

## A new aeschnidiid genus from the Early Cretaceous of China (Odonata: Anisoptera)

D.-Y. Huang<sup>a</sup>, A. Baudoin<sup>b</sup>, A. Nel<sup>c,\*</sup>

<sup>a</sup> State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, P.R. China

<sup>b</sup> AgroParisTech, 16 rue Claude Bernard, F-75005 Paris, France

<sup>c</sup> CNRS UMR 5202, CP 50, Entomologie, Muséum National d'Histoire Naturelle, 45 rue Buffon, F-75005 Paris, France

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### ABSTRACT

The new genus and species of aeschnidiid dragonfly *Linaeschnidium sinensis* is described from the Early Cretaceous of China. Its close relationships with the two Western European genera *Angloaeschmidium*, and *Lleidoaeschmidium* confirms the great affinities between the aeschnidiid faunas of the two areas despite of the presence of continental seas between them during this period.

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### 1. Introduction

The current knowledge on the Mesozoic dragonfly family Aeschniidae greatly improved these last years thanks to the discovery of numerous exquisitely preserved adult and nymph specimens in the Lower Cretaceous of China (Fleck et al., 2001, 2002; Fleck and Nel, 2003; Zhang, 1999, 2000; Zhang and Zhang, 2001). But this family is known by a relatively low number of genera in this area (about four genera), compared to its high diversity in the Lower Cretaceous of UK and Spain (more than ten described genera) (Fleck and Nel, 2003). More precisely, the Aeschniidae are represented by large species in China, while species with wing length between 35 and 45 mm were still unknown there, while they are frequent in the UK Cretaceous. The present fossil is the first Chinese representative of this family having a small size. This fossil is very similar to the two English and Spanish genera *Angloaeschmidium* Fleck and Nel, 2003 and *Lleidoaeschmidium* Nel and Martínez-Delclòs, 1993.

### 2. Systematic palaeontology

We follow the wing venation nomenclature of Riek and Kukalová-Peck (1984), amended by Fleck and Nel (2003) for the Aeschniidae. We use the following standard abbreviations: AA anal vein, Ax0 Ax1 Ax2 primary antenodal cross-veins, CuA cubitus anterior, IRi intercalary radial veins, MA median anterior, MP median posterior, N nodus, O oblique vein, Pt pterostigma, RA radius anterior, RP radius posterior.

Order: Odonoptera Martynov, 1932

Suborder: Anisoptera Selys, 1854

Family: Aeschniidae Needham, 1903

Genus *Linaeschnidium* gen. nov.

*Type species.* *Linaeschnidium sinensis* sp. nov.

*Derivation of name.* Named after Pr Lin Qi-bin and *Aeschmidium*.

*Diagnosis.* Pterostigma coloured, long, crossed by 13 to 15 concave veinlets, with basal side weakly arched, and distal side oblique and stronger than other cross-veins in this area; pterostigma brace sigmoidal; first and second pairs of 'aeschnidiid bullae' present but very weak; primary antenodal cross-veins close together; hind wing distal part of subdiscoidal space not very broad

\* Corresponding author.

E-mail addresses: [huangdiying@sina.com](mailto:huangdiying@sina.com) (D.-Y. Huang), [claudia.baudoinfarah@agroparistech.fr](mailto:claudia.baudoinfarah@agroparistech.fr) (A. Baudoin), [anel@mnhn.fr](mailto:anel@mnhn.fr) (A. Nel).

