Bulletin de la Société entomologique de France, **114** (4), 2009 : 441-443.

First fossil record of a Lindeniidae from the Miocene Shanwang Formation of China (Odonata, Anisoptera)

by Di-Ying HUANG* & André NEL**

*State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, P.R. China <huangdiying@sina.com>
**CNRS UMR 7205, CP 50, Entomologie, Muséum national d'Histoire naturelle, 45 rue Buffon, F – 75231 Paris cedex 05 <anel@mnhn.fr>

Summary. – The first Chinese and fifth fossil Lindeniidae is described but not named from the Miocene Shanwang Formation of Linqu City, Shandong Province. Except for an Early Cretaceous taxon from Brazil, all the representatives of this family are from the Oligocene-Miocene of the Palaearctic region.

Résumé. – **Première mention d'un fossile de Lindeniidae du Miocène de la Fformation Shanwang de Chine (Odonata, Anisoptera)**. Le premier Lindeniidae de Chine et cinquième représentant fossile de cette famille est décrit, mais non nommé, du Miocène (formation Shanwang, Linqu, province du Shandong). Hormis un taxon du Crétacé inférieur du Brésil, tous les fossiles de cette famille sont de l'Oligocène-Miocène de la région paléarctique.

Keywords. – Odonata, Anisoptera, Lindeniidae, Lindeniinae, fossil, Miocene, Shanwang, China.

Although ancient, the gomphid group Lindeniidae: Lindeniinae (*sensu* BECHLY, 1996) is very scarce in the fossil record, with the Early Cretaceous genus *Cratolindenia* Bechly, 2000, from Brazil, one Early Oligocene record of the genus *Ictinogomphus* Cowley, 1934 (with some doubt) from Germany, one record of the same genus from the Early Miocene of Japan, and one Lindeniinae of undetermined genus from the Late Oligocene of Turkey (NEL & PAICHELER, 1994 ; BECHLY, 2000 ; PROKOP & FIKÁCEK, 2007). *Ictinogomphus fur* (Hagen, 1863) from the Oligocene of Germany is an Anisoptera of uncertain position (NEL & PAICHELER, 1994).

Here we describe the second representative of the "gomphid" lineage from the Miocene of Shanwang biota (Shandong Province, China), the first one being *Gomphus wuluogongensis* (Hong, 1985) (ZHANG, 1989).

In the description below we follow the wing venation nomenclature of RIEK & KUKALOVÁ-PECK (1984), amended by NEL *et al*. (1993) and BECHLY (1996). The higher classification of fossil and extant Odonatoptera, as well as familial and generic characters followed in the present work, are based on the phylogenetic system proposed by BECHLY (1996).

Order **Odonata** Fabricius, 1793

Family **Lindeniidae** Jacobson & Bianchi, 1905

Subfamily **Lindeniinae** Jacobson & Bianchi, 1905 (*sensu* BECHLY, 1996)

Genus undetermined (fig. 1)

Material. – Specimen NIGP 151366 (two hindwings attached to fragments of the thorax), housed in Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China.

Age and outcrop. – Miocene, Shanwang Formation, Shanwang, Linqu City, Shandong Province, China.

Description. – Hindwing hyaline, with pterostigma dark brown ; wing length 40.0 mm ; width at nodus 11.3 mm (max. width mm) ; distance from base to nodus 16.0 mm (nodus is situated at about 40% of wing length) ; distance from nodus to pterostigma 13.0 mm ; distance from base to arculus 4.6 mm ; Ax1 and Ax2 are aligned and stronger than the other antenodals (bracket-like) ; Ax1 1.0 mm basal of arculus and Ax2 3 distal of Ax1 (slightly basal of distal angle of discoidal triangle) ; four (first row) secondary

