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The first Archijassidae from the Middle Triassic of China (Hemiptera, Cicadomorpha, Membracoidea)

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Abstract

Eocicadellium grimaldii gen. et sp. nov., the oldest representative and first Triassic member of the subfamily Karajassinae Shcherbakov, 1992, is described on the basis of six forewings from the Middle-Upper Triassic Yanchang Formation of northern China, widening the duration and biogeographic distribution of this extinct subfamily. The new data represents the first known definite record of Karajassinae in China, and further explores the palaeodiversity of Triassic archijassids.

Keywords: Karajassinae, Tongchuan entomofauna, taxonomy, *Eocicadellium*, new genus

Introduction

The Mesozoic hemipteran family Archijassidae Becker-Migdisova, 1962 is recorded in the earliest Late Triassic (Carnian) to mid-Cretaceous of Australia and Eurasia (Westwood, 1854; Handlirsch, 1906; Tillyard, 1916; Evans, 1956; Shcherbakov, 1992, 2012; Ansoerge, 1996; Jell, 2004; Szwedo, 2018; Chen *et al.*, 2020; Lambkin, 2020). It is considered as the ‘ancestral’ group of Membracoidea (Shcherbakov, 2012; Chen *et al.*, 2020). Shcherbakov (2012) summarized the classification history of Archijassidae, and proposed to divide this extinct family into three subfamilies: Archijassinae Becker-Migdisova, 1962, Karajassinae Shcherbakov, 1992, and Dellashariinae Shcherbakov, 2012. The taxonomic framework was later accepted by some authors (Chen *et al.*, 2020; Lambkin, 2020).

The Middle Triassic Tongchuan entomofauna in Shaanxi Province, northern China refers to fossil insects from the lower parts of the Yanchang Formation, which is dominated by Coleoptera, Mecoptera, Hemiptera, and

Blattodea (Lian *et al.*, 2022; Zhang *et al.*, 2022b). The hemipteran insects are well represented in the Tongchuan entomofauna. To date, the number of described species of the infraorder Cicadomorpha in the Tongchuan entomofauna was enriched with five genera and six species ascribed to five families, including Dysmorphoptilidae Handlirsch, 1906, Granulidae Hong, 1980, Curvicubitidae Hong, 1984, Prosbolidae Hong, 1985, and Maguviopseidae Shcherbakov, 2011 (Hong, 1984; Liu *et al.*, 1985; Fu *et al.*, 2021; Fu & Huang, 2022a, b; Zhang *et al.*, 2022a). The diversity of cicadomorphan insects in the Tongchuan entomofauna seems to be severely underestimated.

Here, a new genus and species of Archijassidae, *Eocicadellium grimaldii* gen. et sp. nov., is described and illustrated based on six forewings from the Middle-Upper Triassic Yanchang Formation of Hejiafang Village, Jinsuoguan Township, Tongchuan City, Shaanxi Province, northern China.

Material and methods

The new genus and species is erected based on six specimens (NIGP201027–NIGP201032). The holotype (NIGP201027) is a complete forewing with part and counterpart. All specimens were collected from yellow-greenish shale of lower part (Chang-7) of the Middle-Upper Triassic Yanchang Formation (= Tongchuan Formation in previous palaeontological studies), at the lacustrine deposit near Hejiafang Village, Jinsuoguan Township, Tongchuan City, Shaanxi Province, China (for the map of fossil locality see Fu *et al.*, 2021, fig. 1). The studied specimens were carefully prepared using a sharp blade. Photographs were taken using a Zeiss AxioZoom V16 stereoscope. The line drawing was drafted with Adobe

Illustrator CC 2018 software. The studied specimens are deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China. The wing venation terminology generally follows the scheme of Nel *et al.* (2012), Shcherbakov (2012), and Bourgoïn *et al.* (2015).

Systematic palaeontology

Family Archijassidae Becker-Migdisova, 1962

Subfamily Karajassinae Shcherbakov, 1992

Genus *Eocicadellium* gen. nov.

Type species. *Eocicadellium grimaldii* sp. nov., by present designation.

Etymology. The generic name derives from a combination of the Greek word *eos*, and *Cicadellium*, the first described taxon currently placed in Karajassinae, referring to the status of the fossil as the oldest known representative of the subfamily.

