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The first Chinese Protohymenidae (Palaeoptera: Megasecoptera)

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ABSTRACT

Anhuihymen medianelongata Huang and Nel, gen. nov. et sp. nov., first accurate Chinese Protohymenidae, is described from the Middle Permian Yinping Formation at Chaohu, Anhui Province, Southern China. This region was under a warm and humid climate and separated from the drier Laurussia by the paleo-Thetys ocean during the Middle Permian. This discovery shows that this group was probably very widely distributed during the Permian, and adapted to very different climates and biotas. It also confirms that our current knowledge on the Permian fossil insects is very fragmentary.

Keywords. Palaeodictyoptera; paleobiogeography; Permian; gen. et sp. nov.

Introduction

The Late Palaeozoic megasecopteran family Protohymenidae is known from Laurussia (northern part of the Pangea) by five genera ranging between the Late Carboniferous and the Late Permian. This family is putatively recorded from China by the Early Permian genus *Sunohymen* Hong, 1985, from Shanxi Formation, Artinskian, 290.1 - 279.5 Ma, after Zhang et al. (1997); but Hong (1985a) supposed that the formation was Late Carboniferous. Pecharová and Prokop (2018) put in doubt this family attribution. Hong (1985b) described four bardohymenid species in three genera, viz. *Anthohymen hejinensis* (Xiashihezi Formation, Kungurian), *Sinohymen gancaoshanensis*, *Paleohymen shanxiensis*, and *Paleohymen renmazhuangensis* (all from Shanxi Formation, Sakmarian). Pecharová et al. (2020) removed *Paleohymen* from the Bardohymenidae and considered this genus in 'family uncertain'. Even, all these previously described Megasecoptera were found in the Shanxi Province (Northern China), also a part of the Laurussia. Here we describe a new fossil wing attributable to this family, discovered in a very insect-rich Middle Permian outcrop of the Southern part of China, a region that was separated from Laurussia by an ocean. This discovery widely extends the distribution of this group in an area that was under a very different climate during the Permian.

Material and methods

The fossil was preserved in the black shale of the Yinping Formation near the Houdong Village, Chaohu City, Anhui Province, Southern China (fossil locality map see Szwedó and Huang 2019: fig. 2C). Its age was considered as the late part of Capitanian (Zhang et al. 2019) or around the boundary of Middle-Late Permian (Yao et al. 2015). The present fossil was collected from the Lower part of the Yinping Formation, thus its age is more likely the late Middle Permian.

Photographs were taken using a digital camera attached to a Zeiss Discovery V16 microscope. Line drawings were drafted with Adobe Illustrator CC 2018 graphic software.

We follow the wing venation nomenclature of Pecharová and Prokop (2018). Venation terminology: A1 anal vein; apical cell ac between CA+CP & ScA+ScP and RA; CA+CP costa anterior & posterior; CuA cubitus anterior; CuP cubitus posterior; MA median anterior; MP median posterior; RA radius anterior; RP radius posterior; ScA+ScP subcostal anterior & posterior.

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Results

Superorder Palaeodictyoptera Bechly, 1996

Order Megasecoptera Brongniart, 1885

Family Protohymenidae Tillyard, 1924

Type genus

Protohymen Tillyard, 1924, Early Permian of Elmo (279.5 to 272.5 Ma), Kansas, USA.

Other genera

Arroyohymen Prokop and Kukalová–Peck, 2017 (Early Permian of USA), *Carbohymen* Pecharová and Prokop, 2018 (Late Carboniferous, USA), *Ivahymen* Martynov, 1932 (Late Permian of Russia), *Permohymen* Tillyard, 1924 (Early Permian of USA), *Anhuihymen* gen. nov. (Middle Permian, China).

Genus *Anhuihymen* Huang and Nel, gen. nov.

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Etymology

Named after the Anhui Province and ‘Hymen’, suffix employed in the Protohymenidae.

Type species: *Anhuihymen medianelongata* sp. nov.

Diagnosis

Wing characters only. Very long basal part of MA aligned with basal part of M; RP diverging from RA distal of mid part of wing; bases of CuP and M+CuA at same point; a long anal vein.

Anhuihymen medianelongata Huang and Nel, sp. nov. (Figs 1, 2)

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Etymology

Named after ‘mediana elongata’, Latin for elongate median vein, main characteristic of the new genus.

Type material

Holotype NIGP173320 (imprint and counterimprint of a wing, with extreme base missing), stored at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

Type strata

Late Capitanian, Middle Permian; Yinping Formation.

Type locality

Houdong Village, Chaohu City, Anhui Province, Southern China.

Diagnosis

As for the genus.