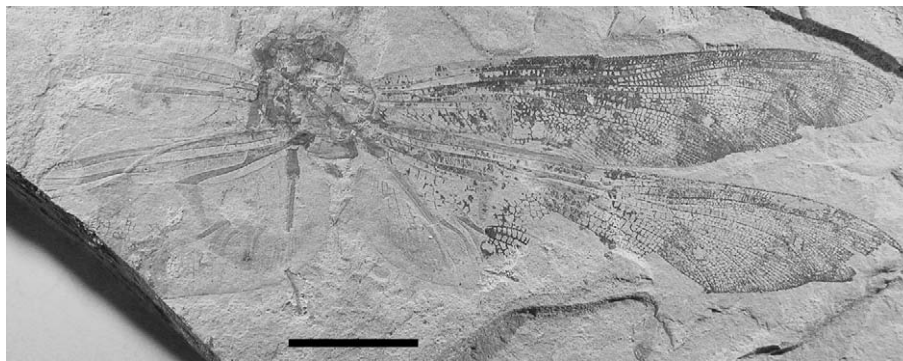


Fig. 1. *Linaeschnidium sinensis* gen. nov., sp. nov., photograph of print (scale bar represents 10 mm).

and rather transverse, presence of a vein AAspl and a well angled AA1b; PsA vein reaching MP + CuA; two (rarely three) rows of cells between Mspl and MA; three to four rows of cells between Rspl and IR2; two rows of cells between RA and RP1 distal of subnodus; fore- and hind wing antenodal supra-ScP beginning at wing base; fore- and hind wing postnodal supra-ScP long, well defined and stronger than the ScP itself, as in *Leidoaeschmidium*; in both fore- and hind wing, only one row of cells between ScP and RA just basal of subnodus; in area between RP1 and RP2, same pattern of three veins as in *Leidoaeschmidium*, viz. basal concave longitudinal vein parallel to RP1 and distally vanishing, a long convex longitudinal vein closely parallel to RP2 distally vanishing, and a second convex longitudinal vein appearing distally and parallel to RP2 too; hind wing MA straight; discoidal triangles rather narrow, with two rows of cells; no cMspl; hind wing basal free part of CuA very short; hind wing elongate and slender.

*Linaeschnidium sinensis* sp. nov.

Figs. 1–7

*Derivation of name.* Named after Sinica, Latin name for China.

*Material.* Holotype NIGP 148831, housed in Nanjing Institute of Geology and Palaeontology, China.

*Type locality and horizon.* Lower Cretaceous, Yixian Formation, Beipiao City, Liaoning Province.

*Description.* Print and counterprint of four wings connected to the thorax with head and leg fragments. The wings have symmetrical dark and hyaline areas (see Fig. 2).

Thorax 12.0 mm long, 8.0 mm wide.

Forewing 40.0 mm long, 8.5 mm wide; distance from base to arculus 2.9 mm, from arculus to nodus 14.1 mm, from nodus to

pterostigma 12.3 mm, from pterostigma to wing apex 7.0 mm; median space with five cross-veins; submedian space with 16 cross-veins; CuP not stronger than other cross-veins between MP + Cu and AA; posterior part of arculus short and weak; arculus between Ax1 and Ax2 very close to Ax1; hypertriangle long (6.2 mm), with about 18 cross-veins; discoidal triangle rather narrow, transverse, 3.1 mm long, 1.5 mm wide, and divided into 25 cells disposed in two rows; distal margin of discoidal triangle (MAB) distinctly curved, 3.1 mm long; basal margin (MP + CuA) very slightly curved, 2.6 mm long; costal margin 1.5 mm long, reaching the angle of MA with MAB; PsA vein reaching MP + CuA; subdiscoidal space divided into two parts by a vein parallel to MP + CuA, with its distal part transverse; at least eight posterior branches of AA, the second and the third ones making a long vein parallel to posterior wing margin; basal free part of CuA long; oblique (CuA + AA)b between CuA and Aspl1 one cell distal of posterior angle of discoidal triangle; (CuA + AA)a with two posterior branches; area between (CuA + AA)a and posterior wing margin reduced; two rows of cells between (CuA + AA)a and MP; postdiscoidal area very wide, with nine rows of cells between MA and MP distal of discoidal triangle, distally greatly widened; base of Mspl six cells distal of discoidal triangle; Mspl nearly straight, nearly vanishing in postdiscoidal area; two-three rows of cells between MA and Mspl; MA nearly straight; no 'MA-Mspl' veinlets and no 'IR2-Rspl' veinlets; first anterior and posterior aeshnidiid bullae present but very weak; base of RP3/4 8.8 mm distal of arculus; base of IR2 one cell distally, 9.4 mm distal of arculus; one row of numerous cross-veins in area between RA and RP between arculus and nodus; 15 Bq cross-veins; two oblique cross-veins 'O', first is one cell distal of subnodus and second is nine cells distally; one or two cross-veins reaching these veins 'O'; strong notches at apices of MA and IR2; area between MA and RP3/4 with one cell basally and four to five rows of cells in widest part; MA and RP3/4