Diagnosis. Tegmen relatively broad, with length/width ratio about 3.0; costal space (= postcostal cell in Bourgoïn *et al.*, 2015, the same below) and clavus covered evenly with dense puncturation, and remaining parts of tegmen covered with dark-coloured patches; bScP present; Pc very long, extending to terminal apex; R+MP stalk present, relatively long; MP deeply forked; terminal branches of RA, RP, and MP radiated outwards; basal cell short and narrow; costal space apparently wider than radial cell and median cell, narrow at base; cell C5 large; crossvein *ir* present, two *rp-mp* present, basal (additional) *rp-mp* slightly beyond midlength of stem MP, and *mp-cua* not replaced with anastomosis.

Eocicadellium grimaldii sp. nov.

(Figs 1–4)

Material. Six isolated forewings (NIGP201027–NIGP201032); deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

Etymology. The specific epithet is dedicated to Dr David Grimaldi, the distinguished American palaeontologist and dipterist, in celebration of his 65th birthday.

Diagnosis. As for the genus (monospecific).

Type locality and horizon. Hejiafang Village, Jinsuoguan Township, Yintai District, Tongchuan City, Shaanxi Province, China; lower part of the Yanchang Formation (Chang 7); Middle Triassic.

The following measurements based on the holotype.

Description. Tegmen length about 8.5–10.9 mm, with

tiny punctures around veins; broadest slightly beyond midlength of tegmen; costal margin smoothly arched; rounded at apex; posterior margin almost straight; venation distinct; bScP slightly arched, short; stem ScP+R+MP almost straight; ScP+R diverged from common stalk ScP+R+MP at about basal 0.36 of tegmen length; ScP+R about 1.5 times and 1.25 times as long as ScP+R+MP and ScP+RA, respectively; ScP+R forked much before MP forking, at basal 0.51 of tegmen length; RP unbranched; MP forked distinctly apicad of CuA forking, at basal 0.74 of tegmen length; MP with 3 terminal branches; stem CuA smoothly curved at base, then almost straight; CuP straight; A₁ arcuate; crossvein *mp-cua* short, straight, distinctly shorter than 1st section of CuA₁; transverse ridge finely distributed in large parts of tegmen except costal space and clavus; basal cell about 0.21 of tegmen length; cells C1' and C2' irregular pentagonal, and cell C5 apparently longer and broader than cell C3 and other apical cells.

Discussion

The new genus and species, *Eocicadellium grimaldii* gen. et sp. nov., can be placed in the extinct hemipteran family Archijassidae on the basis of having the tegmen with CP present; and the presence of seven full-sized apical cells, three subapical cells, and two crossveins *rp-mp* (Shcherbakov, 2012). The new fossil taxon is most appropriately placed in the subfamily Karajassinae based on the present state of knowledge by sharing a series of diagnostic characteristics of the tegmen as defined by Shcherbakov (2012): costal space relatively narrow proximally, rather than broader costal space with deeply arched costal margin in Archijassinae; CP relatively short and oblique; ScP+R and MP forming a common stalk beyond basal cell rather than ScP+R and MP leaving basal cell separately; and MP and CuA₁ connected by a crossvein.

To date, the subfamily Karajassinae with a sparse fossil record, currently comprises five valid genera, only distributed in the Northern Hemisphere since the Middle Jurassic to the Early Cretaceous. They include four Jurassic genera: *Karajassus* Martynov, 1926, which was reported from the Upper Jurassic of Kazakhstan; *Kisa* Shcherbakov, 2012, *Kubecola* Shcherbakov, 2012, and *Kemobius* Shcherbakov, 2012, which were recorded in the Middle Jurassic Itat Formation of Krasnoyarsk, Russia; and the remaining Cretaceous one, *Cicadellium* Westwood, 1854, reported from the Lowermost Cretaceous Durlston Formation of England (Shcherbakov, 2012).

