

Short communication

New female of *Aptenoperissus* from mid-Cretaceous Burmese amber (Hymenoptera, Stephanoidea, Aptenoperissidae)Qi Zhang^{a, b, c}, Alexandr P. Rasnitsyn^{d, e, *}, Haichun Zhang^b^a School of Geography and Tourism, Qufu Normal University, Rizhao 276826, China^b State Key Laboratory of Palaeobiology and Stratigraphy, Center for Excellence in Life and Palaeoenvironment, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China^c University of Chinese Academy of Sciences, Beijing 100049, China^d A.A. Borissiak Palaeontological Institute, Russian Academy of Sciences, Moscow 117647, Russia^e Natural History Museum, Cromwell Road, London SW7 5BD, UK

ARTICLE INFO

Article history:

Received 10 February 2018

Received in revised form

2 June 2018

Accepted in revised form 21 July 2018

Available online 26 July 2018

Keywords:

Hymenoptera

Aptenoperissidae

New species

Burmese amber

Unique morphology

ABSTRACT

A new female of the wasp family Aptenoperissidae from the mid-Cretaceous Burmese amber is described as *Aptenoperissus zonalis* Zhang & Rasnitsyn, sp. nov. and assigned to the genus *Aptenoperissus* Rasnitsyn & Poinar, 2017 due to a combination of double protibial spurs, polymeric geniculate antennae and wingless female body lacking a wasp waist. It is the second fossil female of this enigmatic and highly sexually dimorphic group that provides new and important information about morphological diversity and reveal remarkable characters, particularly in relation to the propleurae which are incorporated immovably into the thoracic box.

© 2018 Elsevier Ltd. All rights reserved.

1. Introduction

The family Aptenoperissidae was established on the basis of a single wingless female parasitic wasp from mid-Cretaceous Burmese amber (Rasnitsyn et al., 2017). Originally, it was attributed to the superfamily Ceraphronoidea and subsequently re-addressed as basal to the apocritan superfamily Stephanoidea: Ephialtitidae based on features of the newly found males (Zhang et al., 2018). The second female of this enigmatic and highly sexually dimorphic genus recently discovered in Burmese amber, reveals new and important features obscured in the earlier-described female. Herein we present a description of this interesting fossil.

2. Material and methods

The single individual described herein was collected from the amber mines situated in the Hukawng Valley of Kachin Province, Myanmar (locality in Kania et al., 2015: fig. 1). The rock yielding the

amber at this site was dated to the late Albian of the Early Cretaceous (97–110 Ma) based on paleontological evidence (Cruickshank and Ko, 2003). A more recent study determined the age of the rock to be 98.79 ± 0.62 Ma, or at the Albian/Cenomanian boundary, using U-Pb zircon dating (Shi et al., 2012). This date corresponds to the early Cenomanian, or the earliest Late Cretaceous. The amber displays clear traces of redeposition (Ross, 2015) and so can be older than enclosing rocks. Thus, we prefer to refer to the amber age as mid-Cretaceous informally.

The holotype is deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS). Observations and photographs were made with a Leica M165C stereomicroscope using a Leica DFC 420 camera. Line drawings were made with CorelDRAW software based on photographs. Helicon Focus Pro $\times 64$ was used to stack photos for better depth of field. 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:FC247F96-942B-49BC-A44E-37FD0384DE31.

3. Systematic palaeontology

Order: Hymenoptera Linné, 1758

Suborder: Vespina Laicharting, 1781

* Corresponding author. A.A. Borissiak Palaeontological Institute, Russian Academy of Sciences, Moscow 117647, Russia.

E-mail address: alex.rasnitsyn@gmail.com (A.P. Rasnitsyn).

Superfamily: Stephanoidea Leach, 1815

Family: Aptenoperissidae Rasnitsyn & Poinar, 2017

Genus *Aptenoperissus* Rasnitsyn & Poinar, 2017

Aptenoperissus zonalis Zhang & Rasnitsyn, sp. nov.

LSID: urn: lsid: zoobank.org: act: 08E4CE75-32C6-4000-B61A-35DCFB788718

Figs. 1 and 2.

