



A new fossil genus of Mesochrysopidae (Neuroptera) from the Early Cretaceous Yixian Formation of China

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Abstract

Longicellochrysa yixiana **gen. et sp. nov.** (Neuroptera: Mesochrysopidae) is described from the Mesozoic Yixian Formation (China). Allopteridae and Tachynymphidae of Nel *et al.* (2005) are considered subfamilies of Mesochrysopidae, along with Mesochrysopinae. *Longicellochrysa* gen. nov. displays a mixture of character states of Mesochrysopinae and Allopterinae and can not be assigned to any subfamily, indirectly supporting a family status of Mesochrysopidae *sensu lato*.

Key words: Neuroptera, Mesochrysopidae, Yixian Formation, Mesozoic, China

Introduction

The Mesozoic family Mesochrysopidae Handlirsch, 1906 *sensu lato* was hitherto represented by 13 genera and 22 species from the Early Jurassic to the Early Cretaceous of Eurasia and South America (Makarkin & Menon 2005; Nel *et al.* 2005; Menon & Makarkin 2008; Martins-Neto & Rodrigues 2009). The taxonomy of this group remained obscure and unresolved for a long time. Some authors believed that this is a fossil subfamily (variously composed) of Chrysopidae (e.g., Adams 1967, Schlüter 1984, Séméria & Nel 1990; Martins-Neto 2003), while others treated it as a separate family, and again its generic composition varied between authors (e.g., Panfilov 1980, Carpenter 1992, Ponomarenko, 2003). Moreover, the taxon was obviously paraphyletic and included some genera distantly related to it as well as true Chrysopidae. Makarkin & Menon (2005) and Nel *et al.* (2005) revised simultaneously the taxon and found almost identical generic composition but as different taxonomic ranks: the clade Allopteridae + Mesochrysopidae + Tachynymphidae + *Mesotermes* Haase, 1890 of Nel *et al.* (2005) was treated by Makarkin & Menon (2005) as the family Mesochrysopidae (*s.l.*).

In the present paper we describe another new genus from the Early Cretaceous Yixian Formation of China. This genus is unlike other genera known from this formation; its systematic position is unclear and can not be assigned to any subfamilies. We consider here the families Mesochrysopidae *s. str.*, Allopteridae and Tachynymphidae of Nel *et al.* (2005) to be subfamilies of Mesochrysopidae.

Material and methods

The specimen examined was collected near Chaomidian Village [120°50'E, 41°37'N] in Liaoning Province, NE China from the deposits of the Yixian Formation. Early Cretaceous age of this formation is considered to be well supported by radiometric dating (using different radioactive decay series) from 133.46 ± 18 for the lowest beds (Chen *et al.* 2004), 126.1 ± 1.7 to 124.6 ± 0.1 Ma for the second Member containing fossil insects

(Swisher *et al.* 1999, 2002, Wang *et al.* 2001, Chen *et al.* 2004, He *et al.* 2006) to 121 ± 0.2 Ma for overlying lava layers and intrusive volcanics (Smith *et al.* 1995), i.e., from the late Hauterivian to early Aptian (geologic time scale of Gradstein *et al.* 2005). The first author (DR) is of the opinion that at the current stage of knowledge, the Yixian Formation should be considered Late Jurassic to earliest Early Cretaceous in age.

We follow here the traditional (*sensu* Wootton 2003) venational terminology of Comstock (1918) with the current interpretation of Makarkin and Menon (2005). Terminology of wing spaces follows Oswald (1993).

Venational abbreviations: 1A–3A, first to third anal veins; abl, anterior Banksian line; CuA, anterior cubitus; CuP, posterior cubitus; *im*, first intramedian cell; M, media; 1m-cu, basal crossvein between M and Cu; MA, media anterior; MP, media posterior; R1, first branch of radius (R); Rs, radial sector; Rs1, most proximal branch of Rs; Sc, subcosta.

Systematic paleontology

Insecta Linnaeus, 1758

Neuroptera Linnaeus, 1758

Mesochrysopidae Handlirsch, 1906

Genus *Longicellochrysa* gen. nov.

Type species. *Longicellochrysa yixiana* gen. et sp. nov.

Etymology. Longi- (from Latin *longus*, long), -cello- (from Latin *cella*, cell) and -chrysa (a traditional ending of chrysopoid genus-group names, from *Chrysopa*), in reference to the long intramedian cell in the forewing of the type species. Gender: feminine.

Diagnosis. May be distinguished from other genera by the following forewing features: antennae long [very short in the Tachynymphinae genus *Tachynymphes* Ponomarenko, 1992], *im* long [short in the genera of Allopterinae], basal crossvein connecting *im* and CuA long [absent or very short in the genera of Allopterinae]; long hypostigmal cell absent [present in the genera of Mesochrysopinae].

Species included. *Longicellochrysa yixiana* sp. nov.

Longicellochrysa yixiana gen. et sp. nov.

