



A new, rare and small “lobeattid” species (Insecta: Archaeorthoptera) found at Xiaheyuan (Pennsylvanian; Ningxia, China)

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Received: 16 January 2020 – Revised: 9 March 2020 – Accepted: 16 March 2020 – Published: 8 April 2020

Abstract. A new species of stem Orthoptera, namely *Phatanomiamia gui* gen. et sp. nov., is described from the Pennsylvanian Xiaheyuan locality in China. Despite the intensive collecting efforts undertaken at this locality, a single forewing was recovered. It shares with the “lobeattid” *Miamia* spp. two peculiar traits, namely a broad ScP–R/RA area and a very early branching of CuA + CuPa. On the other hand, it displays a free portion of CuA (between its divergence from M + CuA and its fusion with CuPa), a trait allowing exclusion of the new species from *Miamia*, to which it is most likely very closely related.

1 Introduction

The Xiaheyuan locality has yielded an unprecedented number of specimens of early-Pennsylvanian winged insects. Many species could be documented on the basis of large to very large samples, in particular among the stem lineages of Orthoptera (crickets, katydids and grasshoppers), which dominate the various taphocoenoses from which insect remains were recovered (Trümper et al., 2020). For example, species such as *Longzhua loculata* Gu, Béthoux and Ren, 2011, *Miamia maimai* Béthoux, Gu, Yue and Ren, 2012b and *Protomiamia yangi* Du, Béthoux, Gu and Ren, 2017 were described based on several tens of specimens each. However, the undertaken collecting effort also allowed sampling of rare species of stem Orthoptera, including *Heterologus duyiwuer* Béthoux, Gu and Ren, 2012a and *Sinogerarus pectinatus* Gu, Béthoux and Ren, 2017, each known from a single, isolated

forewing. Herein we report the discovery of another, rare stem-orthopteran species. Because the chances to collect additional material at Xiaheyuan are very low, we endeavoured to provide a description despite the meagre sample.

2 Material and methods

The studied specimen is housed at the Key Lab of Insect Evolution and Environmental Changes, College of Life Sciences, Capital Normal University, Beijing, China (CNU). It was collected from the locality near Xiaheyuan village (Zhongwei City, Ningxia Hui Autonomous Region, China; Yanghugou Formation; latest Bashkirian (latest Duckmantian) to middle Moscovian (Bolsovian), Pennsylvanian; Trümper et al., 2020). The exact layer from which it was collected was not documented.

A draft drawing was produced using a LEICA MZ12.5 dissecting microscope equipped with a drawing tube (Leica, Wetzlar, Germany). The drawing reproduced in Fig. 1a was prepared using Adobe Illustrator CC 17.0.0 (Adobe Systems, San Jose, CA, USA) using both draft and photographs. Photographs were taken using a digital camera Canon EOS 450D (Canon, Tokyo, Japan) coupled to a Canon MP-E 65 mm macro lens (equipped with polarizing filter). The resulting photographs were optimized using Adobe Photoshop CC 2015.5. The photograph reproduced in Fig. 1b is a combination of photographs of the dry specimen and when immersed in ethanol.

