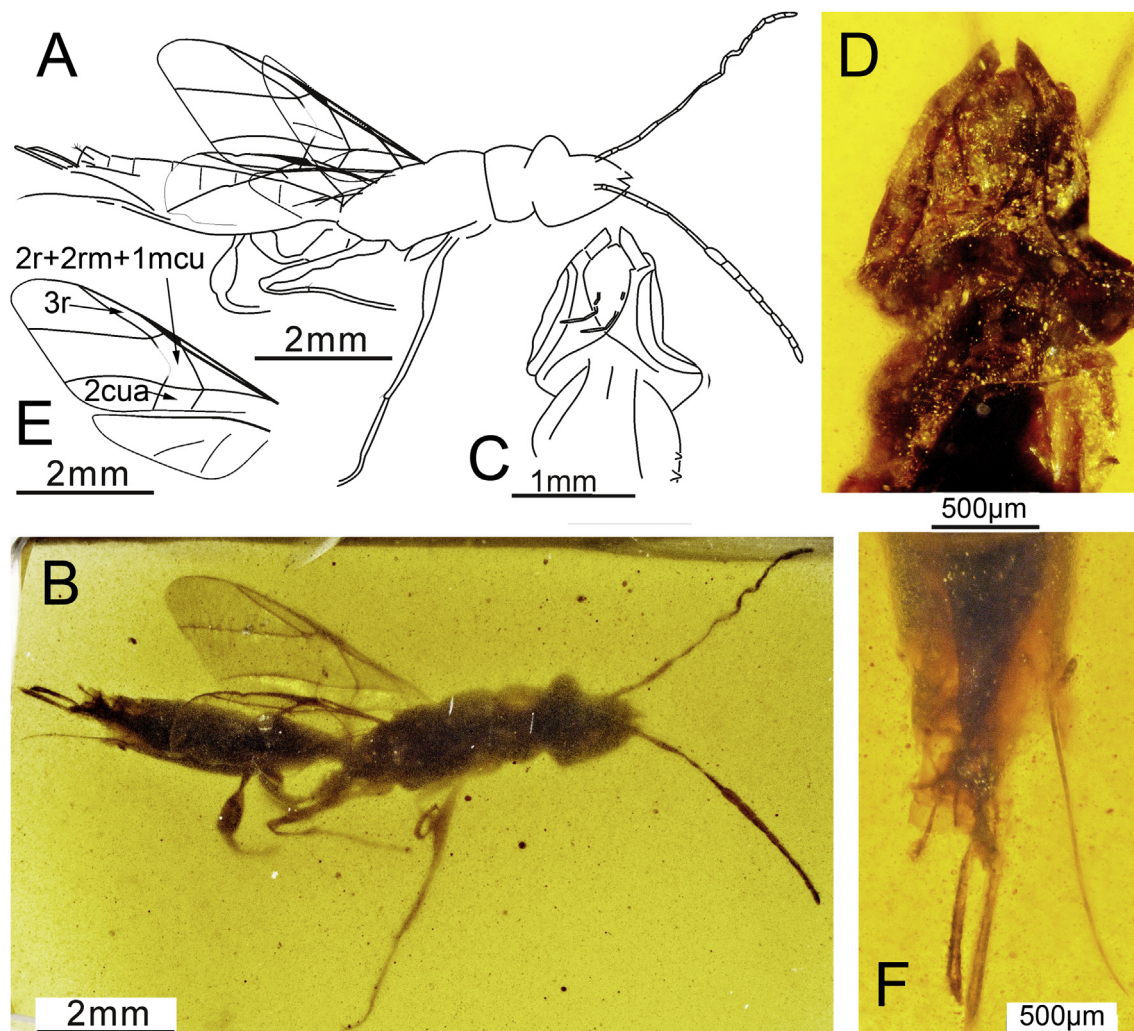


Fig. 2. *Peleserphus genalis* sp. nov. Holotype NIGP166460. A, B. Dorsolateral view. C, D. Head and prothorax, ventral view, showing short genal bridge and short spines on pronotum. E. Wing venation. F. Metasomal apex with ovipositor.

Etymology. The genus name combines the truncated genus names *Pelecinus* and *Proctotrupes*. Gender masculine.