Derivation of name. From the Greek *zone*, for belt, because of ornamentation of propodeum and metasomal terga.

Holotype. Female, NIGP167786. Complete specimen with apices of antenna cut and lower aspect obscured in part by cracks in the amber.

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

Diagnosis. Female. Propodeum and metasomal terga 1–5 with pale, transverse double-band, apparently consisting of small appressed setae. Flagellar segment 1 shorter than pedicel. Metatrochanter with dorsal lobe. Tarsomeres with lower apices bearing elongate setae, and lacking plantula. Metatarsal segment 4 much longer than wide.

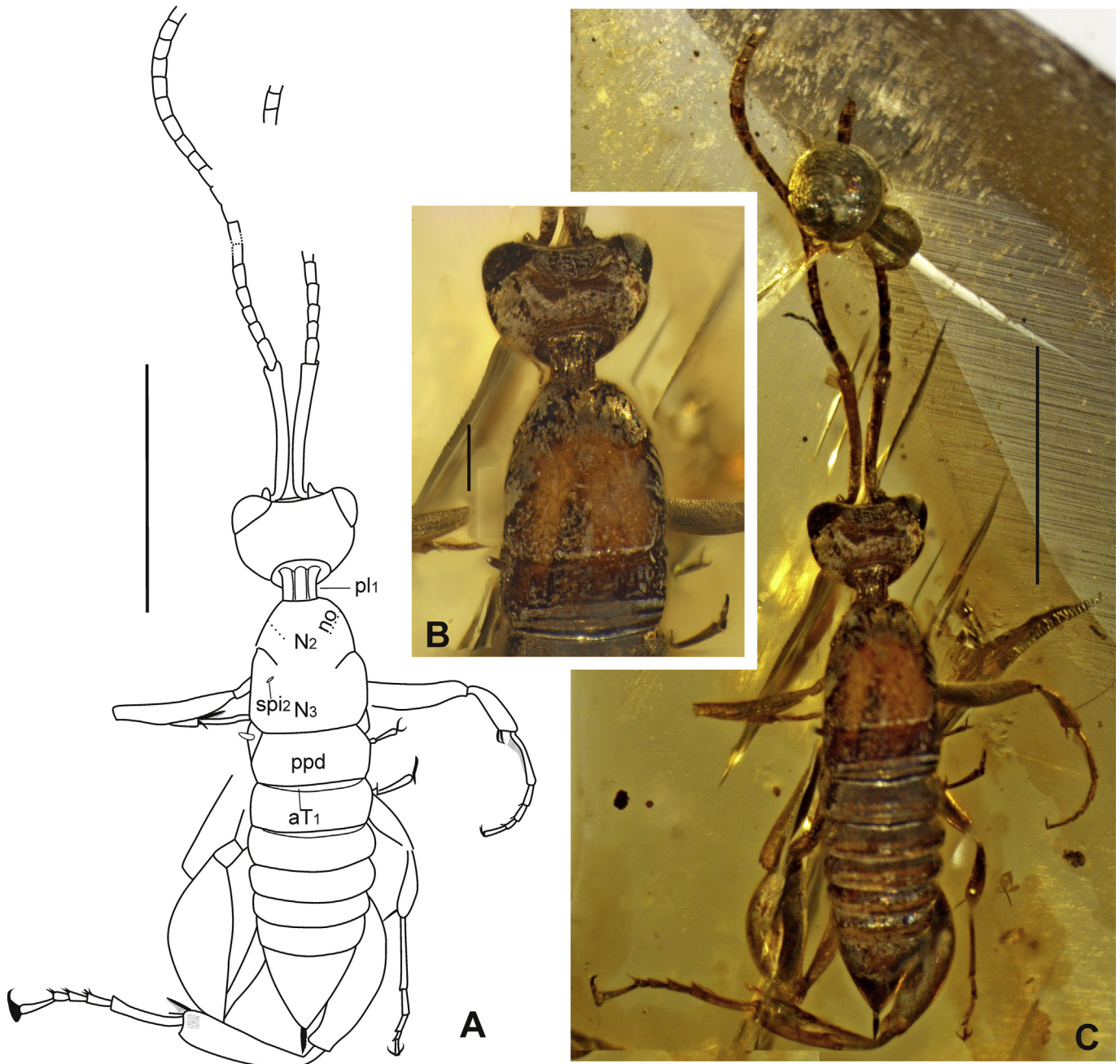


Fig. 1. *Aptenoperissus zonalis* sp. nov., holotype NIGP167786. A, C. Reconstruction and habitus in dorsal aspect. B. Head and mesosoma, dorsal view. Explanations of symbols in Figs. 1 and 2: aT₁ – antecosta of 1st metasomal tergum, occc – occipital carina, cx₁, cx₂, cx₃ – fore, mid and hind coxa, IT₁ – laterotergite of 1st metasomal tergum, N₁ – pronotum, N₂ – mesonotum, N₃ – metanotum, no – notaulus, oc – eye, ov – ovipositor, pl₁, pl₂, pl₃ – pro-, meso-, metapleuron, ppd – propodeum, spi₁–spi₅ – first 5 spiracles, tl₃ – hind trochantellus, tr₃ – hind trochanter, I–VI – metasomal segments. Dotted line denotes weakly impressed lines. Scale bar 1 mm (A, C), 0.2 mm (B).

