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A new hawker dragonfly from the Middle Jurassic of China (Odonata: Aeshnoptera)

Une nouvelle libellule Hawker du Jurassique moyen de Chine (Odonata : Aeshnoptera)

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ABSTRACT

A new genus and species *Linqibinia panae* of paracymatophlebiid hawker dragonfly is described from the Middle Jurassic Haifanggou Formation (Inner Mongolia, China). Previously only known from Karatau in Kazakhstan, the discovery of another member of this family extends its range across Central Asia. It confirms that the Aeshnoptera was among the most diverse odonatan clades during the Middle-Late Jurassic.

RÉSUMÉ

Le nouveau genre et la nouvelle espèce *Linqibinia panae* de Aeshnoptera Paracymatophlebiidae sont décrits du Jurassique moyen (formation de Haifanggou, Mongolie intérieure, Chine). Cette famille n'était connue que de Karatau au Kazakhstan ; cette découverte étend sa distribution au travers de l'Asie centrale. Elle confirme que les Aeshnoptera étaient parmi les clades d'Odonata les plus diversifiés au Jurassique moyen–supérieur.

Mots clés :
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1. Introduction

A clade Aeshnoptera was much diversified during the Late Jurassic and the Cretaceous, with numerous families now extinct (Bechly et al., 2001; Nel et al., 2008). China is a diversity ‘hot spot’ 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 are closely related to the aeshnid fauna of the Karatau outcrop (Kazakhstan). Herein we describe a new Chinese genus and species belonging to a family till now known only from Karatau, which provides further support for the initial hypothesis of a close relation between these two faunas and the high diversity of hawker dragonflies during the Jurassic.

2. Material and method

Only one specimen was examined. It is a nearly complete hindwing that was preserved in greyish tuffaceous shale from a locality near the village of Daohugou. The abundantly co-occurring conchostracans indicated that the specimen was collected in the middle-up shale 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. Line drawings were made using Adobe Photoshop CS6 and Inkscape graphic software. The wing venation nomenclature used in this paper follows Riek and 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, ‘O’ oblique veins, Pt pterostigma, RA radius anterior and RP radius posterior. We follow the classification of Bechly et al. (2001) to compare our fossil to the Mesozoic Aeshnoptera.

3. Systematic palaeontology

Order Odonata Fabricius, 1793
Clade Aeshnoptera Bechly, 1996
Family Paracymatophlebiidae Bechly et al., 2001
Genus: ***Linqibinia*** gen. nov.

Type species. *Linqibinia panae* sp. nov.

Etymology. Named after our friend and colleague Prof. Lin Qi-bin. Gender feminine.

Diagnosis. Hindwing characters only. Anal loop posteriorly closed; two rows of cells between RP1 and RP2 well basal of pterostigma; Mspl and Rspl present, but rudimentary, with two rows of cells above them; strongly curved RP3/4 and MA; RP3/4 and MA not widely separated near posterior wing margin; IR2 distinctly curved; RP2 only weakly curved; up to three rows of cells between IR2 and RP2 in mid part; very short pseudo-IR1; antenodals of first and second rows not well aligned; postnodals and postsubnodals not well aligned either; two oblique veins; subdiscoidal space two-celled; only one Bqs vein.

Fig. 1. *Linqibinia panae* gen. et sp. nov., holotype NIGP165027, photograph of hindwing (the scale bar represents 2 cm).

Fig. 1. *Linqibinia panae* gen. et sp., holotype NIGP16501166, photographie d’une aile arrière (la barre d’échelle représente 2 cm).

Linqibinia panae sp. nov. (Figs. 1 and 2)

Etymology. Named after the first author’s daughter, Lotta Pan Pinkert.

Material. Holotype NIGP165027, stored at the Nanjing Institute of Geology and Palaeontology.

Diagnosis. As for the genus.