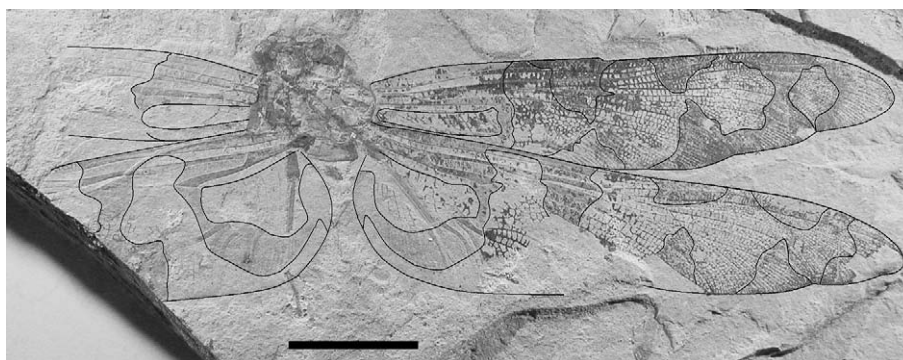


Fig. 2. *Linaeschnidium sinensis* gen. nov., sp. nov., photograph of print with the limits of the hyaline areas (scale bar represents 10 mm).

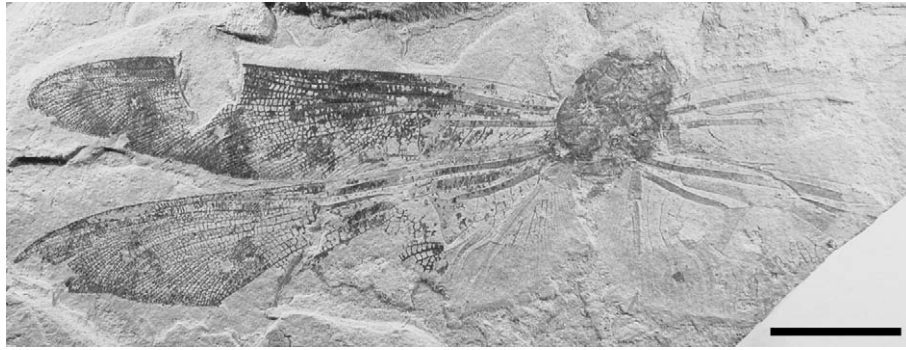


Fig. 3. *Linaeschnidium sinensis* gen. nov., sp. nov., photograph of counterprint (scale bar represents 10 mm).

strongly convergent near posterior wing margin (two rows of cells); area between IR2 and RP2 with one cell basally and four to five rows of cells in widest part; IR2 and RP2 strongly convergent near posterior wing margin (two rows of cells); Rspl nearly straight with four rows of cells between it and IR2; Rspl vanishing distally; second anterior and posterior aeschnidiid bullae present but very weak; ScP straight, clearly crossing through nodus and reaching costal margin 7.9 mm distally; nodal V rather closed; three secondary antenodal cross-veins between Ax0 and Ax1, three between Ax1 and Ax2, and about 40 distal of Ax2; Ax1 and Ax2 close together, 2.6 mm apart; Ax1 perpendicular to ScP and Ax2 oblique; antenodal supra-ScP beginning at wing base and ending at nodus; nodal Cr and subnodus oblique and aligned; base of RP2 aligned with subnodus; postnodal supra-ScP 5.0 mm long and well defined; about 30 postnodal and postsubnodal cross-veins, not aligned together; pterostigma 3.8 mm long, 0.9 mm wide, well defined, slightly sclerotized, but divided into small cells by 14 cross-veins; basal margin of pterostigma weakly arched; distal margin distinct; pterostigmal brace distinct but rather weak; pterostigma covering about 20 cells; two rows of cells in area between RA and RP1 distal of mid part of pterostigma; one or two rows of cells in area between C and RA; in area between RP1 and RP2, a basal concave longitudinal vein parallel to RP1 and distally vanishing, a long convex longitudinal vein closely parallel to RP2 distally vanishing, and a second convex longitudinal vein appearing distally and parallel to RP2 too.