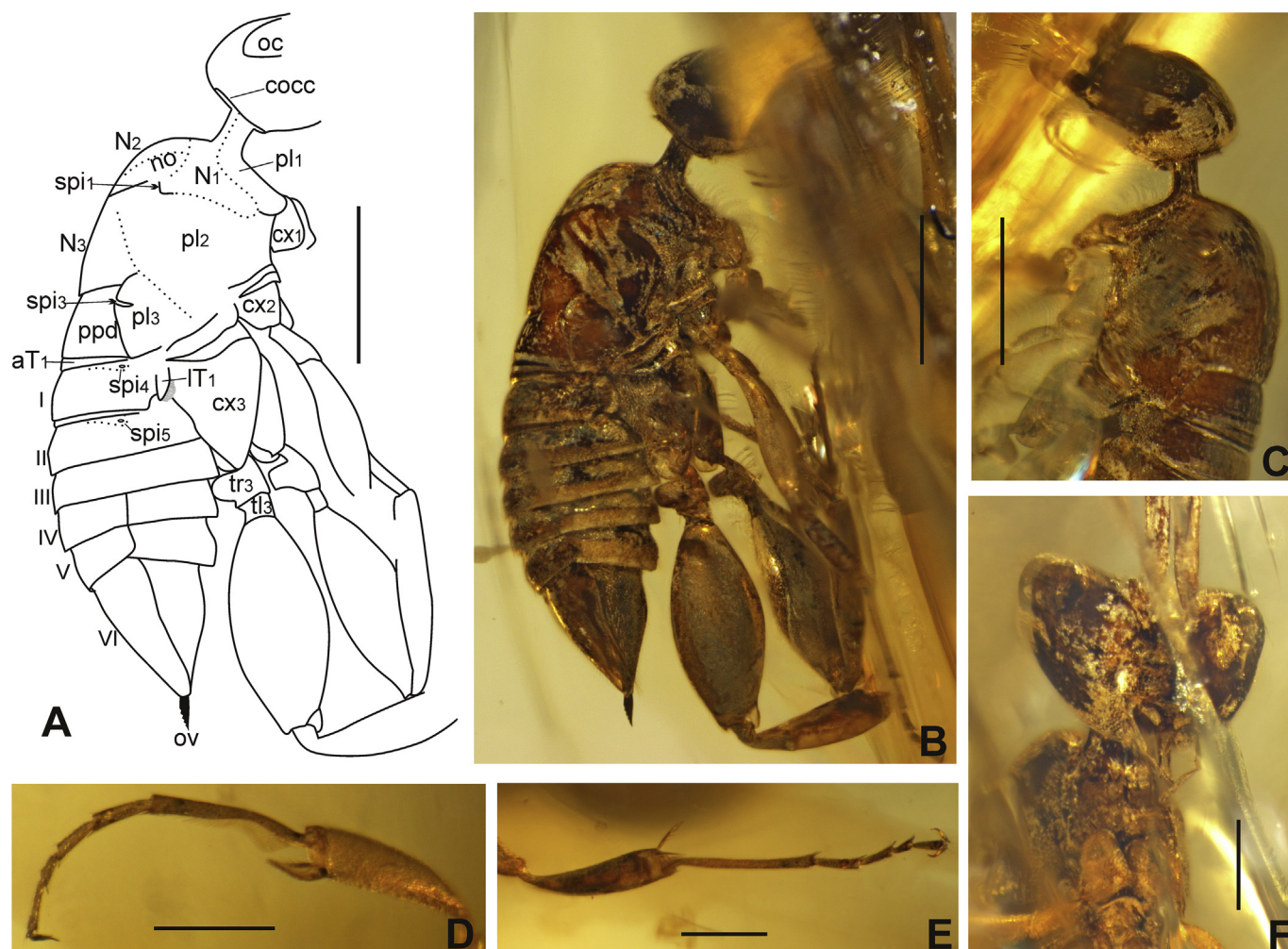


Fig. 2. *Aptenoperissus zonalis* sp. nov., holotype NIGP167786. A, B. Reconstruction and habitus in lateral aspect. C. Head and mesosoma, lateral aspect. D, E. Fore and mid tibia and tarsus. F. Head and anterior mesosoma, ventral aspect. Scale bar 0.5 mm (A–C), 0.2 mm (D–F).

Description. Body and appendages dark brown as preserved, propodeum and metasomal terga 1–5 with double apical transverse pale band apparently of small appressed setae. Surface sculpture weak (not well discernible). Head transverse in dorsal aspect, widened anteriorly, with prominent eyes. Compound eyes oval, not well visible. Ocelli absent. Antennal attachment medial to high, sublateral frontal lobes, close to clypeus. Clypeus narrow, convex. Occipital carina complete, forming comparatively small circle distant from mouth cavity (which is not visible). Antenna with at least 20 segments; scape about as long as thorax between neck and propodeum, bent outward basally (with side attachment), somewhat widened distally; pedicel similar to basal flagellomeres but slightly longer; flagellomeres almost uniform, subcylindrical, less than twice as long as wide, basal ones slightly shorter than others. Mandibles wide, slightly narrowing apically, but apex not visible. Maxillary palp with 2 short basal segments poorly visible, and 3 long and narrow apical ones growing longer apically. Labial palp with 1 wide, triangular basal segment, and 3 elongate distal ones. Mesosoma atypical in that thorax consolidated in almost sutureless box including propleurae; propodeum left delimited by sutures, or even folds, from both metanotum and metapleuron. Boundaries between pro-, meso- and metathorax mainly obscured, except for free posterior pronotal lobe above anterior spiracle. Long neck