The new genus *Eocicadellium* displays some similarities with the three Middle Jurassic genera

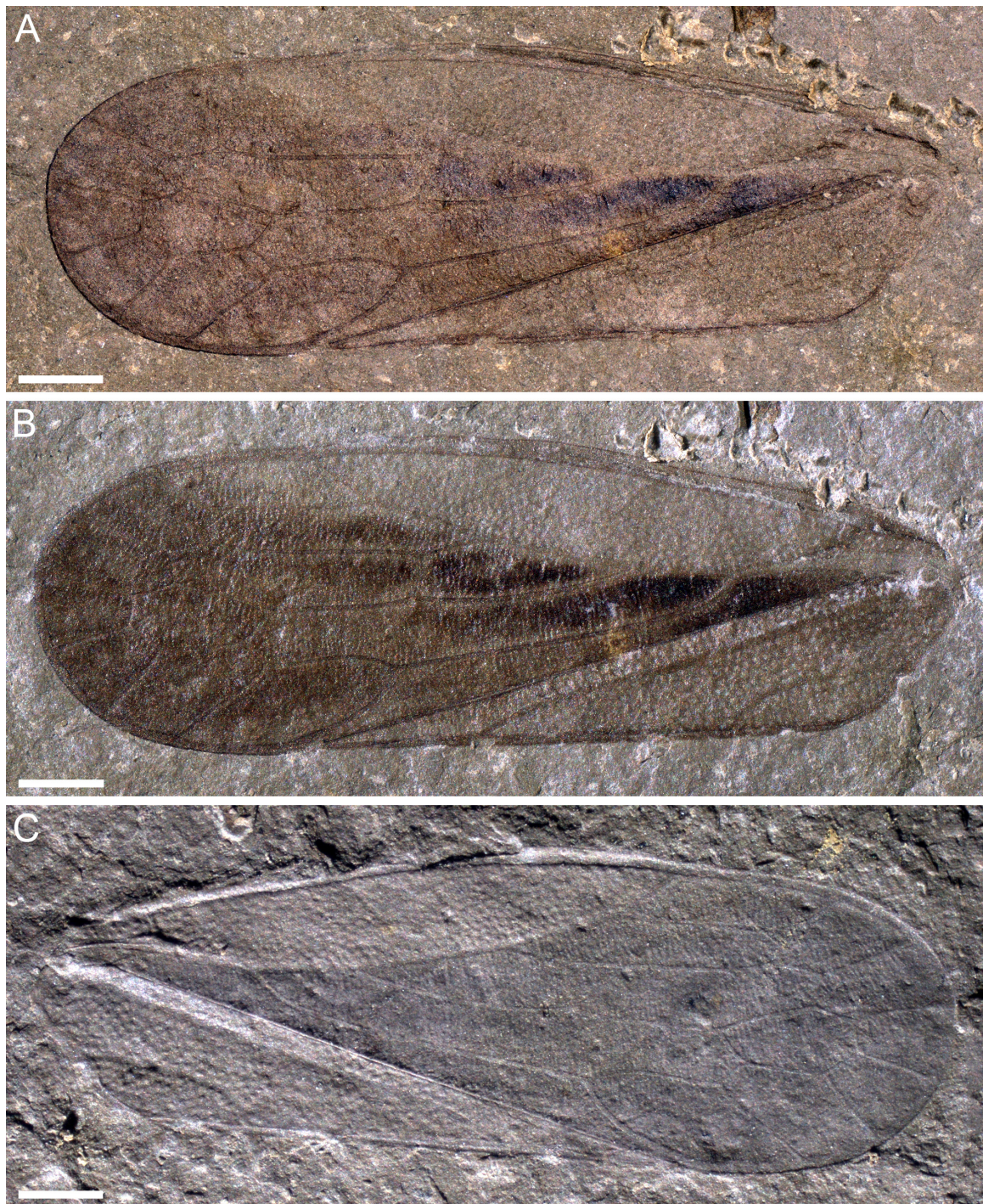


FIGURE 1. Photographs of holotype of the new genus and species, *Eocicadellium grimaldii* **gen. et sp. nov.**, from the Yanchang Formation, Shaanxi Province, China. **A**, Part (NIGP201027a), moistened with 70% ethanol. **B**, Part (NIGP201027a). **C**, Counterpart (NIGP201027b). Scale bars = 1 mm.

