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An enigmatic hawker dragonfly from the Middle Jurassic of China (Odonata, Aeshnoptera)

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Abstract The aeshnopteran *Propecymatophlebia magnifica* gen. et sp. nov. is described from the Middle Jurassic Hiafanggou Formation of Inner Mongolia in China, on the basis of a complete forewing. It confirms the remarkable paleodiversity of the stem group of the hawker dragonflies in Central Asia in the period between the Middle Jurassic and the Early Cretaceous.

Die neu aeshnopteran *Propecymatophlebia magnifica* gen. et sp. Wird aus der mitteljurassischen Hiafanggou Formation der Inneren Mongolei in China, auf der Grundlage einer vollständigen Vorderflügel beschrieben. Es bestätigt die bemerkenswerte erhöhte Vielfalt der Aeshnoptera in Zentralasien in der Zeit zwischen dem Mittleren Jura und der Frühe Kreide.

Keywords Insecta, Aeshnoptera, gen. et sp. nov., diversity, Mesozoic, China.

Introduction

The clade Aeshnoptera was very diverse during the Late Jurassic and the Cretaceous, with numerous families now extinct (Bechly et al. 2001; Nel et al. 2008). China is a ‘hot spot’ of diversity for this group during the Mesozoic, with several new families and genera recently described (see references in Nel and Huang 2009, 2010; Li et al. 2011). Some of these taxa from The Haifanggou Fm. in Inner Mongolia has given an exceptionally rich and diverse fauna. Herein we describe a new Chinese genus and species on the basis of a complete forewing from this locality. This fossil is a further representative of the stem group of the modern aeshnid lineage. True Aeshnidae diversified much later, probably during the Late Cretaceous and Paleocene.

Material and methods

A nearly complete forewing preserved in the whitish tuffaceous shale collected near Daohugou Village. The absence of spinicaudatans or anostracans on the piece of rock indicates that the specimen was collected in the upper section of the Daohugou beds (Huang 2015). Its geological age could be close to the Middle-Late Jurassic boundary but slightly earlier than the Karatau fauna from Kazakhstan (Huang 2015).

The specimen was examined with a Nikon SMZ1500 dissecting microscope and illustrated using a drawing tube attached to the microscope. The wing venation nomenclature used in this paper follows Riek & Kukalová-Peck (1984), as amended by Nel et al. (1993) and Bechly (1996). We use the following standard abbreviations: AA anal vein, AP anal posterior, Ax0 Ax1 Ax2 primary antenodal cross-veins, CuAa distal branch of cubitus anterior, CuAb proximal branch of cubitus anterior, IR1, IR2 intercalary radial veins, MAa distal branch of median anterior, MAb posterior branch of median anterior, MP median posterior, N nodus, ‘O₁’ and ‘O₂’ oblique veins, PsIR1 pseudo-IR1, Pt pterostigma, RA radius anterior and RP radius

posterior. We follow the classification of Bechly et al. (2001) to compare our fossil with the Mesozoic Aeshnoptera.

Systematic palaeontology

Order **Odonata** Fabricius, 1793

Suborder Anisoptera Selys in Selys & Hagen, 1854

Infrasuborder **Aeshnoptera** Bechly, 1996

Familia incerta

Genus ***Propecymatophlebia*** gen. nov.

Type species Propecymatophlebia magnifica sp. nov.

Etymology After ‘prope’, Latin for ‘nearly’, and *Cymatophlebia*.

Diagnosis Forewing characters only. Ax2 opposite basal part of discoidal triangle; discoidal triangle broad, nearly as long as broad, divided into six cells; vein MAb straight; Rspl well-defined; pterostigmal brace oblique, two rows of cells between Rspl and IR2, hypertriangle crossed by only one vein; only two rows of cells between Rspl and IR2; a relatively well-defined Mspl; no supplementary crossvein between CuP and PsA; a very broad area between RP3/4 and MAa with ca. six rows of cells or more; only two Bqs crossveins; IR2 weakly curved; pterostigma covering three crossveins.

Propecymatophlebia magnifica sp. nov.

Figure 1

Material Holotype NIGP165285, stored at the Nanjing institute of Geology and Palaeontology.

Etymology Named after the wonderful state of preservation of the type specimen.

Diagnosis As for the genus.

Type stratum and locality Hiafanggou Formation, Middle Jurassic; near Daohugou Village, Wuhua Township, Ningcheng County, Inner Mongolia, China.

Description Forewing complete, hyaline, pterostigma dark brown; wing 41.8 mm long, 10.9 mm wide; distance between base and arculus 5.5 mm, between arculus and nodus 1.6 mm; distance from nodus to pterostigma 11.8 mm; distance between Ax1 and Ax2 3.7 mm, between Ax1 and wing base 3.9 mm; 14 secondary antenodal crossveins of first row distal of Ax2, not aligned with those of second row between ScP and RA, three secondary antenodal crossveins of first row between Ax1 and Ax2; Ax2 lies just distal of basal side of discoidal triangle; arculus angular; pterostigma elongated, 3.7 mm long, 0.8 mm wide, covering three and a half cells, not basally recessed; pterostigmal brace slightly oblique and aligned with basal side of pterostigma; 11 postnodal crossveins between nodus and pterostigma not well aligned with postsubnodal crossveins; median space free of crossveins; submedian space only traversed by CuP-crossing; PsA slightly angular; hypertriangle with one crossvein; discoidal triangle not very elongated, divided into six cells; MAb straight, 4.4 mm long; a well-defined three-celled subdiscoidal triangle; bases of IR2 and of RP3/4 in distal fourth of space between arculus and nodus; only four crossveins between RP and IR2 basal of first oblique vein 'O₁', two Bqs basal of base of RP2; two oblique veins 'O₁' and 'O₂', 1.8 mm and 3.7 mm distal of subnodus, 'O₂' much more oblique than 'O₁'; IR1 strongly zigzagged; pseudo-IR1 short, just distal of pterostigma; area between RP1 and RP2 with two rows of cells between them in basal part; base of RP2 aligned with subnodus, RP2 strongly undulate at its mid part; IR2 less undulate, area between it and RP2 widened with 2-3 rows of cells at their undulate parts; IR2 and RP2 basally parallel, with seven rows of cells near posterior wing margin; a well-defined nearly straight Rspl with two rows of cells between it and IR2; no strongly convex oblique and undulating secondary vein anastomosing between IR2 and RP3/4 directly basal of origin of Rspl; RP3/4 and MA rather parallel and strongly undulate, with one row of cells between them basally and six rows near

