Palaeoentomology 005 (6): 599–605
https://www.mapress.com/j/pe/

Article

ISSN 2624-2826 (print edition)
PALAEOENTOMOLOGY
ISSN 2624-2834 (online edition)

https://doi.org/10.11646/palaeoentomology.5.6.9
http://zoobank.org/urn:lsid:zoobank.org:pub:0426977C-F223-4471-BF62-77FB420876C2

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

YAN-ZHE FU[1] & DI-YING HUANG[1, *]

[1]*State Key Laboratory of Palaeobiology and Stratigraphy, Center for Excellence in Life and Paleoenvironment, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China*

yzfu@nigpas.ac.cn; https://orcid.org/0000-0002-7819-1703

dyhuang@nigpas.ac.cn; https://orcid.org/0000-0002-5637-4867

**Corresponding author*

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; Ansorge, 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

Submitted: 2 Dec. 2022; accepted by J. Szwedo: 8 Dec. 2022; published: 23 Dec. 2022

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 Bourgoin *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 Bourgoin *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; A_1 arcuate; crossvein *mp-cua* short, straight, distinctly shorter than 1st section of CuA_1; 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 CuA_1 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 Hylicellidae, 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

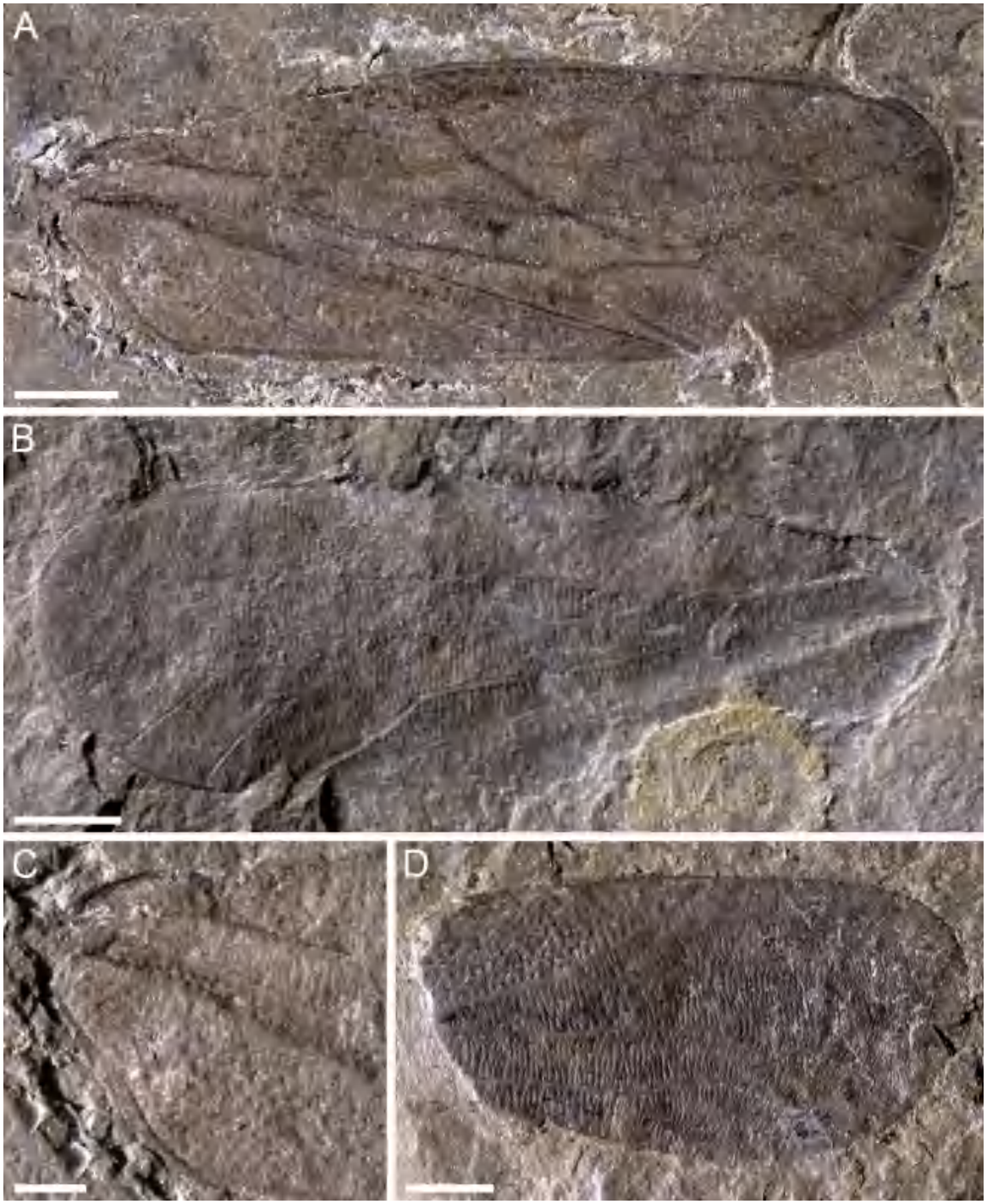

FIGURE 3. *Eocicadellium grimaldii* **gen. et sp. nov.**, photographs of paratypes. **A**, NIGP201030. **B**, NIGP201031. **C**, Enlargement of **A**, showing basal portion of tegmen. **D**, NIGP201032. Scale bars = 1 mm in **A**, **B**, **D**, 500 μm in **C**.

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.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (41925008 and 42288201), the

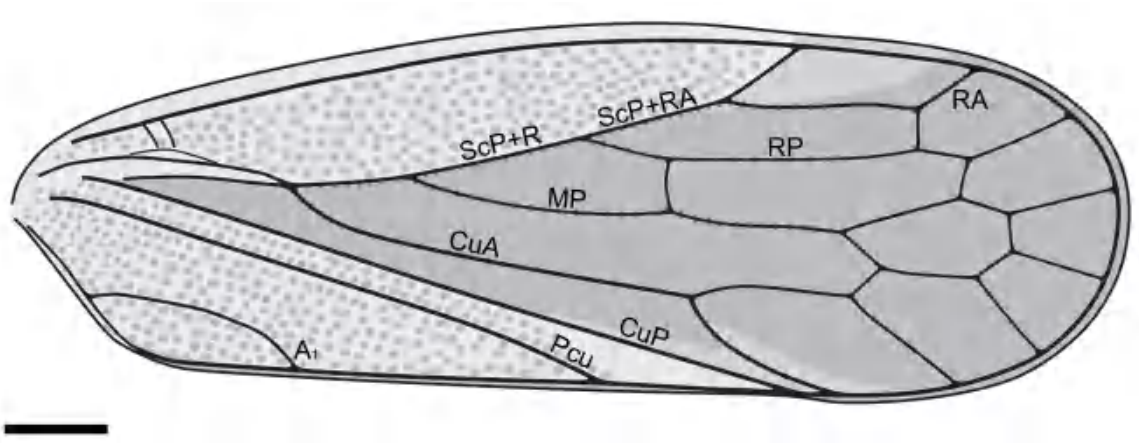

FIGURE 4. Line drawing of *Eocicadellium grimaldii* **gen. et sp. nov.** Scale bar = 1 mm.