from Krasnoyarsk, viz., *Kisa*, *Kubecola*, *Kemobius* (Shcherbakov, 2012). *Eocicadellium* appears to be most similar to the genus *Kemobius*. They share the relatively broad tegmen and costal space, and the presence of crossveins *ir* and *mp-cua* (Shcherbakov, 2012). However, *Eocicadellium* differs from these three Jurassic genera mainly in the tegmen with the vein *bScP* present, a very long *Pc*, deeply forked stem *MP*, short and narrow basal

cell, large cell *C5*, the terminal branches of *RA*, *RP*, and *MP* radiated outwards rather than horizontal, and the costal space and clavus covered with dense puncturation. Furthermore, the new fossil is clearly different from *Kubecola* and *Kemobius* in having the common stalk *ScP+R+MP* relatively long (*ScP+R+MP* very short in *Kubecola*, and *ScP+R* and *MP* leaving basal cell at one point in *Kemobius*), and the presence of two crossveins *rp-*

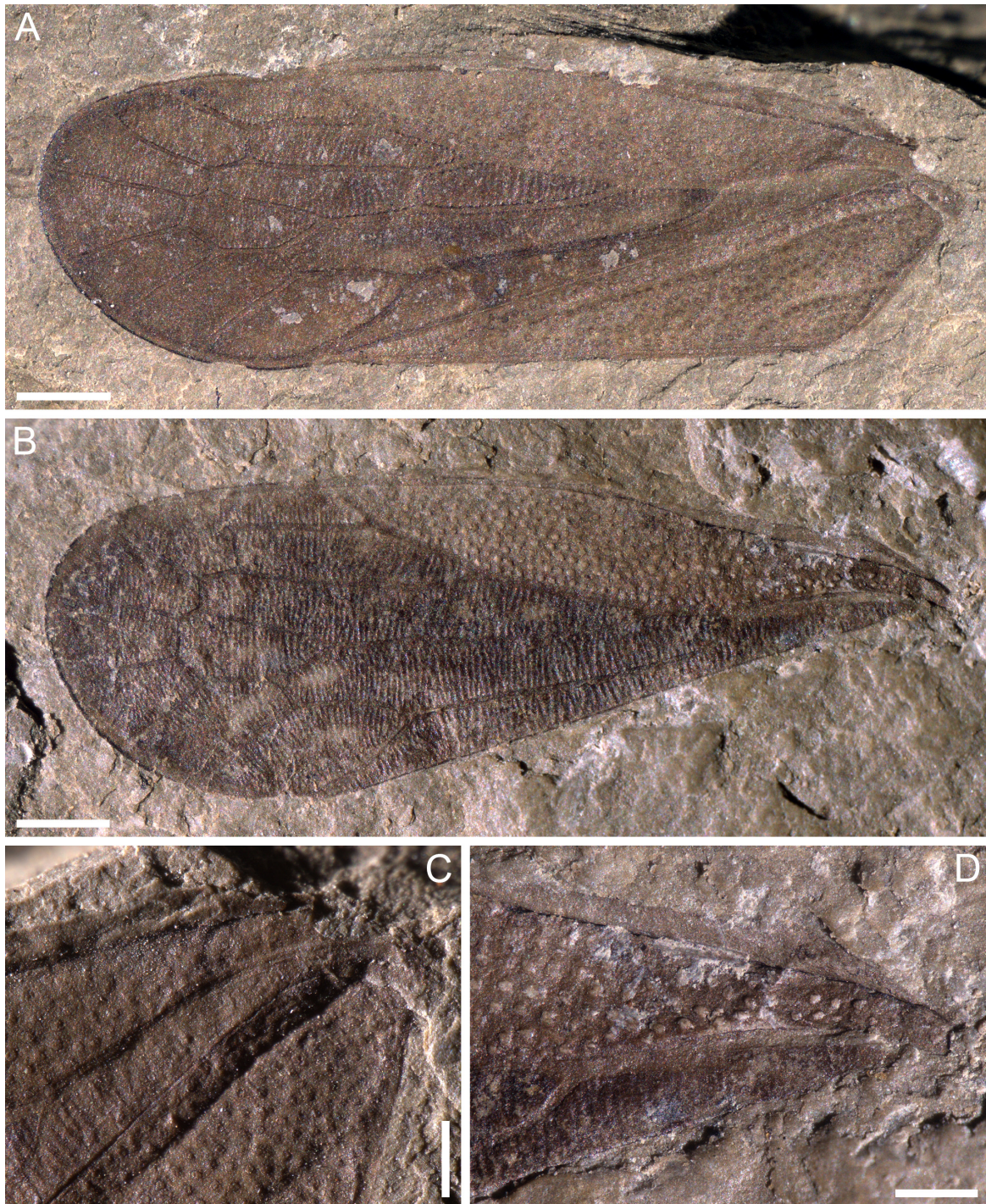


FIGURE 2. *Eocicadellium grimaldii* gen. et sp. nov., photographs of paratypes. **A**, NIGP201028. **B**, NIGP201029. **C**, Enlargement of **A**, showing basal portion of tegmen. **D**, Enlargement of **B**, showing basal portion of tegmen. Scale bars = 1 mm in **A**, **B**, 500 µm in **C**, **D**.

mp (only one *rp-mp* present in *Kubecola* and *Kemobius*). Moreover, *Eocicadellium* also differs from *Kisa* in the basal crossvein *rp-mp* slightly beyond the midlength of stem MP, while basal *rp-mp* at the point of MP forking in the latter. Due to the confusion in the classification of Archijassidae, we compare *Eocicadellium* to all known members of this family. One possible major difference between the new fossil and other archijassids is the

