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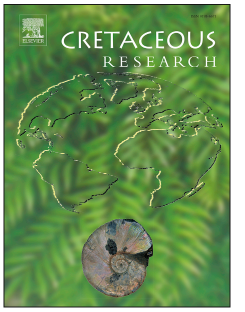

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The first cyclaxyrid beetle from Upper Cretaceous Burmese amber (Coleoptera: Cucujoidea: Cyclaxyridae)

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Abstract:

Cyclaxyridae is a small cucujoid beetle family, and no fossil cylaxyrids have been known up to date. Here we report the first definitive Mesozoic cylaxyrid, *Cyclaxyra cretacea* sp. nov., based on a single well-preserved adult from the Upper Cretaceous Burmese amber. The fossil can be placed in the extant genus *Cyclaxyra* of Cyclaxyridae, based on its morphological similarities to the extant species, especially the single pair of large deep foveae located at the anterior half of the elytral epipleuron. The discovery of *Cyclaxyra cretacea* sp. nov. in Burmese amber suggests that the New Zealand endemic family Cyclaxyridae orginated before mid-Cretaceous, and was once much more widely distributed than it is in the present.

Keywords:

Cucujoidea, Cyclaxyridae, Burmese amber, austral fauna

1. Introduction

Cyclaxyridae is a very small family of Cucujoidea, containing only two extant species (*Cyclaxyra politula* and *C. jelineki*) assigned in one genus confined to New Zealand (Leschen et al., 2010). Cyclaxyrid adults process a very distinguishable character: a single pair of large deep foveae located at the anterior half of elytral epipleuron. This feature is otherwise not known in any other groups of Coleoptera, except the New Zealand leiodid *Baeosilpha rufescens* (Gimmel et al., 2009), but the latter displays a reduced antennomere 8 and other typical characters of Leiodidae. Historically, *Cyclaxyra* has been considered as a member of Nitidulidae (Broun, 1881), Sphindidae (Crowson, 1955), or Phalacridae (Crowson, 1981; Lawrence 1982). Until 2009, Gimmel et al. (2009) formally raised the enigmatic genus to its own family. Their phylogenetic relationship within Cucujoidea is not fully confirmed up-to-now. Some authors placed it as a sister group of Tasmosalpingidae (Leschen et al., 2005), an Australian family, or weakly supported it as the sister group of Phalacridae (Gimmel, 2013), according to adult characters; whereas some authors placed it close to Lamingtoniidae based on larval characters (Lawrence and Leschen, 2003). Recent molecular-based phylogeny revealed Cyclaxyridae as a sister group to Passandridae, within the laemophloeid clade (McElrath et al., 2015), or sister to Myraboliidae, outside the laemophloeid group (Robertson et al., 2015).

Living cyclaxyrids, as both adults and larvae, are all collected from sooty-mould fungi (Ascomycota: Dothideomycetes: Capnodiales), which mainly grow on *Nothofagus* bark, and their growths are associated with some kind of Hemiptera (Klimaszewski and Watt, 1997). The distribution of cyclaxyrids is very limited, only found in New Zealand. No true fossil species have been found yet, and the Quaternary subfossil *C. impressa* from silt sediments of Taranaki, New Zealand (ca. 33~34 kya), reported by Marra et al. (2008), has been proved to be a synonym of *C. politula* (Gimmel et al., 2009). In this paper, the first definitive fossil species of Cyclaxyridae is described from the well-known Cretaceous Burmese amber.

2. Material and Methods

The new species is described on the basis of a single specimen preserved in Burmese amber (Hukawng Valley, northern Myanmar; ca. 99 Ma) (Shi et al., 2012; Yin et al., 2018). Observations, measurements and photographs were made using a Zeiss Axio Zoom. V16 light microscope with a digital camera Axiocam 512 color attached. Extended depth of field images were digitally compiled using GEN software, and arranged in Adobe Photoshop CS5. Illustration was finished using CorelDRAW2017. The nomenclatural acts established herein are registered under ZooBank LSID urn:lsid:zoobank.org:pub:B99C9848-DE95-4C70-9904-63771C0E22CC.