Strategic Priority Research Program of the Chinese Academy of Sciences (XDB26000000), the International Postdoctoral Exchange Fellowship Program (PC2022058), and National Mineral Rock and Fossil Specimens Resource Center.

References

Ansorge, J. (1996) Insekten aus dem oberen Lias von Grimmen (Vorpommern, Norddeutschland). *Neue Paläontologische Abhandlungen*, 2, 1–132.

Becker-Migdisova, E.E. (1962) Nekotorye novye poluzhestkokrylye i senoedy. [Some new Hemiptera and Psocoptera]. *Paelontologicheskii Zhurnal*, 1, 189–104. [In Russian]

Bourgoin, T., Wang, R., Asche, M., Hoch, H., Soulier-Perkins, A., Stroiński, A., Yap, S. & Szwedo, J. (2015) From micropterism to hyperpterism: recognition strategy and standardized homology-driven terminology of the forewing venation patterns in planthoppers (Hemiptera: Fulgoromorpha). *Zoomorphology*, 134, 63–77. https://doi.org/10.1007/s00435-014-0243-6

Chen, J., Wang, B., Zheng, Y., Jiang, H., Jiang, T., Wang, X.L. & Zhang, H.C. (2020) The youngest record of the leafhopper family Archijassidae in Kachin amber from the lowermost Upper Cretaceous of northern Myanmar (Cicadomorpha, Cicadelloidea). *Cretaceous Research*, 106, 104252. https://doi.org/10.1016/j.cretres.2019.104252

Evans, J.W. (1956) Palaeozoic and Mesozoic Hemiptera (Insecta). *Australian Journal of Zoology*, 4, 165–158. https://doi.org/10.1071/ZO9560165

Fu, Y.Z., Azar, D. & Huang, D.Y. (2021) The first Dysmorphoptilidae from the Middle Triassic of China (Hemiptera: Cicadomorpha). *Historical Biology*, 33, 3506–3512. https://doi.org/10.1080/08912963.2021.1874374

Fu, Y.Z., Gao, J. & Huang, D.Y. (2022) Revision of the genus *Sinogranulus* (Hemiptera, Granulidae) with description of a new species from the Middle Triassic of China. *Palaeoentomology*, 5 (1), 81–89. https://doi.org/10.11646/palaeoentomology.5.1.10