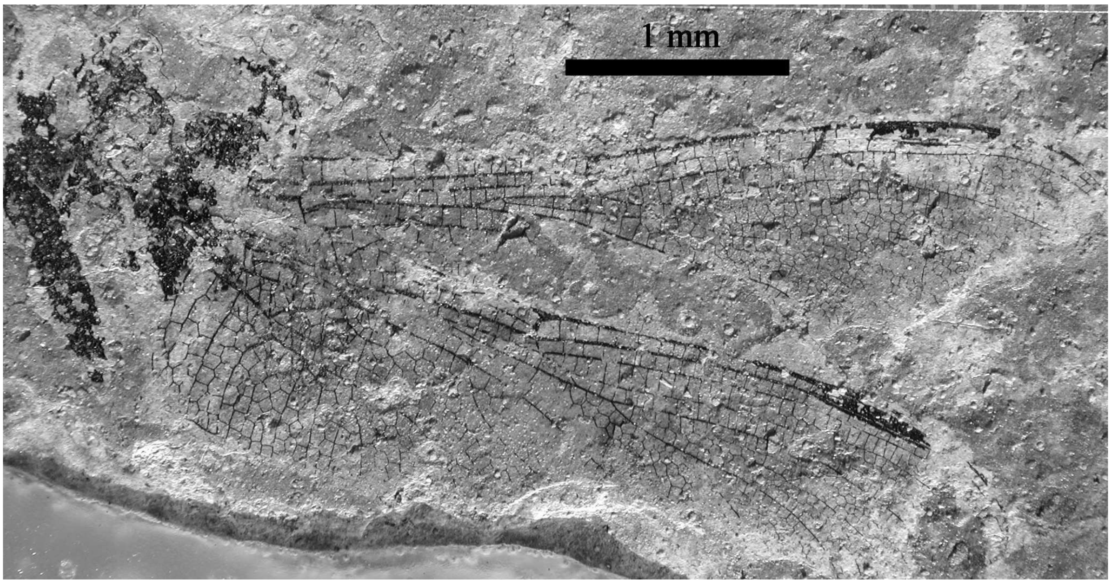

Fig. 1. – Subfamily Lindeniinae, genus undetermined, specimen NIGP 151366, photograph of wings.

antenodal cross-veins between Ax1 and Ax2 (not aligned); distal of Ax2 there are 11 secondary antenodal cross-veins between costal margin and ScP and eight of them between ScP and RA; 12 antesubnodal cross-veins with no gap near arculus and no "cordulegastrid gap" (*sensu* BECHLY, 1996) directly basal of subnodus; secondary antenodal cross-veins are not aligned; 18 postnodal cross-veins between nodus and pterostigma, and at least 20 postsubnodal cross-veins between subnodus and stigmal brace (not aligned with postnodal cross-veins); no "libellulid gap" (*sensu* BECHLY, 1996); pterostigma 5.6 mm long, max. 1.0 mm wide; pterostigma not distinctly braced and covering about 10 cells; RA somewhat broadened along pterostigma.

Arculus rather far from Ax1 and apparently straight; bases of veins RP and MA (sectors of arculus) distinctly separated at arculus; hypertriangle 4.3 mm long, max. 1.0 mm wide, divided by one cross-vein, with costal side (MA) weakly curved; discoidal triangle elongate and two- to four-celled; length of basal side of discoidal triangle 1.6 mm, length of costal side 3.6 mm, length of distal side MAb 3.6 mm; MAb strongly kinked with a strong but short postdiscoidal intercalary vein originating at kink.

A distinct pseudo-anal vein PsA (= AA0) delimits an unicellular subdiscoidal triangle; basal space free; cubital cell with cross-veins (plus CuP-crossing and PsA); CuP-crossing 1.0 mm basal of arculus; anal area max. 6.0 mm wide with six rows of cells; cubito-anal area max. 5.0 mm wide with up to seven rows of cells; CuA with five strong posterior branches; CuAb distinctly developed; "gaff" short; anal loop weakly defined and posteriorly nearly open, and five-celled; MP ending near level of nodus; basal postdiscoidal area with two rows of cells basally, but distally strongly widened (width near discoidal triangle 2.0 mm; width at hind margin about circa 4.0 mm); no Mspl, but a strong intercalary vein in distal postdiscoidal area.

RP3/4 and MA relatively straight and parallel, with only one row of cells between their basal parts, but with two rows of cells between their distal parts; first branching of RP ("midfork") 5.3 mm basal of subnodus; IR2 originating on RP1/2; RP2 aligned with subnodus; only one lestine oblique vein 'O' between RP2 and IR2 2.0 mm, 2-3 cells distal of subnodus; seven bridge cross-veins between RP2 and IR2 basal of basal of oblique vein; RP2 and IR2 parallel with only one row of cells between them but two rows of cells between them near wing margin; no Rspl, but one strong intercalary vein in area between IR2 and RP3/4; RP1 and RP2 divergent with one row of cells between them basal of pterostigma; pseudo-IR1 distinct and originating on RP1 below distal side of pterostigma; two rows of cells between pseudo-IR1 and RP1, and three rows of cells between pseudo-IR1 and RP2.

Wing base rounded without anal angle and anal triangle (female specimen); three posterior branches of anal vein between CuAb and anal margin; no visible membranule.

Discussion. – This fossil can be attributed to the Lindeniidae: Lindeniinae (*sensu* BECHLY, 1996, 2000) for the following synapomorphies (putative after BECHLY, 2000): hypertriangle divided; IR2 and MA with a more or less distinct secondary branch (very distinct in our fossil); hindwing discoidal triangle longitudinal elongate with a strongly sigmoidal and angulated distal side, caused by the development of a more distinct supplementary sector (trigonal planate) in the postdiscoidal area; forewing discoidal triangle divided in more than two cells.