3. Systematic Palaeontology

Order: Coleoptera Linnaeus, 1758

Family: Cyclaxyridae Klimaszewski and Watt, 1997

Genus: *Cyclaxyra* Broun, 1893

(*Type species*. *Cyclaxyra politula* (Broun, 1881))

Cyclaxyra cretacea Wu sp. nov.

LSID urn:lsid:zoobank.org:act:FDF4D62B-184C-4A85-8BB8-547798F90D43

Figs. 1–2

Etymology. The specific epithet refers to the age of the fossil.

Holotype. ZMNH M6845, sex uncertain. Nearly complete specimen preserved in a very clear piece of amber; elytra hold in original position; hindwings not visible; antennae bent ventrally; part of legs polished away, only part of left pro-tibia, left mesotibia, and part of meta-femora preserved. The holotype is deposited in the Zhejiang Museum of Natural History, Hangzhou, China.

Locality and horizon. Hukawng Valley, northern Myanmar, lowermost Cenomanian.

Diagnosis. Body small (ca. 2 mm long); pronotum without protruding anterior angles; antennomere 2 obviously thicker than antennomere 3. Prosternal process comparatively long, extended longer than procoxae.

Description.

Length 1.9 mm, width 1.4 mm. Body (Fig. 1) shape nearly circular, strongly convex. Dorsal surface glabrous; vestiture of sparse, inconspicuous, recumbent hairs. Head preserved in downwardly bending position, making compound eyes very close to anterior margin of prosternum, length unmeasurable, width 0.65 mm, not constricted behind eyes; mouthparts anteriorly oriented; frons finely punctate. Frontoclypeal suture absent; clypeus extending well in front of antenanal insertions, subrectanular at apex. Eyes moderately large, subcircular, moderately coarsely facetted, without interfacetal setea. Antennae (Fig. 2A,B) 11-segmented; antennomere 1(scape), thick, not clearly seen because of preservation; antennomere 2 (pedicel) twice as wide as antennomere 3; last three segment abruptly clubbed, with sparse moderately long hairs; clubbed antennomeres with denser hairs than regular ones. Labrum visible externally, rounded anteriorly, setose. Mandible partly visible, bent abruptly mesally, apex with two teeth visible, right mandible process different shape of dentation. Maxillary palp 3-segmented, sparsely setose. Gular suture and cervical sclerites invisible because of preservation.

Pronotum (Fig. 2H) length 0.33mm, about 3 times as wide as long, base as wide as elytral base; sides evenly arcuate; anterior angles not protruding; anterior edge slightly anteriorly arcuate;

posterior angles obtuse, slightly protruding; disc with moderately dense, irregularly spaced punctures. Prosternum not short in front of coxae, about the same length as procoxae; prosternal process (Fig. 2F) broad, long, extended posteriorly beyond level of procoxae, sides expanded laterally towards apex. Notosternal suture complete. Procoxae not projecting. Scutellar shield slightly wider than long, rounded posteriorly, almost semicircular, impunctate. Mesoventrite short. Elytra 1.4 mm long, about 1.8 times as long as wide and about 3.8 times as long as pronotum; humeri well developed, slightly obtuse; disc strongly and evenly convex, punctuation moderately fine and sparse, punctures not in disdinct rows; epipleura complete, wide anteriorly, abruptly narrowed about midway to apex, with a deep longitudinal fovea in anterior half. Epipleural fovea (Fig. 2C, D) 0.67 mm long, 0.14 mm wide, narrowed towards apex, with fine, moderately long erect or sub erect setae lined a row at the inner margin (Fig. 2E). A small bulb formed in right elytra epipleural fovea (Fig. 2C). Metaventrite about 1.7 times wider than long, convex, coarsely puncatation, with a short discrimen, shorter than length of metacoxae. Metaepisternum long and narrow, about 6 times longer than wide. Metacoxae strongly transverse, subcontiguous, reaching metepisternum. Legs not fully persevered; trochanterofemoral joint oblique; femur obviously inflated near middle; only part of pro- and meso-tibiae preserved (Fig. 2G), obviously thinner than femur, without spines; tarsi not preserved. Abdomen with five free ventrites. Ventrite 1 not much longer than 2; intercoxal process acute.