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

Description. Hindwing hyaline, pterostigma dark brown; wing 46.0 mm long, 15.0 mm wide; distance between base and arculus 18.7 mm, between arculus and nodus 26.0 mm; distance from nodus to mid of pterostigma 17.8 mm; distance between Ax1 and Ax2 6.0 mm, between Ax1 and wing base 3.5 mm; eight secondary antenodal cross-veins of first row, not aligned with those of second row between ScP and RA, three of them being between Ax1 and Ax2; Ax2 lies opposite distal angle of discoidal triangle; arculus straight; pterostigma elongated, 4.0 mm long and 0.8 mm wide, covering two and a half cells, not basally recessed; pterostigmal brace slightly oblique and aligned with basal side of pterostigma; 12 postnodal cross-veins between nodus and pterostigma not well-aligned with postsubnodal cross-veins; median space free of cross-veins; submedian space only traversed by CuP-crossing; PsA straight; hypertriangle free; discoidal triangle elongated, divided into three cells; MAb straight, about 4.5 mm long; a well-defined two-celled subdiscoidal triangle; bases of IR2 and of RP3/4 in distal third of space between arculus and nodus; only 4–5 cross-vein between RP and IR2 basal of first oblique vein ‘O$_1$’, only one Bqs basal of base of RP2; two oblique veins ‘O$_1$’ and ‘O$_2$’, 3.7 mm and 6.7 mm distal of subnodus, ‘O$_2$’ much more oblique than ‘O$_1$’; pseudo-IR1 very short, 2.8 mm distal of pterostigma; area between RP1 and RP2 with two rows of cells between them in basal part; base of RP2 just slightly distal to subnodus, RP2 smoothly undulate at its mid part; IR2 more undulate, area between it and RP2 widened with three rows of cells at their undulate parts; IR2 and RP2 basally parallel, with five rows near posterior wing margin; a not very well-developed and zigzagged Rspl with two rows of

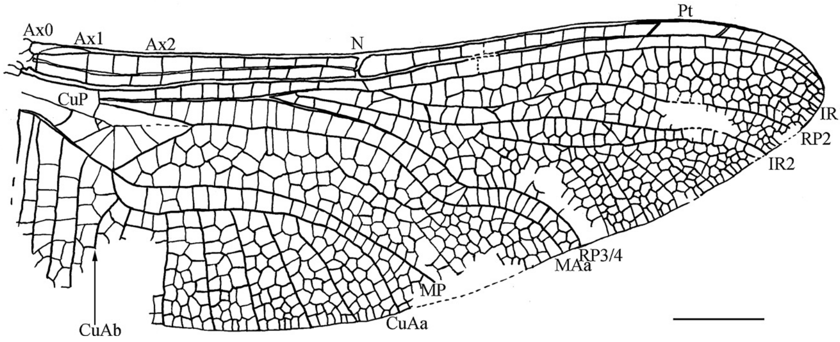

Fig. 2. *Linqibinia panae* gen. et sp. nov., holotype NIGP165027, line drawing of hindwing (the scale bar represents 5 mm).

Fig. 2. *Linqibinia panae* gen. et sp. nov., holotype NIGP165027, dessin au trait d'une aile arrière (la barre d'échelle représente 5 mm).

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 parallel and strongly undulate, with one row of cells between them basally and two 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 rudimentary Mspl 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 seven well-defined and parallel posterior branches; CuAb directed towards posterior wing margin, anal loop posteriorly completely opened, gaff (basal part of CuA) very short; four posterior branches of AA between AP and CuAb; no anal angle and no anal triangle (female specimen); a long and broad, strongly sclerotized darkened membranule.

4. Discussion

This fossil shares several characters with the genus *Paracymatophlebia*: anal loop rudimentary (even if it is posteriorly closed in *Paracymatophlebia splendida*); two rows of cells between RP1 and RP2 well basal of pterostigma; Mspl and Rspl present, even if they are rather rudimentary (especially for Mspl that is zigzagged), with two rows of cells above them; strongly curved RP3/4 and MA, IR2 distinctly curved while RP2 is only weakly curved; up to three rows of cells between IR2 and RP2 in mid part; same shape of discoidal triangle and subtriangle; very short pseudo-IR1; antenodals of first and second rows not well-aligned; postnodals and postsubnodals not well-aligned too. Differences are very few, viz. the anal cell is closed in *P. splendida*, whereas it is posteriorly opened in our fossil (plesiomorphy); our fossil has two oblique veins (plesiomorphy), whereas *P. splendida* has only one, subdiscoidal space is two-celled in our fossil, whereas it is unicellular in *P. splendida*, only one Bqs vein, whereas there are four in *P. splendida*.