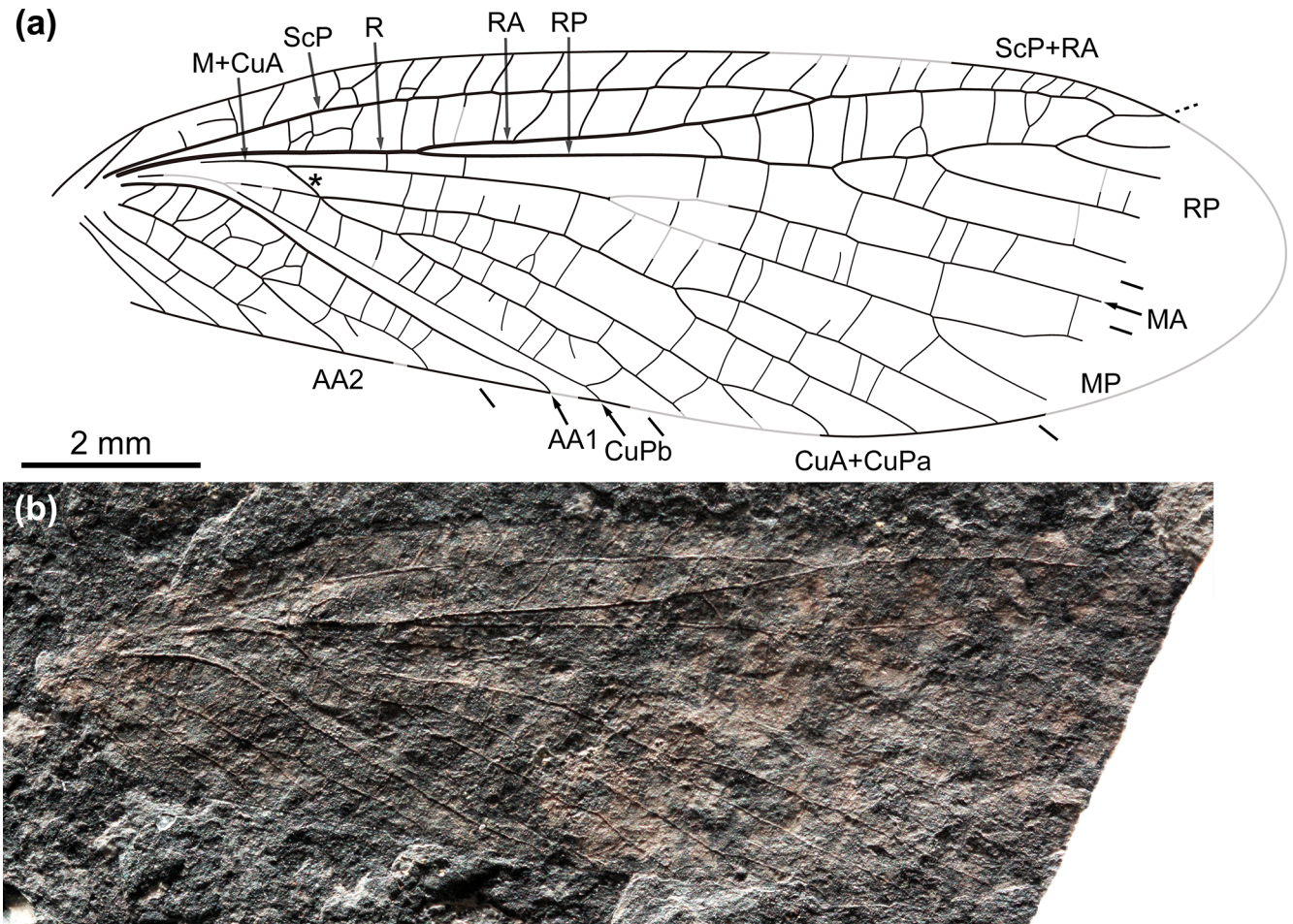


Figure 1. *Phthanomiamia gui* gen. et sp. nov., holotype (specimen CNU-NX1-324): (a) interpretative drawing (the asterisk indicates the free portion of CuA) and (b) photograph (composite, light mirrored).

We use the wing venation homologies elaborated by Béthoux and Nel (2002) for Archaeorthoptera. Corresponding abbreviations are the following: ScP, posterior subcosta; R, radius; RA, anterior radius; RP, posterior radius; M, media; CuA, anterior cubitus; CuP, posterior cubitus; CuPa, anterior branch of CuP; CuPb, posterior branch of CuP; AA, anterior analis; AA1, first anterior analis; AA2, second anterior analis.

3 Systematic description

Taxon **Archaeorthoptera** Béthoux and Nel, 2002

Family *incertae sedis*

Phthanomiamia Chen, Ren and Béthoux gen. nov.

(urn:lsid:zoobank.org: 3FAEB099-6FAA-473F-899D-89BA96B9C729)

Type species

Phthanomiamia gui sp. nov.

Gender

Masculine.

Etymology

A combination of “*phtanos*”, “come earlier” in ancient Greek, and “*Miamia*”, the name of a related genus; referring to close proximity of the new genus with *Miamia* spp.

Diagnosis

By monotypy, as for the type species.

Phtanomiamia gui Chen, Ren and Béthoux sp. nov.

(urn:lsid:zoobank.org: 1AC9FA32-A6B7-4AD8-9CDA-DADE964B9271)

(Fig. 1)

Type species

Phtanomiamia gui sp. nov.

Material

Holotype only, CNU-NX1-324, deposited at the CNU.

Etymology

The species name is dedicated to Junjie Gu, for his contributions to fieldwork at Xiaheyan and to the systematics of Orthoptera.

Diagnosis

Forewing: ScP–R/RA area broad (at its broadest, broader than the area between the anterior wing margin and ScP); first fork of M in a distal position (distal to the second fifth of wing length, basal to wing mid-length); CuA + CuPa branched shortly after the fusion of CuA and CuPa; CuA with a distinct, free portion between its divergence from M + CuA and its fusion with CuPa.

