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A new genus and species of the subfamily Pemphredoninae (Hymenoptera: Crabronidae) in Upper Cretaceous amber from Myanmar



Un nouveau genre et une nouvelle espèce de la sous-famille Pemphredoninae (Hymenoptera : Crabronidae) de l'ambre Crétacé supérieur de Birmanie

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ABSTRACT

A new genus and species from the subfamily Pemphredoninae (Hymenoptera: Crabronidae) is described from the Upper Cretaceous amber of Myanmar, commonly known as Burmese amber. A complete, illustrated description is provided. *Colmepsiterona cumcarena* n. gen. et sp. represents the third record of the subfamily in the deposit, as well as the tenth of the family Crabronidae in Mesozoic. This taxon is morphologically close to *Cretospilomena familiaris*, previously described in the same deposit. However, although numerous features are shared, a number of unique features justify the proposition of a new genus. The co-occurrence of three specimens belonging to the same taxon could be interpreted as an example of a social behavior, compact nesting behavior, or possibly a sexual congregation.

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R É S U M É

Un nouveau genre et une nouvelle espèce de la sous-famille Pemphredoninae (Hymenoptera : Crabronidae) sont décrits dans l'ambre de Birmanie du Crétacé supérieur. Une description complète et illustrée est fournie. *Colmepsiterona cumcarena* gen. et sp. nov. représente le troisième enregistrement fossile de la sous-famille dans le gisement ainsi que le dixième de la famille Crabronidae au Mésozoïque. Ce taxon est morphologiquement proche de *Cretospilomena familiaris*, précédemment décrit dans le même gisement. Cependant, bien que de nombreux caractères soient partagés, un certain nombre de caractères uniques justifient l'établissement d'un nouveau genre. La co-occurrence de trois spécimens de même affinité taxonomique pourrait être interprétée comme la manifestation d'un comportement social, de nidification compacte, ou bien encore de regroupement sexuel.

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1. Introduction

The subfamily Pemphredonidae is composed of medium-sized to tiny wasps and is one of the most generalized taxa of the family Crabronidae. The subfamily is widespread: records have been reported from all continents except Antarctica, and nearly all members of the subfamily are solitary wasps (Kim and Yang, 2010). Their typical prey items belong to various hexapod taxa such as Auchenorrhyncha, Sternorrhyncha, Thysanoptera, or Collembola (Bohart and Menke, 1976). They are abundant in terrestrial habitats and show various nesting tactics (Bennett et al., 2014).

Sixteen fossil genera of Pemphredoninae have been reported from Upper Cretaceous ambers of Siberia, Vendée (France), Canada, Myanmar and New Jersey (Antropov, 2000a, 2000b, 2011; Bennett et al., 2014; Budrys, 1993; Evans, 1969, 1973), middle Eocene Saxonian amber (Ohl and Bennett, 2009), and Eocene Baltic and Rovno ambers (Antropov and Perkovsky, 2009; Budrys, 1993; Sorg, 1986). A few descriptions have been made also from compression fossils (Antropov et al., 2014; Zhang, 1989). Most of these genera are highly specialized forms (Antropov, 2011). Herein, we report the discovery of a new genus and species from Cretaceous Burmese amber. This discovery adds a tenth genus and species to our knowledge of the family Crabronidae in the Mesozoic, and it is the third taxon belonging to Pemphredoninae recovered from the deposit.

Burmese amber (from northern Myanmar) is considered as one of the most important deposits for studying terrestrial diversity around the boundary between the Lower and Upper Cretaceous (Ross et al., 2010). This deposit has been known for nearly 2000 years, and for centuries, was traded in China (Ross et al., 2010). It is rich in diverse insect inclusions, but plants and molds were also found. Only amber from Hukawng valley (northern Myanmar) was traded extensively, this material is often referred to as “Burmese amber”; the main source for this material being the site of the *Noije Bum* hill. Amber comes from the finer grained facies: clastic stones from sandstone to shale. Uranium-Lead radiometric dates obtained from zircons more accurately established the deposit age of the amber: 98.8 Ma (± 0.62), or Upper Albian to Lower Cenomanian (Shi et al., 2012).

2. Material and methods

This study was based on three specimens deposited in the Royal Saskatchewan Museum, Regina, Canada. The specimens originated from a single piece of amber. This piece was cut into two parts to separate the inclusions and thus, facilitate study. The preparation followed the methods established by Nascimbene and Silverstein (2000) for the preparation of fragile amber. Specimens were embedded in mineralogical-grade epoxy (Epotek-301) using a vacuum chamber, then cut and polished to remove excess material and provide clear views. Observations were made using a stereomicroscope (Leica MZ12.5) and a compound microscope (Olympus CH30), while photographs were obtained using a Visionary Digital macrophotography station (a Canon EOS 5D DSLR camera equipped with

a Canon MP-E-65 mm lens, on a motorized stand). Pictures were taken at various focal lengths and combined using Helicon Focus software in order to provide increased depth of field in the resulting images. Specimen illustrations were completed with a graphic tablet utilizing Sketchbook Pro and Adobe Photoshop software; this allowed us to trace anatomical features directly from specimen photographs.