posterior wing margin; MA and MP more or less parallel in their basal halves, postdiscoidal area weakly widened at level of nodus; a Mspl more rudimentary than Rspl, with two rows of cells between it and MA; area between MP and CuA with only one row of cells basally and distally divergent; CuAa with six well-defined and parallel posterior branches; CuAb very short, directed towards posterior wing margin, anal area with two rows of cells and a secondary vein between AA and AP.

Discussion

This fossil differs from the Mesuropetalidae, the Liupanshaniidae, and the Austropetaliidae in the fore wing discoidal triangle divided into six cells, instead of max. two. The Rspl well-defined supports an attribution to the Aeshnomorpha. Affinities with the Progobiaeschniidae are excluded for the pterostigmal brace oblique, two rows of cells between Rspl and IR2, hypertriangle crossed by only one vein, Ax2 opposite basal part of discoidal triangle instead of being opposite its apex. It also differs from the Cymatophlebiidae in the presence of only two rows of cells between Rspl and IR2, presence of a relatively well-defined Mspl, no supplementary crossvein between CuP and PsA. Nevertheless *Propecymatophlebia* gen. nov. shares with the Cymatophlebiidae a very broad area between RP3/4 and MAa with ca. six rows of cells or more. It would also share with *Cymatophlebia purbeckensis*, to the exclusion of the other Cymatophlebiidae, several characters, viz. Ax2 situated nearer to basal part of discoidal triangle than to its apex, hypertriangle with very few crossveins, and a better defined Mspl. Nevertheless *C. purbeckensis* has a third reinforced antenodal crossvein distal of Ax2, absent in *Propecymatophlebia*. *Cymatophlebia pumilio* has also an Ax2 situated near basal part of discoidal triangle, but no Mspl, unlike *Propecymatophlebia*. A *Cymatophlebia* sp. drawn by Needham (1907: fig. 1) shares with *Propecymatophlebia* the same position of Ax2, apparently no supplementary crossvein in submedian space, a relatively well-defined Mspl, but

Propecymatophlebia differs from this fossil in the presence of only two Bqs crossveins instead of five, a more weakly curved IR2, presence of only two rows of cells between Rspl and IR2, and only one crossvein in hypertriangle. *Propecymatophlebia* shares with the cymatophlebiid genus *Sinacymatophlebia* Nel and Huang, 2009 (based on a hindwing) the same shapes of the radial branches, but *Propecymatophlebia* differs from this genus in the pterostigma covering three crossveins instead of one, and the better defined Mspl (Nel and Huang 2009). *Propecymatophlebia* differs from the Rudiaeschnidae in the position of Ax2 in forewing, absence of supplementary crossvein in submedian space, a more sigmoidal RP2, only two Bqs veins, and a better defined Mspl. The comparison with the Paracymatophlebiidae is more difficult to do because this family is based on hindwing characters only. They share with *Propecymatophlebia* a widened area between RP3/4 and MAa, few Bqs veins, two rows of cells between RP1 and RP2 in their basal parts, but they differ in the position of Ax2, the very short pseudo-IR1, the narrower area between RP3/4 and MAa along posterior wing margin, and the more rudimentary Mspl in *Paracymatophlebia*. *Propecymatophlebia* differs from the Euaeschnida in the discoidal triangle broad, nearly as long as broad, the fore wing subdiscoidal space not free, and the vein MAb straight. It differs from the Neoaeshnida in the presence of the second oblique crossvein, the Mspl more poorly defined. *Propecymatophlebia* differs from *Cymatophlebiella* (a taxon of uncertain position, based on hindwings) in the better defined Mspl, longer pterostigma, position of Ax2, and MA and RP3/4 more strongly sigmoidal. *Propecymatophlebia* differs from *Sinocymatophlebiella* Li et al., 2011 in the forewing discoidal triangle divided into six cells instead of three, in the position of Ax2, in the pterostigma covering three crossveins instead of one, and in the better defined Rspl and Mspl (Li et al. 2011).

In conclusion, *Propecymatophlebia* corresponds to a new genus and species, but its phylogenetic affinities are uncertain, between the Cymatophlebiidae and the

Paracymatophlebiidae, or even a new family. The clarification of its position should await the discovery of the hindwing structures of this taxon, which are crucial for this purpose.

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Fig. 1. *Propecymatophlebia magnifica* gen. et sp. nov., holotype NIGP165285, photograph of forewing. Scale bar: 10 mm.