Description

Holotype specimen (CNU-NX1-324): negative imprint of an isolated, left forewing, apex missing; preserved length about 12.2 mm, estimated length about 13.8 mm, maximum width 4.2 mm; ScA present, short; ScP–R/RA area broader than area between anterior wing margin and ScP; area between the anterior wing margin and ScP/ScP + RA with strong cross-veins, mostly oblique and simple, reticulated near the wing base; ScP reaching RA slightly basal to the second third of wing length; RA/RP fork slightly basal to the first third of wing length; RA simple; RA and RP close and parallel until wing mid-length, where both veins diverge; RP simple for 4.7 mm, posteriorly pectinate (as preserved), with five branches preserved, the anterior-most one reaching RA; M weak, simple for 3.7 mm before it forks into MA and MP; MA simple (as preserved), MP with two preserved branches (it probably possessed 3); CuA 0.5 mm long before its fusion with CuPa; CuA + CuPa forked immediately after the fusion of CuA and CuPa; CuA + CuPa with a total of five branches (2, 3); CuPb simple and straight; area between CuPb and AA1 narrow; AA1 strong and simple, some cross-vein between AA1 and AA2 have cross-veins between them; AA2 with six branches; cross-veins occasionally reticulated; no colouration pattern visible.

Locality and horizon

Xiaheyan Village, Zhongwei City, Yanghugou Formation (Ningxia Hui Autonomous Region, China); latest Bashkirian (latest Duckmantian) to middle Moscovian (Bolsovian), early Pennsylvanian (Trümper et al., 2020).

Discussion

The new specimen can be confidently assigned to Archaeorthoptera as it exhibits the character “CuA (diverging from M + CuA) fused with the anterior branch of CuP (CuPa)”, which is the defining character state of this taxon (Béthoux, 2007). Conversely, assignment to the Panorthoptera (including crown Orthoptera and stem groups closely related to them) can be excluded, as CuPa is not branched before its fusion with CuA. Non-panorthopteran Archaeorthoptera include “lobeattid” insects, the order Cnemidolestodea Handlirsch, 1937 (which is probably derived from a subset of lobeattid insects) and a number of unplaced species. The new specimen displays an RA–RP area narrow for a long distance, a trait occurring in the former, represented at Xiaheyan by *Sinopteron huangheense* Prokop and Ren, 2007, *Chenxiella liuae* Liu, Ren and Prokop, 2009, *L. loculata*, *M. maimai* and *Pr. yangi*. Among lobeattids, the new specimen shares with *Miamia* spp. (here considered to include *Aviologus duquesnei* Coty, Háva, Prokop, Roques and Nel, 2014; and see Béthoux, 2008; Béthoux et al., 2012b; Béthoux and Jarzembowski, 2010) a comparatively broad ScP–R/RA area. Another peculiar trait shared with the corresponding species (but not unique to *Miamia* spp.) is the very early branching of CuA + CuPa. However, the new specimen lacks the defining character state of *Miamia*, namely “in forewings, CuPa fuses with M + CuA” (Béthoux, 2008), a condition implying that CuA does not possess a free portion between its divergence from M + CuA and its fusion with CuPa. This free portion of CuA is present in the new specimen, which represents a plesiomorphy within Archaeorthoptera. In summary, the new specimen belongs to a species closely related to *Miamia*, yet it can be confidently excluded from this genus. It follows that it belongs to a new species to be accommodated in its own genus. *Phtanomiamia gui* is smaller than any known species of *Miamia*, and among the smallest “lobeattid” species.

Data availability. The new material included in the paper is accessible and deposited in the Capital Normal University, Beijing, China, and all data are included in the description.

Author contributions. LC and OB contributed the descriptive section (including preparation of the illustration). LC, DR and OB contributed the Discussion.

Competing interests. The authors declare that they have no conflict of interest.

Acknowledgements. We are grateful to two anonymous reviewers for their constructive comments. We thank the numerous students who, over the years, contributed to fieldwork at Xiaheyan.

Financial support. Dong Ren was supported by grants from the National Natural Science Foundation of China (grant nos. 31730087 and 41688103), the Program for Changjiang Scholars and Innovative Research Team in University (grant no. IRT-17R75), and Project of High-level Teachers in Beijing Municipal Universities (grant no. IDHT20180518).

Review statement. This paper was edited by Florian Witzmann and reviewed by two anonymous referees.

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