Hind wing 39.7 mm long, 10.6 mm wide; distance from base to arculus 4.1 mm, from arculus to nodus 12.0 mm, from nodus to pterostigma 13.2 mm, from pterostigma to wing apex 6.4 mm; median space with six cross-veins; submedian space with at least 13 cross-veins; CuP not stronger than other cross-veins between MP + Cu and AA; posterior part of arculus short and weak; arculus

between Ax1 and Ax2 very close to Ax1; hypertriangle long (5.0 mm), with about 12 cross-veins; discoidal triangle rather narrow, transverse, 3.5 mm long, 1.3 mm wide, and divided into 15 cells disposed in two rows; distal margin of discoidal triangle (MAb) distinctly curved, 3.5 mm long; basal margin (MP + CuA) very slightly curved, 3.2 mm long; costal margin 1.3 mm long, reaching the angle of MA with MAb; PsA vein reaching MP + CuA; subdiscoidal space divided into two parts by posterior branch AAspl of AA, with its distal part rather transverse, 3.2 mm long, 2.3 mm wide, divided into 27 cells; at least six posterior branches of AA viz. AAspl, and AA1 to AA6 clearly defining the basal part of subdiscoidal area and five infradiscoidal spaces, the one between AAspl and AA1 being of 10 cells, the one between AA1 and AA2 being of six cells; about three other posterior branches of AA at the very base of the wing; anal area broad, with about 23 cells between AA and the posterior wing margin; Aspl1 sigmoidal with four posterior branches in a wide area between CuA and AA1; Aspl2 divided into two main branches; division of Aspl3 also present but less clear; basal free part of CuA very short; oblique (CuA + AA)b between CuA and Aspl1 aligned with posterior angle of discoidal triangle; area between (CuA + AA)a and posterior wing margin reduced; one row of cells between (CuA + AA)a and MP in its basal part; postdiscoidal area very wide, with eight rows of cells between MA and MP distal of discoidal triangle, distally greatly widened; base of Mspl four cells distal of discoidal triangle; Mspl nearly straight, nearly vanishing in postdiscoidal area; two-three rows of cells between MA and Mspl; MA nearly straight; no 'MA-Mspl' veinlets and no 'IR2-Rspl' veinlets; first anterior and posterior aeschnidiid bullae present but very weak; base of RP3/4 7.6 mm distal of arculus; base of IR2 one cell distally, 8.5 mm distal of arculus; one row of numerous cross-veins in area between RA and

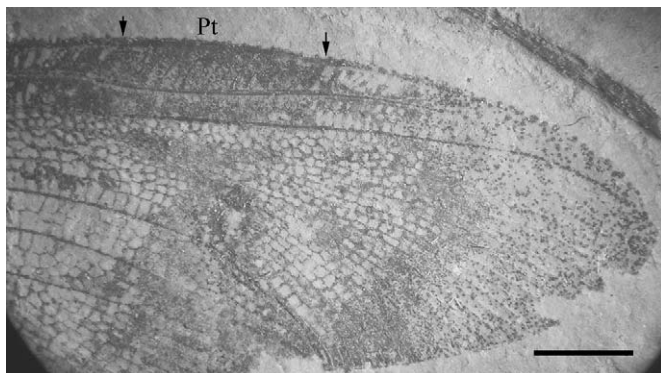


Fig. 4. *Linaeschnidium sinensis* gen. nov., sp. nov., photograph of pterostigma and wing apex (scale bar represents 2 mm).