Measurements. Head width, 0.7 mm; antennomere length, from antennomere 2 to antennomere 11, 29 μm, 26 μm, 23 μm, 22 μm, 16 μm, 17 μm, 19 μm, 30 μm, 27 μm, 51 μm; eye width, 0.25 mm; prosternum length, 0.33 mm; prosternal process maximum width, 0.22 mm; pro-coxa length, 0.17 mm; mesoventrite length, 0.1 mm; metaventrite length, 0.5 mm; metacoxa width, 0.48 mm; profemur length 0.39mm.

4. Discussion

The fossil beetle can be assigned to the extant Cyclaxyridae based on its generally rounded and strongly convex body form, 11-segmented antennae, with a distinct 3-segmented club and antennomere 8 not significantly reduced in size, and presence of typical elytral epipleural fovea (Gimmel et al., 2009; Leschen et al., 2010). Basically, the new specimen is very similar to the type genus of Cyclaxyridae, both in size and other morphologies, except for some tiny differences lies on prothorax, antenna and metaventrite. No characters of hind wing or genitalia can be clearly observed, so it is not suitable to establish a new genus for the specimen, and it is tentatively placed in the sole extant genus *Cyclaxyra*.

When compared with the two extant species, *C. cretacea* displays several differences discussed as follow. The most obvious one is that *C. cretacea* sp. nov. has a much longer prosternal process, extending beyond the posterior level of the procoxae, whereas in both extant species, the process is not extending beyond the posterior level of procoxae. Second, the antennomere 2 of *C. cretacea* sp. nov. is twice as thick as the antennomere 3, whereas in both extant species the 2nd antennomere is not such thick. Third, the clubbed antennomeres of *C. cretacea* sp. nov. are obviously much longer than extant species when compared to the rest antennomeres. In extant species, the clubbed antennomeres are rather compact. Except the differences mentioned above, some other differences lie on the pronotum and metaventrite. In extant species, the anterior angels of pronotum protrude more or less, and there is no discremen on the metaventrite. But in *C. cretacea* sp. nov., no protruding pronotum anterior angels exists, and there is a short discrimen located on posterior edge of metaventrite.

Cyclaxyra cretacea sp. nov. is the first fossil species of Cyclaxyridae known to date. Considering the endemism of this family, some biogeographic implications can be inferred. The extant cyclaxyrids are now restricted to the North, South, and Stewart Islands in New Zealand (Gimmel et al., 2009). Among the two living species, the distribution of *C. politula* seems to be more confined, which is mostly absent from northeastern South Island. The first discovery of definite cyclaxyrid from Burmese amber suggest that this family originated before mid-Cretaceous, some 100 million years ago, and its past distribution has been much wider than it is at the present, at least across the Gondwana, as supported by the hypothesis that Burmese amber had a Gondwanan origin (Oliveria et al., 2016; Poinar, 2018). Probably due to dramatic global climate change, those cyclaxyrids lived in other areas beyond New Zealand have become extinct and the modern distributional patterns had been formed. Such a geographic distribution can be compared with those of some other beetle groups (eg. Cai et al., 2012; Thayer et al., 2012; Cai and Huang, 2015, 2017a, 2017b; Jałoszyński et al., 2017; Wu et al., 2015), which suggests that the modern endemism of some beetles may have probably resulted from later extinctions of once much more widespread groups.