Diagnosis. Head very big (1.5 times as wide as pronotum). Antenna 21-segmented. Pronotum with subbasal transverse ridge arched. Forewing with 1m-cu completely lost. Hindwing with basal (rm) cell closed. Hind tibia not particularly incrassate. Ovipositor almost as long as metasoma.

Species included. Type species only.

Peleproctus dolichurus sp. nov.

(LSID: urn:lsid:zoobank.org:act:E8ABDF79-8CBF-4763-8276-4506A9B5304C)

Fig. 3

Etymology. *Dolichurus* is the Greek for long-tailed.

Holotype. NIGP166461. A complete insect in a piece of amber with some scattered debris and filaments, with an opaque plane cutting through and obscuring the antennae and legs. The body surface is obscured by numerous small irregular cracks, which make it hard to see the integument structure, while the dark staining of amber around the body and appendages additionally hinders observation; however, there is no obvious deformation. The amber piece is polished as a rectangular trapezoidal cabochon, 10 mm wide at the top, 15 mm wide at the bottom, about 10 mm long and 2 mm high.

Locality and Horizon. Hukawng Valley, Kachin State, Myanmar; lowermost Cenomanian or uppermost Albian, mid-Cretaceous.

Diagnosis. As for the genus.

Description. Body dark brown with legs brown. Head large, nearly oval, transversely broad; eyes large and widely spaced. Antennae 21-segmented, attached near anterior eye margins, scape twice as long as wide, pedicel small, slightly longer than wide; flagellomere 1 about as long as scape and pedicel together, narrowed basally; flagellomeres 2–5 about as long as first, remaining ones slightly shorter and thinner than 5 but still longer than wide; terminal one rounded. Mesosoma oblong; pronotum slightly shorter than wide, widest at midlength, with hind margin deeply arcuate; mesonotum narrowed basally. Fore- and midlegs similar in size, narrow, with coxa long and narrow, each leg with tibia longer than femur but shorter than tarsus; hindleg distinctly thicker than midleg, with femur thickened, tibia longer than femur and widened apically; mid- and hind-tibiae with two apical spurs; all tarsi with basitarsi as long as remaining segments, with fourth segment shortest; claws symmetrical, acute, and moderately bent. Forewing with pterostigma narrow and long, gradually decreasing in width distally, acute apically; 2r-rs about as long as pterostigmal width; cell 3r narrow and elongate; RS straight, reaching anterior wing margin well before wing apex; basal vein (RS&M) straight and connected to