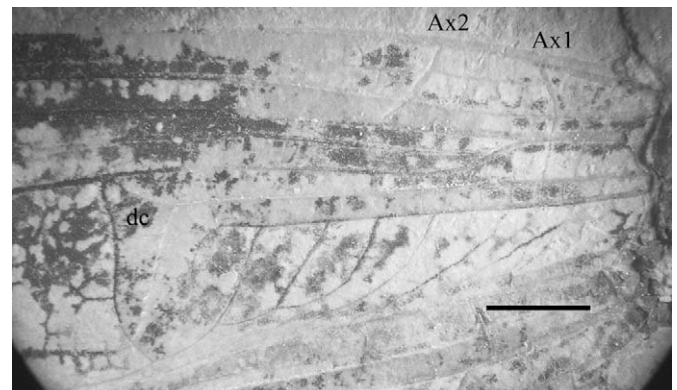


Fig. 5. *Linaeschnidium sinensis* gen. nov., sp. nov., photograph of forewing base (scale bar represents 2 mm).

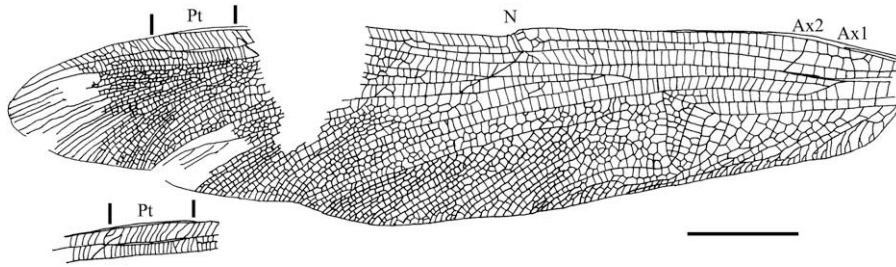


Fig. 6. *Linaeschnidium sinensis* gen. nov., sp. nov., drawing of forewing (scale bar represents 5 mm).

RP between arculus and nodus; 11 Bq cross-veins; two oblique cross-veins 'O', first is one cell distal of subnodus and second is 12 cells distally; one or two cross-veins reaching these veins 'O'; strong notches at apices of MA and IR2; area between MA and RP3/4 with one cell basally and four to five rows of cells in widest part; MA and RP3/4 strongly convergent near posterior wing margin (one row of cells); area between IR2 and RP2 with one cell basally and four rows of cells in widest part; IR2 and RP2 strongly convergent near posterior wing margin (two rows of cells); Rsp1 nearly straight with four rows of cells between it and IR2; Rsp1 vanishing distally; second anterior and posterior aeschnidiid bullae present but very weak; ScP straight, clearly crossing through nodus and reaching costal margin 6.7 mm distally; nodal V rather closed; three secondary antenodal cross-veins between Ax0 and Ax1, three between Ax1 and Ax2, and about 26 distal of Ax2; Ax1 and Ax2 close together, 1.7 mm apart; Ax1 perpendicular to ScP and Ax2 oblique; antenodal supra-ScP beginning at wing base and ending at nodus; nodal Cr and subnodus oblique and aligned; base of RP2 aligned with subnodus; postnodal supra-ScP 2.9 mm long and well defined; about 45 postnodal and postsubnodal cross-veins, not aligned together; pterostigma 3.8 mm long, 0.9 mm wide, well defined, slightly sclerotized, but divided into small cells by 14 cross-veins; basal margin of pterostigma weakly arched; distal margin distinct; pterostigmal brace distinct but rather weak; pterostigma covering about 20 cells; two rows of cells in area between RA and RP1 distal of pterostigma; one row of cells in area between C and RA; in area between RP1 and RP2, a basal concave longitudinal vein parallel to RP1 and distally vanishing, a long convex longitudinal vein closely parallel to RP2 distally vanishing, and a second convex longitudinal vein appearing distally and parallel to RP2 too.