All measurements are given in millimetres and were obtained with an ocular micrometre. Abbreviation include: RSM: Royal Saskatchewan Museum, Regina, Canada; HL: Head Length; HW: Head Width; MsL: Mesosomal Length; FWL: Forewing Length; MtL: Metasomal Length; PBL: Preserved Body Length. Notations include: first flagellomere and tarsomere are written Fl and tarsomere I; second, FlI and tarsomere II, etc.

3. Systematic Palaeontology

Superfamily Apoidea Latreille, 1802
 Family Crabronidae Latreille, 1802
 Subfamily Pemphredoninae Dahlbom, 1835
 Tribe Pemphredonini Dahlbom, 1835

Genus *Colmepsiterona*

Type of species. *Colmepsiterona cumcarena*, by original designation.

Diagnosis. Scapal basin broad (nearly one-third of head width) and tall (extending along most of height of compound eyes). Mesosoma with faint parapsidal lines. Propodeum minutely punctured with three pairs of dorsal longitudinal ridges (submedian, sublateral, lateral) and posterolateral horizontal spines; lateral carina bears row of foveae along lateral margin. Forewing venation with basal M, m-Cu and 2-Cu curved.

Remarks. The specimens described are close to the genus *Cretospilomena* Antropov, 2000 (this is suggested by a few characteristic features, particularly those related to the propodeum and the general pattern of the forewing venation). However, numerous characters (forewing proportions, palpal formula, etc.) are different, leading us to define a new genus. We can be relatively confident in our taxonomic placement, because the amber piece appears to contain both male and female members of the species. One of the specimens has twelve antennal segments and an exposed ovipositor tip, whereas the other two specimens have eleven antennal segments and lack exposed genitalia. This difference is probably due to sexual dimorphism, with one female and two males.

Etymology. The genus name is an anagram of the genus *Cretospilomena*, which shares many morphological similarities, and was previously described in the same deposit (Antropov, 2000a).

C. cumcarena new species
 (Figs. 1 and 2)

Material examined. Holotype, RSM inclusion number P3306.004a (anteriormost female in amber piece that also contains P3306.004b) from Upper Cretaceous Burmese amber. Two paratype inclusions (both probably males) numbered P3306.004b (posteriormost specimen in amber

piece that also contains P3306.004a), and P3306.005 (specimen in separate piece of amber). Originally, all three specimens came from the same piece of amber, which additionally contains a dipteran and is very rich in particulate inclusions. Each specimen has a peculiar posture, with the metasoma bent toward the ventral part and the head. This taphonomic feature could indicate behaviour, such as a defense reaction of the insects while they were mired in the fresh resin. Amber pieces dimensions: $12.7 \times 7.8 \times 3.9$ mm (containing P3306.004a and P3306.004b) and $11.4 \times 4.6 \times 3.6$ mm (P3306.005).

Diagnosis. As for genus, by monotypy.

Description: Integument preserved with dark brown color, with silver parts (taphonomic artefact); with margin between tergites and legs paler brown; middle and apex of mandibles colored in dark brown. Setae generally short and sparse, visible on antennae, vertex of head, eyes, mesopleuron and legs.

Head. Flattened anteriorly, hypognathous, much wider than long. Oval-shaped eyes, elongated, without postorbital groove or carina. Maxillary palpus with five segments, labial palpus with four segments. Non foveate occipital carina complete. Antennae with compact flagellomeres; very long, compressed scape (about three times length of pedicel), last flagellomere longer than preceding flagellomere, about length of flagellomeres X plus XI, with rounded apex. Short setae present on antennae (but sometimes longer than width of flagellomeres) and vertex of head. Deep grooves on the frons, above and below antennae. Long and thin mandibles, short malar space. Horizontal frontoclypeal suture deeply impressed between toruli, clypeus bulges dorsally. Distance between lateral ocelli representing about 3 ocellar diameters. Distance between median ocellus and lateral ocelli, about two ocellar diameters, and between lateral ocellus and compound eye, four ocellar diameters.

Mesosoma. Faint parapsidal lines present, mesoscutum about as long as one-quarter of mesosoma. Long pronotum with rectangular outline dorsally, quite strong slope at anterior edge; pronotal slope elongate forming a long neck with prominent transverse carina near mid-length and rounded lateral carinae bordering dorsal surface. Length of mesoscutum approximately equal to cumulative length of scutellum and metanotum; scutellum strongly convex, metanotum very short and convex; sutures between mesoscutum, scutellum, and metanotum nearly straight. Mesopleuron developed with thin setae, no visible setae on mesosoma otherwise, only prominent setae on mesosoma are those on dorsal surface of pronotum. Propodeum with pair of straight submedial carinae, punctured dorsally, and delimited by strong ridge ending laterally with spine. Transition between propodeum and metasoma formed by strong slope, slightly concave at bottom, then with longitudinal medial ridge.