formed with contributions from both pronotum and propleura, with boundaries not very distinct. Both first and third spiracular orifices covered with, respectively, pronotal lobe and excised metapleural fold; second (metathoracic) spiracle open. Mid and hind coxae attached widely to metasoma, hind coxa big. Hind trochanter with high dorsal lobe; hind trochantellus short, cylindrical; hind femur 2.2 times as long as wide. All tibiae shorter than respective femora, and rather robust; hind femur particularly robust, slightly narrowed apically, looking empty and hypertrophied except basally, supposedly providing wide space for putative subgenual vibration detector (cf. Orussidae and Stephanidae; Vilhelmsen et al., 2001, 2008). Each tibia with one spur moderately long and pectinate. Tarsi longer than tibiae, with ratios of dorsal length as follows, fore 1: 0.37: 0.29: 0.6: 0.39; mid 1: 0.34: 0.27: 0.14: 0.3; hind 1: 0.32: 0.21: 0.13: 0.63. Claws simple, moderately bent apically, gradually thickening basally, with several bristles at end of thicker part. Metasomal terga 1–5 similar to propodeum in form, except with distinct and rather long antecosta, and deeper basal transverse impression, growing shorter distally; terga 1–2 with small spiracles; tergum 1 with slightly deflected lateral lobe fringed along margin; tergum 6 triangular, about as long as terga 2–5 together. Preapical sterna similar to respective terga; apical sternum similar to its respective tergum in size and form, with

margins of both fit to each other and making metasomal apex closed at rest. Ovipositor internalized (incompletely so as preserved), comparatively thick, notched apically.