### 3. Discussion

*Linaeschnidium sinensis* gen. nov., sp. nov. is a relatively small species with wing lengths around 41 mm. It is easy to distinguish it from all small aeschnidiids (genera *Aegyptidium* Schlüter and Hartung, 1982, *Aeshniopsis* Tillyard, 1917, *Iberoaeschnidium* Nel and Martínez-Delclòs, 1993, *Leptaeschnidium* Pritykina, 1977, *Diastatopsaeschnidium* Fleck and Nel, 2003, *Kessleraeschnidium* Fleck and Nel,

2003, *Rossaeschnidium* Fleck and Nel, 2003, *Coramaeschnidium* Fleck and Nel, 2003), except for *Angloaeschnidium* and *Lleidoaeschnidium*. Differences with these two genera are few and *Linaeschnidium* fits well with the diagnosis of *Angloaeschnidium* (see Fleck and Nel, 2003: 80), except for the following differences: basal side of pterostigma less arched; fore- and hind wing supra-ScP beginning at wing base instead of beginning distal of Ax2; in both fore- and hind wing, only one row of cells between ScP and RA just basal of subnodus, instead of two rows; presence of a well developed secondary 'primary IR1'; fore- and hind wing postnodal supra-ScP long, well defined and stronger than the ScP itself, instead of being weak and short; PsA vein reaching MP + CuA. These differences correspond to those between *Angloaeschnidium* and *Lleidoaeschnidium*. Differences of *Linaeschnidium* with *Lleidoaeschnidium* are as follows: distal side of pterostigma stronger than other surrounding cross-veins; first and second pairs of 'aeschnidiid bullae' very weak (differences shared by *Angloaeschnidium*); fore- and hind wing supra-ScP beginning at wing base instead of beginning near Ax1; in both fore- and hind wing, only one row of cells between ScP and RA just basal of subnodus, instead of two rows.

The close relationships between *Linaeschnidium*, *Angloaeschnidium*, and *Lleidoaeschnidium* are of interest for the biogeography of the Mesozoic family Aeschniidae. *Angloaeschnidium* and *Lleidoaeschnidium* are known from the Lower Cretaceous of Spain and UK. The present finding of a closely related taxon in the Lower Cretaceous of China confirms the close affinities between the aeschnidiids of these two areas, already suggested by the presence of the Chinese genus *Sinaeschnidia* Hong, 1965 in the Lower Cretaceous of Spain (Fleck and Nel, 2003). As there were at least continental seas during the Upper Jurassic and the Lower Cretaceous between China, England, and Spain, this pattern of distribution of continental insects questions the possibilities of land bridges between these areas or the capacities of flight over seas by these dragonflies. The species of *Sinaeschnidia* are large insects probably more robust than the representatives of the three genera *Linaeschnidium*, *Angloaeschnidium*, and *Lleidoaeschnidium*. Thus their capacities to fly over seas were probably better. *Linaeschnidium*, *Angloaeschnidium*, and *Lleidoaeschnidium* are gracile dragonflies. Their distribution suggests that at least the continental seas

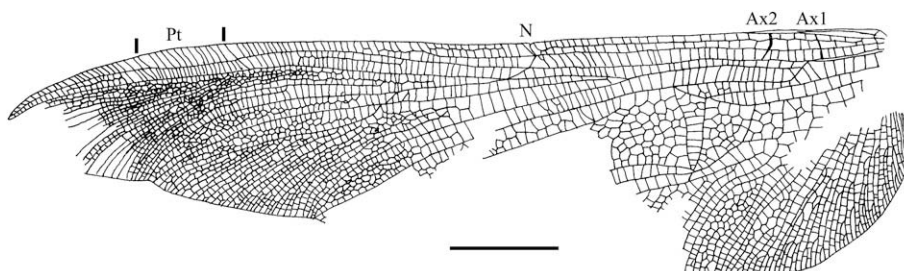


Fig. 7. *Linaeschnidium sinensis* gen. nov., sp. nov., drawing of hind wing (scale bar represents 5 mm).

that were covering Europe during the Lower Cretaceous were not very wide.

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