presence of bScP in the former. The vein bScP is commonly present in some ancient groups of cicadomorphan insects such as Hylcellidae, Minlagerrontidae, and two early representatives of Cercopoidea, viz., Procercopidae and Sinoalidae.

The discovery in the Middle-Upper Triassic Ordos basin of a taxon attributable to the subfamily Karajassinae represents the oldest record and first Triassic member



FIGURE 3. *Eocicadellium grimaldii* gen. et sp. nov., photographs of paratypes. **A**, NIGP201030. **B**, NIGP201031. **C**, Enlargement of **A**, showing basal portion of tegmen. **D**, NIGP201032. Scale bars = 1 mm in **A**, **B**, **D**, 500 µm in **C**.

of Karajassinae, suggesting the great antiquity of this subfamily, formerly only known from the middle to late Mesozoic. The new data represents the first known definite representative of Karajassinae in China, expanding the biogeographic distribution of this ancient hemipteran family to eastern Asia, and suggesting that archijassids had a wide distribution range during to the Triassic, probably encompassing the Gondwanan landmass. With the discovery of more cicadomorphan groups, the

Tongchuan entomofauna will increase the information of the morphological diversity and early evolution of this diverse insect lineage.

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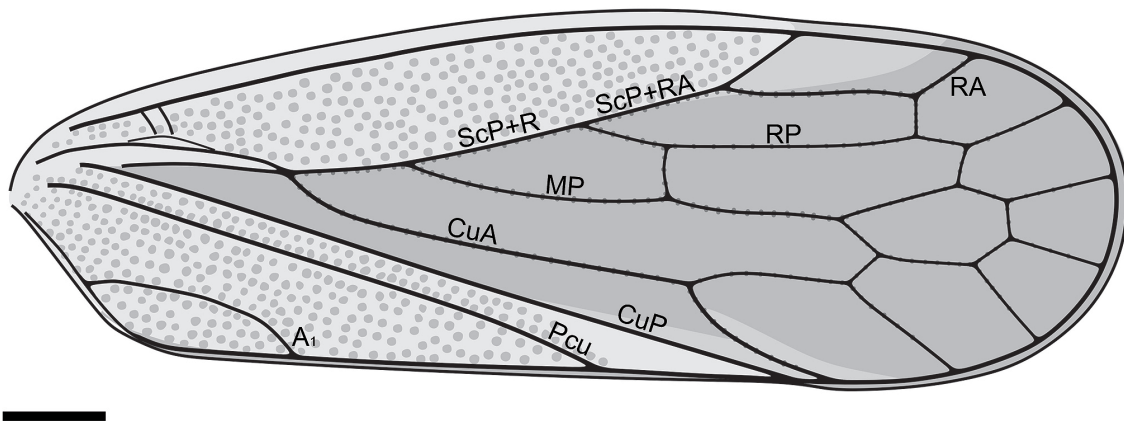


FIGURE 4. Line drawing of *Eocicadellium grimaldii* gen. et sp. nov. Scale bar = 1 mm.

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