5. Concluding remarks

The discovery of *Cyclaxyra cretacea* sp. nov. from the Upper Cretaceous Burmese amber represents the first fossil for the family Cyclaxyridae and thus for the extant genus *Cyclaxyra*. It suggests that the family is probably a very ancient group, and this family probably much more widespread in the past, meanwhile, their general similarity to extant species suggests some morphological stasis of cyclaxyrids through some 100 million years.

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Fig. 1. *Cyclaxyra cretacea* sp. nov., holotype, ZMNH M6845. A. Dorsal view. B. Ventral view. Scale bars=0.5mm.

Fig. 2. Enlargements and illustration of *Cyclaxyra cretacea* sp. nov., holotype, ZMNH M6845. A. Ventral view of right antenna. B. Illustration of right antenna, hairs neglected. C. Ventral view of

right elytral epipleural fovea, noticing a bulb inside. D. Ventral view of left elytral epipleural fovea. E. Enlargement of part of left elytral epipleural fovea, displaying erect setae on inner edge. F. Enlargement of prosternal process. G. Enlargement of left pro-leg and mid-leg. H. Enlargement of head and pronotum. Scale bars=0.2 mm in A, B, C, D, F, G, H, 0.05 mm in E.

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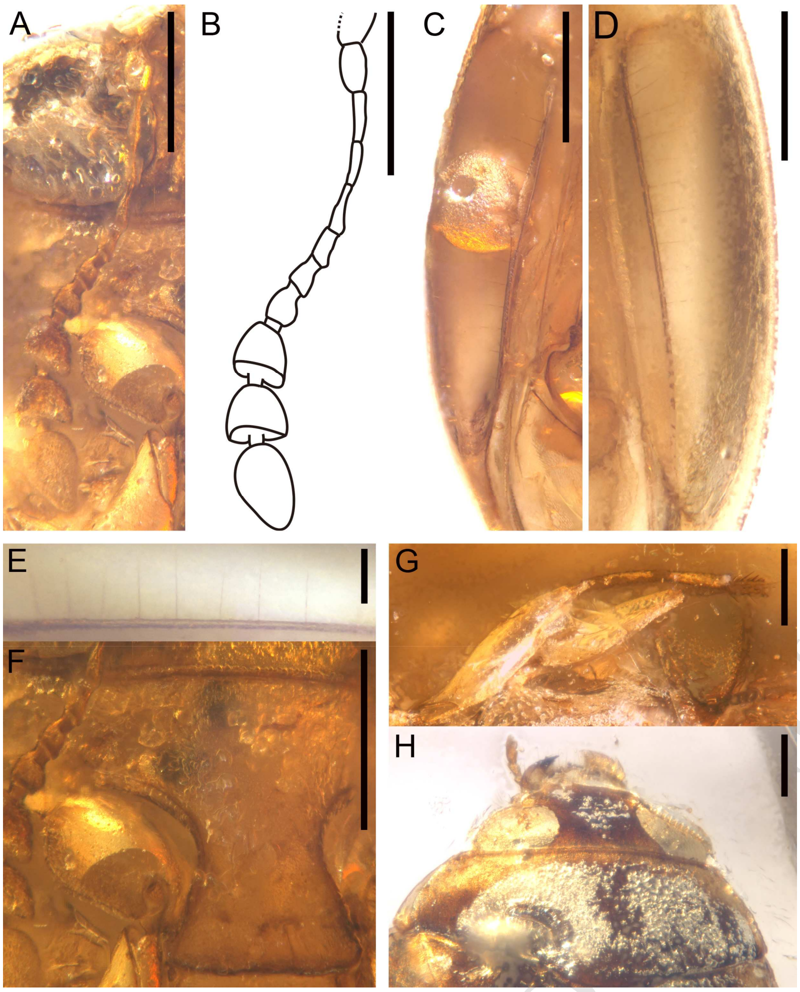
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