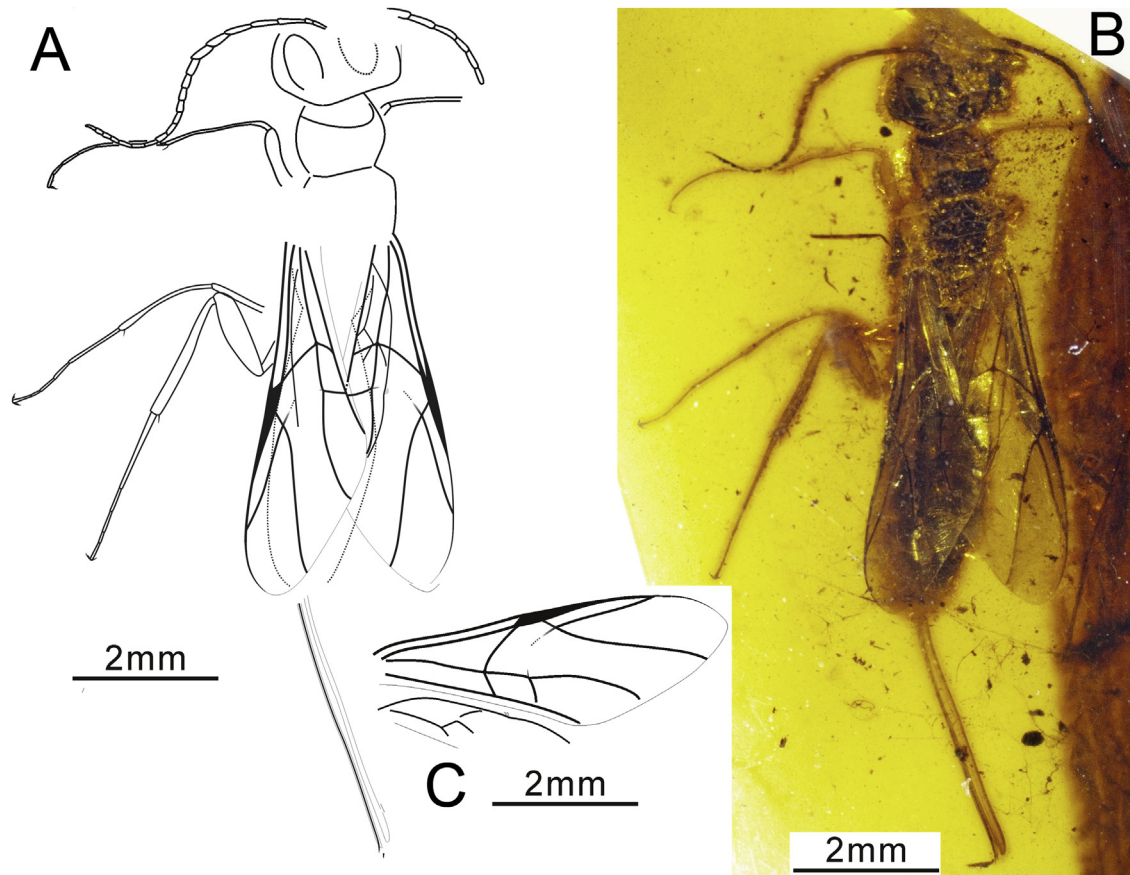


Fig. 3. *Peleproctus dolichurus* sp. nov. Holotype NIGP166461. A, B. Dorsolateral view. C. Wing venation.

R near pterostigma base; M reaching outer wing margin; 2-RS+M distinct near 2r-rs; 1m-cu rudimentary; 1cu-a interstitial and parallel to 2cu-a, distant from it by 1.5 lengths of 2cu-a; Cu subparallel to M. Hindwing with M+Cu present, r-rs longer than 1M and almost colinear with it, free M parallel to free Cu. Metasoma elongate-oval, about as long as mesosoma, with no structures visible. Ovipositor and sheaths slender, slightly longer than metasoma.

Measurements. Total body length, 8.5 mm; head length, 1.5 mm, width, 1.7 mm; mesosomal length, 2.9 mm; metasomal length, 4.0 mm; antennal length, 4.4 mm; forewing length, 4.9 mm, width, 1.5 mm; hindwing length, 2.7 mm, width, 0.5 mm; ovipositor length, 3.6 mm.

4. Discussion

The new family, even though incompletely known because of the poor state of preservation of the available material, considerably expands our knowledge of Hymenopteran diversity during the mid-Cretaceous. The basal Proctotrupomorpha, particularly Mesoserphidae, flourished during the Jurassic and occurred uncommonly in the pre-Albian Early Cretaceous (Shi et al., 2013, and references therein). The present findings are the first records of the basal Proctotrupomorpha from as late as the mid-Cretaceous, when the majority of advanced branches of the infraorder Proctotrupomorpha had already appeared and were highly diverse (Rasnitsyn et al., 2016, SI table 1). This characterizes the records of Peleserphidae from Burmese amber as relictual.

The new family shares no distinct synapomorphies with any main proctotrupomorph branch and therefore we consider it as an isolated blind basal offshoot of the basal proctotrupomorph superfamily Proctotrupeoidea. It can be hypothesized that these wasps

had a host, possibly a holometabolous larva, concealed within a substrate, perhaps wood or the like. This is suggested by the specific combination of characters, described by Vilhelmsen and Turrisi (2011), namely, the big prognathous heads, the long external ovipositor in one genus (*Peleproctus* gen. nov.), and the hypertrophied subgenual vibration detector in the other (*Peleserphus* gen. nov.).

5. Concluding remarks

Peleserphidae fam. nov. adds the sixth to the above list of endemic families of Hymenoptera described from the Burmese amber (see Introduction)—more than in any other Cretaceous or Cenozoic amber assemblage. This list is not yet complete (APR, pers. observ.) but is already longer than such a list for the Levantine amber. Because the Levantine amber is the oldest among relatively rich hymenopteran amber assemblages and represents the only Cretaceous amber assemblage which is unquestionably Gondwanian, it is expected to include numerous endemics. Yet, surprisingly, it does not. The reasons remain obscure, calling for a more thorough study of the history, paleogeography, and biota of the Burmese terrain.

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