Measurements. Total body length, 2.2 mm; head length, 0.55 mm, width, 0.52 mm; mesosoma length (excluding neck), 0.75 mm; metasoma length, 0.9 mm; scape length, 0.57 mm; flagellum length, not less than 1.4 mm; hind femur length, 0.7 mm, width, 2.7 mm; fore and hind tibia length 0.35 and 0.65, respectively; fore, mid, and hind tarsus length, 0.59, 0.65 and 0.7 mm, respectively; metasoma length (excluding ovipositor), 0.98 mm.

Remarks. The present species is easily differentiated from the only known other female of *Aptenoperissus*, the familial type species *A. burmanicus* Rasnitsyn & Poinar, 2017, based upon the characters listed above under Diagnosis. The latter species has a body lacking obvious color patterns, with flagellar segments that are not shorter than the pedicel, a simple metatrochanter, tarsomeres ventroapically with cylindrical plantula, and 4th hind tarsomere shortened. As explained by Zhang et al. (2018), the deep sexual dimorphism prevents straightforward association of a female with any of the three males that have been described in the genus. The male of *A. formosus* Zhang & Rasnitsyn, 2018 is the only one similar to the present female in having the hind trochanter inflated (even though transversely and not dorsally), and the 4th tarsomere elongate. However, the difference between the male and female morphology is so deep in *Aptenoperissus* that we prefer to refrain from suggesting conspecificity of *A. zonalis* with *A. formosus* until more information is accumulated about these enigmatic insects.

4. Discussion

The new species described above unfortunately adds little to our understanding of the biology of *Aptenoperissus*, which is still obscure. Instead, it supports a certain diversity of Aptenoperissidae in the mid-Cretaceous Myanmar terrain, contrasting with another inference that the family was endemic to that terrain as one of other endemic families recorded there (Bryopompilidae, Melittosphaecidae, Myanmarinidae, Othniodellithidae, Peleserphidae, Sypastoxylidae; Ross, 2018; Diversinitidae; Haas et al., 2018).

Furthermore, *A. zonalis* provides new and important information about the morphological diversity of the family Aptenoperissidae and of the order Hymenoptera in general. As much as we are aware, the extent of thoracic consolidation revealed by the fossil under description is unique in the whole order, in that the propleurae are incorporated immovably into the thoracic box, which occurs in no other known wingless hymenopterans. Even female Mutillidae and Bradynobaenidae have propleura, movable in spite of the fact that their remaining mesosoma is fused into an almost sutureless box. What is particularly unexpected and difficult to explain is that the female *Aptenoperissus* has its propodeum well delimited throughout. Moreover, its propodeum forms a fold-like connection with the metapleuron, this character resembling the state characteristic of Symphyta and Orussoidea (Rasnitsyn et al., 2006; Rasnitsyn and Zhang, 2010) and lost by all Apocrita. Unfortunately, the preservation of available males of *Aptenoperissus* is not good enough to be certain concerning the propodeum-to-metapleuron contact, and yet one case seems to show a possible similarity to the state described herein (Zhang et al., 2018: fig. 2A). If the similarity proved real, this would mean that *Aptenoperissus* is either more basal than Ephialtitidae (which are similar to other Apocrita in that respect, cf. Rasnitsyn and Zhang, 2010: fig. 17a), or has undergone a reversal. Until more information is accumulated about the propodeum-to-metapleuron contact in the male *Aptenoperissus* and in additional Ephialtitidae, including particularly

Symphypterinae, it seems premature to draw phylogenetic and taxonomic inferences from the possible similarity under discussion.