The aeshnopteran genus *Sinocymatophlebiella* Li et al., 2011, also from Daohugou, shows high similarities with our fossil, in the shape of the veins MAa, RP3/4, RP2, pseudo-IR1, presence of two oblique veins, only one Bqs vein, opened anal cell (Li et al., 2011). However *Sinocymatophlebiella* differs from our fossil in the absence of Mspl, more rudimentary Rspl, with one row of cells between it and IR2, only one row of cells between RP2 and IR2 in their mid-parts, RP3/4 and MA more widely separated near posterior wing margin, and one row of cells between RP2 and RP1 basal of pterostigma. *Sinocymatophlebiella* is an aeshnopteran of uncertain affinities that could be related to *Paracymatophlebia*, but also to *Cymatophlebiella* Pritykina, 1968 (Bechly et al., 2001; Pritykina, 1968).

Similarities with *Cymatophlebiella* are: opened anal cell, two rows of cells between RP2 and RP1 basal of pterostigma, but it differs from it in the strongly curved RP3/4 and MAa, with only one row of cells in between, a rudimentary but present Mspl, two of cells between IR2 and RP2 basal of pterostigma level, only one Bqs vein instead of two in *Cymatophlebiella*.

The hindwing venation of our fossil is also similar to that of the Daohugou cymatophlebiid genus *Sinacymatophlebia* Nel and Huang, 2009, which shows some similarities with our fossil especially in the strongly curved RP3/4 and MAa. They differ in the presence of a strong widening of the area between these veins, and the absence of Mspl in the latter (Nel and Huang, 2009).

The diagnosis for the Paracymatophlebiidae (Bechly et al., 2001) is based on the following characters: (1) two rows of cells in the basal area between RP1 and RP2, (2) the distal second oblique vein 'O' between RP2 and IR2 is secondarily absent, (3) RP3/4 and MA more strongly undulated, (4) hypertriangles free (reversal), (5) secondarily no accessory cubito-anal cross-veins in the submedian space between CuP-crossing and PsA, (6) anal loop posteriorly weakly closed.

Characters (4), (5), and (6) are present in our fossil, in *Paracymatophlebia*, *Sinomatophlebiella*, and *Cymatophlebiella*, but character (3) is only present in our fossil, in *Paracymatophlebia*, and *Sinomatophlebiella*, while character (1) is present in our fossil, in *Paracymatophlebia*, and *Cymatophlebiella*. Lastly character (2) is only present in *Paracymatophlebia*. It seems that these taxa could belong to the same clade because the distribution of these characters among these taxa is conflictual. The lack of information on the body and forewing characters for many of them, however, forbids us to group them together. Nevertheless, the presence of a Mspl vein constitutes a further synapomorphy of our fossil with *Paracymatophlebia*, among these taxa. Thus we consider that our fossil is more closely related to *Paracymatophlebia* than to *Sinomatophlebiella* and *Cymatophlebiella*.

There is a further difficulty in the relative position of our fossil as compared with *Paracymatophlebia splendida*, because the differences that can be found between the two justify the separations between *Paracymatophlebia*, *Sinomatophlebiella*, and *Cymatophlebiella*. Therefore, we prefer to consider that it belongs to a new genus *Linqibinia*.

Paracymatophlebia and *Cymatophlebiella* are known from the Karatau outcrop (Oxfordian Kazakhstan), while *Sinomatophlebiella* and *Linqibinia* come from Daohugou (Callovian, Inner Mongolia, China). The new taxon provides further support for the ecological and biological similarities between these two outcrops, already recorded for other insect taxa (cf. Khramov et al., 2016).

Linqibinia shows more plesiomorphic characters in its venation than *Paracymatophlebia*, which would fit in with the slightly older age for the Hiafanggou Formation than for the Karatau Formation.

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