Description

Wing apparently hyaline (no trace of a pterostigma visible), preserved part 35.0 mm long, wing ca. 31.0 mm long, 5.8 mm wide; CA+CP & ScA+ScP running together towards apex of wing, forming a broad double vein; RA following CA+CP & ScA+ScP, diverging at 4.0 mm of wing apex, an elongate (lanceolate) apical cell ac between CA+CP & ScA+ScP and RA; RP diverging from RA vein RP well distal of mid part of wing, at 13.3 mm of wing apex, and splitting into two branches; stem of M basally attached to CuA, separating from R 25.3 mm of

wing apex; CuP and M+CuA diverging at same point from R(+M+Cu); CuA separating from M 2.9 mm from common base; M parallel to R; MA and MP separating 4.8 mm from common base; MA very long, aligned with basal part of M, touching RP in one point; single CuP, CuA, MP, and MA ending at posterior margin, single A1 weakly zigzagged, long, reaching level of mid wing; cross veins few in number (ca. 20), widely spaced.

Discussion

After the emended diagnosis of the Protohymenidae proposed by Pecharová and Prokop (2018), *Anhuihymen* gen. nov. has the following characters of this family: CA+CP & ScA+ScP running together towards apex of wing; RA follows CA+CP & ScA+ScP, diverging on distal third of wing, which when it reaches the wing margin and forms an elongate (lanceolate) apical cell ac (main synapomorphy of the family); RP diverges from RA and splits into two branches; stem of M basally attached to CuA, which runs close to RP proximally, then diverges at an acute angle from the radius towards the posterior wing margin, the stem of M and CuA divides in basal third of the wing; single MA directed towards short anastomosis with RP, then ends at the posterior margin, single MP ends at the posterior margin; CuA running basally attached to stem of M for a short distance, then continues towards hind margin; single CuP ends at posterior margin of the wing; single A1 present, crossveins few in number (10-21), widely spaced.

Anhuihymen gen. nov. differs from all the protohymenid genera in the very long basal part of MA aligned with basal part of M, instead of being short, obliquely directed, and looking like the crossveins in the area between M and RP. This pattern is similar to that found in the Scytohymenidae Martynov, 1937 (Martynov 1937: fig. 20; Pecharová et al. 2015: fig. 1). Nevertheless, *Anhuihymen* gen. nov. differs from this family in the vein RP with two branches and the presence of a cell ca (Shcherbakov et al. 2009: 9). The vein RP diverges from RA distal of mid part of wing in *Anhuihymen* gen. nov., instead of diverging near middle as in other

Protohymenidae. *Ivahymen* has the veins M+CuA and CuP emerging at wing base. In *Protohymen* and *Arroyohymen*, CuP diverges basal of base of M+CuA, but *Protohymen* (*Pseudohymen*) *sharovi* (Novokshonov, 1995) has the bases of CuP and M+CuA at the same point, as in *Anhuihymen* gen. nov. Thus this character is subject to some variation in a same genus. *Permohymen* and *Carbohymen* have the base of CuP very near to wing base, far from base of M+CuA. *Carbohymen* and *Permohymen* have a very short anal vein, unlike in *Anhuihymen* gen. nov.

Conclusion

The Protohymenidae are currently known from the Late Carboniferous and Permian localities in Laurussia (Archangelsk region, Perm district, Illinois, Kansas, and Oklahoma). Pecharová and Prokop (2018: 118) indicated that ‘the putative member *Sunohymen xishanensis* Hong, 1985 from the Lower Permian of Shanxi Formation in China’ ‘should be excluded from the Protohymenidae and transferred to Bardohymenidae. Thus *Anhuihymen* gen. nov. is the first record of this family from China. Furthermore, the Southern part of China, from where this fossil comes, was a group of islands in the paleo–Thetys ocean, separated from the Pangea (and Laurussia) during the Middle Permian (Campi 2012; Zhang et al. 2019: fig. 1). It was at the level of equator and probably under a much more humid and equally warm than the paleo–regions where the other Protohymenidae were found (Chumakov and Zharkov 2002; Wang and Pfefferkorn 2013). The central Pangea is supposed to have been under an arid climate with extreme seasonality (Roscher and Schneider 2006; Looy et al. 2016). The present discovery strongly suggests that the Protohymenidae were quite widespread and adapted to a higher diversity of climatic conditions during the Permian than previously supposed.

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Disclosure Statement

No potential conflict of interest was reported by the author.

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Figure 1. *Anhuihymen medianelongata* Huang and Nel, gen. et sp. nov., holotype NIGP173320, photographs of wing. A = imprint. B = counterimprint. C = enlargement of A. (scale bars = 2 mm).

Figure 2. *Anhuihymen medianelongata* Huang and Nel, gen. et sp. nov., holotype NIGP173320. Line drawing. Scale bar = 2 mm.