Fu, Y.Z. & Huang, D.Y. (2022) The first maguviopseids (Hemiptera, Cicadomorpha, Prosboloidea) from the Triassic of China. *Palaeoentomology*, 5 (1), 76–80. https://doi.org/10.11646/palaeoentomology.5.1.9

Handlirsch, B.A. (1906–1908) *Die fossilen Insekten und die Phylogenie der Rezenten Formen. Ein Handbuch für Paläontologen und Zoologen*. Engelmann, Leipzig, 1430 pp. https://doi.org/10.5962/bhl.title.34145

Hong, Y.C. (1980) Granulidae, a new family of Homoptera from the Middle Triassic of Tongchuan, Shaanxi Province. *Acta Zootaxonomica Sinica*, 5, 63–70. [In Chinese with English abstract]

Hong, Y.C. (1984) Curvicubitidae fam. nov. (Lepidoptera, Insecta) from Middle Triassic of Shaanxi. *Acta Palaeontologica Sinica*, 23, 782–785. [In Chinese with English abstract]

Jell, P.A. (2004) The fossil insects of Australia. *Memoirs of the Queensland Museum*, 50 (1), 1–124.

Lambkin, K.J. (2020) Revision of *Mesojassus* Tillyard, 1916, from the Late Triassic of Queensland (Hemiptera: Cicadomorpha: Membracoidea: Archijassidae). *Zootaxa*, 4718 (3), 413–422. https://doi.org/10.11646/zootaxa.4718.3.9

Lian, X.N., Cai, C.Y. & Huang, D.Y. (2022) New species of permochoristids (Insecta, Mecoptera) from the late Middle Triassic Tongchuan entomofauna in Shaanxi Province, northwestern China. *Historical Biology*. [Published online 07 October 2022] https://doi.org/10.1080/08912963.2022.2130794

Liu, Z.J., Liu, S.T. & Hong, Y.C. (1985) Discovery and studying of the Triassic fauna and flora from the Niangniangmiao in Longxian, Shaanxi. *Bulletin of the Xi'An Institute of Geology and Mineral Resources*, 10, 105–120. [In Chinese with English abstract]

Martynov, A. (1926) Jurassic fossil insects from Turkestan. 6. Homoptera and Psocoptera. *Bulletin de l'Académie des Sciences de l'URSS*, 20, 1349–1366.

Nel, A., Prokop, J., Nel, P., Grandcolas, P., Huang, D.Y, Roques, P., Guilbert, E., Dostál, O. & Szwedo, J. (2012) Traits and evolution of wing venation pattern in paraneopteran insects. *Journal of Morphology*, 273, 480–506.
https://doi.org/10.1002/jmor.11036

Shcherbakov, D.E. (1992) The earliest leafhoppers (Hemiptera: Karajassidae n. fam. from the Jurassic of Karatau). *Neues Jahrbuch für Geologie und Palaontologie Monatshefte*, 1 (1), 39–51.
https://doi.org/10.1127/njgpm/1992/1992/39

Shcherbakov, D.E. (2011) New and little-known families of Hemiptera Cicadomorpha from the Triassic of Central Asia—early analogs of treehoppers and planthoppers. *Zootaxa*, 2836 (1), 1–26.
https://doi.org/10.11646/zootaxa.2836.1.1

Shcherbakov, D.E. (2012) More on Mesozoic Membracoidea (Homoptera). *Russian Entomological journal*, 21 (1), 15–22.
https://doi.org/10.15298/rusentj.21.1.02

Szwedo, J. (2018) The unity, diversity and conformity of bugs (Hemiptera) through time. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, 107, 109–128.
https://doi.org/10.1017/S175569101700038X

Tillyard, R.J. (1916) Mesozoic and Tertiary insects of Queensland and New South Wales. *Geological Survey of Queensland Publication*, 253, 11–64.

Westwood J.O. (1854) Contributions to fossil entomology. *The Quarterly Journal of the Geological Society of London*, 10, 378–396.
https://doi.org/10.1144/GSL.JGS.1854.010.01-02.43

Zhang, Q.Q., Chen, J. & Zhang, H.C. (2022a) New Granulidae (Hemiptera: Scytinopteroidea) from the Middle Triassic Tongchuan Formation of NW China. *Historical Biology*, 34, 152–157.
https://doi.org/10.1080/08912963.2021.1903892

Zhang, Q.Q., Zheng, D.R., Wang, B. & Zhang, H.C. (2022b) A review of Triassic insects in China. *Geological Society, London, Special Publications*, 521 (1), 45.
https://doi.org/10.1144/SP521-2021-121