Wing. Membrane hyaline. Pterostigma very thick (at least as broad as medial cell) and long; vein R1 long, almost reaching wing apex. All venation tubular. Apical Rs straight reaching anterior wing margin. Costal cell narrow, two submarginal cells: one large and pentagonal, and one small and subtrapezoidal. Discal cell subrectangular, as long as

first submarginal cell. Second cubital cell present. Apical segments of M and Cu, basal part of M, m-Cu, and 2-Cu curved.

Legs. Two hind tibial spurs roughly equal in length, and slightly longer than apical width of tibia; one mid tibial spur and one foretibial spur half-length of probasitarsus. Long and thin tibial spurs, especially on foreleg. Tarsal claws simple. Tarsomeres I–IV decreasing in length, tarsomere I longer than tarsomeres II–IV combined. Setae short and inclined on tibia and tibial spur; tarsomeres I–IV with more abundant and long setae. Arolium well-developed and plantulae visible on mid-leg.

Metasoma. Wide (maximum width: 0.57 mm), and long (metasoma represents about 60% of total body length; size does not appear to be related to taphonomic distortion). Anterior slope of metasoma with very faint pair of grooves present at base, then disappearing posteriorly. Five tergites visible, second is widest and longest; then length and width decreasing toward apex. Tergite T1 and T2 articulated with each other, posterior margin of T1 prominent dorsally and laterally. Short petiole present. Metasomal apex appears narrow and without pygidial plate.

Measurements. Three specimens are listed in sequence P3306.004a holotype (anterior)/P3306.004b paratype (posterior)/P3306.005 (second paratype). HL: 0.30/0.28/0.23; HW: ?/0.53/0.63; BL: 2.73/3.08/2.88; MsL: 0.93/1.0/1.0; Mtl: 1.50/1.80/1.65; FWL: 1.65/1.53/1.58; PBL: 3.97.

Etymology. The species name is formed with the Latin words *cum* meaning “with” and *carena*. It refers to the particular carinate ornamentation of the specimen.

4. Discussion

The new fossils clearly belong to the subfamily Pemphredoninae on the basis of having a single mesotibial spur and simple tarsal claws. The characteristic wing venation, with a large pterostigma and two submarginal cells, as well as the presence of a short petiole, allows placement within the tribe Pemphredonini. Like the two species previously described from Burmese amber by Antropov (2000a), the new specimens combine features of the subtribes Stigmina Bohart and Menke, 1976 and Spilomenina Menke, 1989. Consequently, the genus cannot be assigned confidently to a subtribe. However, the new specimens seem to be more closely related to the subtribe Spilomenina. This is suggested by a few features: the presence of five-segmented maxillary palpi; a short petiole formed with tergite I and sternite I (Antropov, 2000a); a fairly large pterostigma; and a single discal cell within the forewing. Furthermore, the antennal sockets are positioned low on the frons, adjacent to the clypeus, which is a character of the subtribe Stigmina.

The new fossils show some features that clearly distinguish them from the two species previously described by Antropov (2000) in Burmese amber. Members of *Prolemistus apiformis* and *Cretospilomena familiaris* have six maxillary palpal segments (not five), and a frons that is flat and not convex like in the new fossils. The scutellum is also flat in both existing genera, whereas the new fossils have an obviously convex scutellum. Finally, the wing venation is less complete in the new fossil speci-

mens, at least compared to that of *Prolemistus*. Features such as the presence of tarsal plantulae, and palpal segments that are not particularly shortened are unique to the new genus.

C. cumcarena is morphologically closest to *C. familiaris*, with numerous shared features. The two species have a similar forewing venation, a propodeum divided by carinae ending posterolaterally with sharp spines, a head that is flattened with the upper frons slightly convex, a complete occipital carina, tarsal claws that are simple, and a petiole that is formed with tergite I and sternite I. However, more than half of the diagnostic characters of the genus differ from those observed in the new species, making it difficult to accommodate the new material within the existing genus. In the new genus, the palpal formula is different (5–4 and not 6–4), there are three pairs of longitudinal propodeal carinae (one in the genus *Cretospilomena*), and there are more than five hamuli on the hindwing (at least six, maybe seven or eight). There are also variations in the forewing cell proportions. For instance, the marginal cell is about two times as long as the pterostigma (1.5 times as long in *Cretospilomena*), and submarginal cell II is about 0.4 times as long as the marginal cell (0.3 times as long in *Cretospilomena*). Thus, the diagnosis of the genus differs by too many characters to consider the possibility of a new emended diagnosis of the taxon. It appears more reasonable to propose a new genus, until more material is available for study.

Among the crabronid wasps, the majority of species are characterized by solitary behaviour. However, some members of the subtribe Spilomenina show a complex social behaviour (Matthews, 1991). The presence of three specimens belonging to the same taxon in the same piece of amber may be explained by such a type of social behaviour. Alternatively, this co-occurrence could also be attributed to a sexual congregation (the three specimens appear to include one female and two males), or compact nesting behaviour, as has been suggested for multiple inclusions of *Cretospilomena* (Antropov, 2000a). The narrow metasomal apex and lack of a pygidial plate in *C. cumcarena* may suggest that it nested in wood, as has been proposed for *Cretospilomena* (Antropov, 2000a).

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