Furthermore, the plesiomorphic presence of more than five antefurcal cross-veins between RP and MA in the hindwing excludes a position within "higher" gomphids. BECHLY (*l. c.*) included in this subfamily the Lindeniini *sensu* BRIDGES (1994), plus the Cretaceous genus *Cratolindenia*. This fossil differs from the latter in the presence of strong fork of IR2, hindwing discoidal triangle divided into three cells, and pterostigmal brace not strongly oblique.

It is nearly impossible to attribute this fossil to a precise genus with the lack of information concerning its body and forewing structures, especially its genital appendages and its discoidal triangle (FRASER, 1939, 1942; NEEDHAM, 1944; PINHEY, 1964; BELLE, 1986; CARLE, 1986). Its hindwing venation is very similar to that of an *Ictinogomphus* Cowley, 1934, or a *Lindenia* De Haan, 1826. Nevertheless it is impossible to attribute this fossil to a precise genus within the Lindeniinae.

The relative rarity of these gomphid dragonflies in the fossil record is surprising as the Lindeniinae is clearly an ancient group, already known in the Early Cretaceous of Brazil. Other fossil records are from the Oligocene-Miocene of Europe, China, and Japan, while the family is now well represented in the intertropical regions.

ACKNOWLEDGEMENTS. – We thank Mr Tang Yonggang who presented this specimen for our studying. This subject was supported by the NSFC (grants no 40672013, and 40632010), and the Major Basic Research Projects of MST of China (2006CB806400).

REFERENCES

BECHLY G., 1996. – Morphologische Untersuchungen am Flügelgeäder der rezenten Libellen und deren Stammgruppenvertreter (Insecta ; Pterygota ; Odonata), unter besonderer Berücksichtigung der Phylogenetischen Systematik und des Grundplanes der Odonata. *Petalura*, Böblingen, Special Volume **2** : 402 p.

—— 2000. – Two new dragonfly species (Insecta : Odonata : Anisoptera : Araripegomphidae and Lindeniidae) from the Crato limestone (Lower Cretaceous, Brazil). *Stuttgarter Beiträge zur Naturkunde*, (B), *Geologie und Paläontologie,* **296** : 16 p.

BELLE J., 1986. – New World Lindeniinae, with *Melanocacus interioris* gen. nov, spec. nov. (Gomphidae). *Entomologische Berichten,* **46** : 97-102.

BRIDGES C.A., 1994. – *Catalogue of the family-group, genus-group and species-group names of the Odonata of the World*. Third edition. Bridges C.A. (publisher), Urbana, Illinois, USA : 950 p.

CARLE F.L., 1986. – The classification, phylogeny and biogeography of the Gomphidae (Anisoptera). I. Classification. *Odonatologica,* **15** (3) : 275-326.

FRASER F.C., 1939. – A note on the generic characters of *Ictinogomphus* Cowley (Odonata). *Proceedings of the Royal Entomological Society,* London (B), **8** (2) : 21-24.

—— 1942. – Dr Raymond Wheeler's collection of Odonata from the Federated Malay States with the description of new genera and two new species. *Proceedings of the Royal Entomological Society,* London (B), **11** (7) : 95-105.

NEEDHAM J.G., 1944. – Further studies on Neotropical Gomphine dragonflies (Odonata). *Transactions of the American Entomological Society,* **69** : 171-224.

NEL A., MARTÍNEZ-DELCLÒS X., PAICHELER J.-C. & HENROTAY M., 1993. – Les 'Anisozygoptera' fossiles. Phylogénie et classification (Odonata). *Martinia,* Hors Série **3** : 1-311.

NEL A. & PAICHELER J.-C., 1994. – Les Gomphidae fossiles. Un inventaire critique (Odonata, Gomphidae). *Annales de la Société entomologique de France* (N. S.), **30** : 55-77.

PINHEY E., 1964. – Dragonflies (Odonata) of the Angola-Congo borders of Rhodesia. *Publicaçoes Culturais Companhia de Diamantes de Angola,* **63** : 97-130.

PROKOP J. & FIKÁCEK M., 2007. – Early Oligocene insect fauna from Seifhennersdorf (Saxony, Germany). *Acta Musei Nationalis Pragae* (B), *Historia Naturalis,* **63** (2-4) : 205-213.

RIEK E. F. & KUKALOVÁ-PECK J., 1984. – A new interpretation of dragonfly wing venation based upon Early Carboniferous fossils from Argentina (Insecta : Odonatoidea) and basic characters states in pterygote wings. *Canadian Journal of Zoology,* **62** : 1150-1166.

ZHANG J.-F., 1989. – [*Fossil insects from Shanwang, Shandong, China*.] Shandong Science and Technology Publishing House, Jinan : 459 p. [in Chinese with abstract in English].