5. Conclusion

The new species representing the second known female in the extravagant basal apocritan family Aptenoperissidae, and it reveals new and unexpected morphological information. The complete thoracic (not mesosomal) carapace unknown in any other Hymenoptera is combined with the propodeum separated from adjacent sclerites better than in any other Apocrita. The internalized ovipositor recalls that in a more basal family Orussidae only superficially: the latter has its abdominal apex closed only by enlarged apical tergum, with apical sternum being short. In contrast, metasoma of *Aptenoperissus* is closed with elongate apical sternum in parallel to that in Aculeata and many Proctotrupomorpha. In general, phylogenetic, taxonomic and adaptive interpretation of unique morphology of *Aptenoperissus* (double protibial spurs, polymerous geniculate antennae, thoracic and not mesosomal carapax, and others) depends on better knowledge of the group. And yet the data available, even though badly incomplete, attest Aptenoperissidae as an enigmatic taxon that makes the hymenopteran assemblage of the Burmese amber still more exotic and difficult to understand and to explain its singularity and isolation.

Acknowledgements

We offer our sincere gratitude to Dr. G.F. Turrissi (Catania, Italy) and the anonymous reviewer for their comments. This research was supported by the National Natural Science Foundation of China (41272013 and 41688103).

References

- Cruikshank, R.D., Ko, K., 2003. Geology of an amber locality in the Hukawng Valley, northern Myanmar. *Journal of Asian Earth Sciences* 21, 441–455.
- Haas, M., Burks, R.A., Krogmann, L., 2018. A new lineage of Cretaceous jewel wasps (Chalcidoidea: Diversinitidae). *PeerJ* 6, e4633. <https://doi.org/10.7717/peerj.4633>.
- Kania, I., Wang, B., Szewdo, J., 2015. *Dicranoptycha* Osten Sacken, 1860 (Diptera, Limoniidae) from the earliest Upper Cretaceous Burmese amber. *Cretaceous Research* 52, 522–530.
- Rasnitsyn, A.P., Zhang, H.C., 2010. Early evolution of Apocrita (Insecta, Hymenoptera) as indicated by new findings in the Middle Jurassic of Daohugou, Northeast China. *Acta Geologica Sinica (English Edition)* 84 (4), 834–873.
- Rasnitsyn, A.P., Ansoorge, J., Zhang, H.C., 2006. Ancestry of the orussoid wasps, with description of three new genera and species of Karatavidae (Hymenoptera = Vespidae: Karatavitoidea stat. nov.). *Insect Systematics and Evolution* 37, 179–190.
- Rasnitsyn, A.P., Poinar Jr., Brown, A.E., 2017. Bizarre wingless parasitic wasp from mid-Cretaceous Burmese amber (Hymenoptera, Ceraphronoidea, Aptenoperissidae fam. nov.). *Cretaceous Research* 69, 113–118.
- Ross, A., 2015. Insects in Burmese amber. *Entomologentagung Frankfurt/M. Programm und Abstracts*, p. 72.
- Ross, A.J., 2018. Burmese (Myanmar) amber taxa. on-line checklist v.2018.1. 96pp. <http://www.nms.ac.uk/explore/stories/natural-world/burmese-amber/>.
- Shi, G., Grimaldi, D.A., Harlow, G.E., Wang, J., Wang, J., Wang, M., Lei, W., Li, Q., Li, X., 2012. Age constraint on Burmese amber based on U-Pb dating of zircons. *Cretaceous Research* 37, 155–163.
- Vilhelmsen, L., Isidoro, N., Romani, R., Basibuyuk, H.H., Quicke, D.L.J., 2001. Host location and oviposition in a basal group of parasitic wasps: the subgenual organ, ovipositor apparatus and associated structures in the Orussidae (Hymenoptera, Insecta). *Zoomorphology* 121, 63–84.
- Vilhelmsen, L., Turrissi, G.F., Beutel, R.G., 2008. Distal leg morphology, subgenual organs and host detection in Stephanidae (Insecta, Hymenoptera). *Journal of Natural History* 42, 1649–1663.
- Zhang, Q., Rasnitsyn, A.P., Wang, B., Zhang, H.C., 2018. New data about the enigmatic wasp from mid-Cretaceous Burmese amber (Hymenoptera, Stephanioidea, Aptenoperissidae). *Cretaceous Research* 84, 173–180.