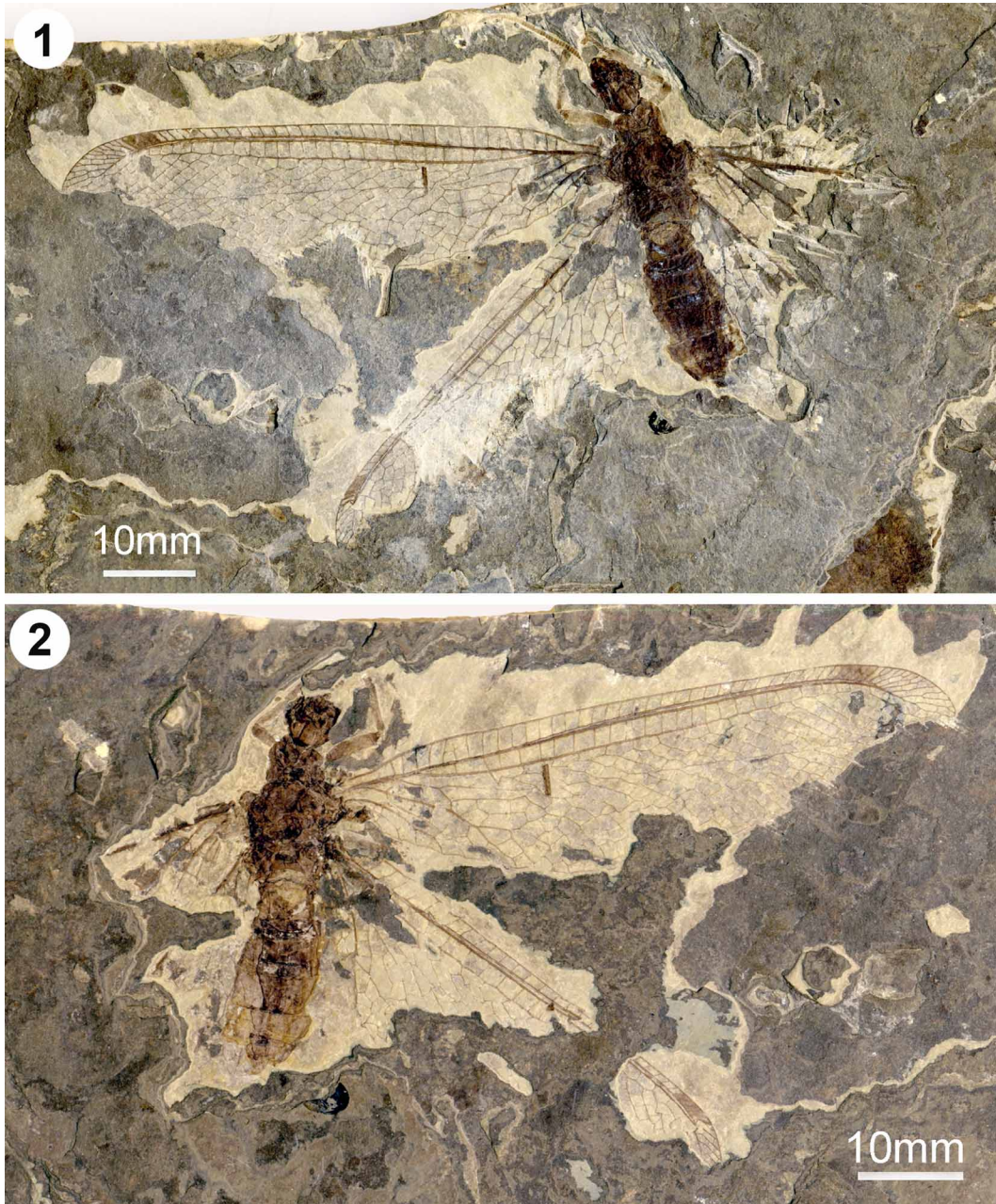
(Figs 1–5)

Diagnosis. See generic diagnosis.

Description. Head relatively elongate; vertex with distinct longitudinal epicranial suture (Fig. 3); eyes poorly preserved; antennae moniliform, flagellomeres transverse (twice as wide as long), covered with dense minute hairs; antennal sockets situated closely to each other. Prothorax crumpled as preserved, slightly shorter than length of head. Mesothorax: prescutum with distinct mid-dorsal suture; shape of scutum and scutellum unclear. Details of metathorax poorly visible. Femora and tibiae of all legs covered with dense, very short hairs; fore femur somewhat stouter than tibia. Hairs on thorax and abdomen not apparent.

Forewing: 61 mm long, ca. 17 mm wide. Costal space very slightly expanded in proximal part, narrowed at base of wing. Subcostal veinlets proximal to pterostigma simple, widely spaced; connected by two crossveins in left wing (aberration). Pterostigma distinct, occupying four costal cells. Veinlets of Sc and Sc+R1 forked distal to pterostigma, connected by two rows of crossveins. Subcostal space narrow, crossveins not detected. R1 space (between R1 and Rs) tapering basally, with 22 crossveins before pterostigma. Stem of Rs smooth, slightly zigzagged distally, with 16 regularly pectinate, zigzagged branches. Crossveins in radial space numerous, not forming distinct gradate series. No crossveins between stem of Rs and M. Anterior

Banksian line distinct, straight, not accompanied by Banksian fold (wings preserved as flattened); posterior Banksian line not detected (probably absent). M divided into MA and MP well proximal to origin of Rs1, and distal to origin of Rs. MA and MP short, arched, somewhat zigzagged; with only one deep branch of MP. First intramedian cell (*im*) long, about 5 times longer than maximal width. Basal crossvein 1m-cu long, at origin of M; 2m-cu connecting *im* and CuA long. Crossveins in medial, mediocubital spaces numerous, not forming distinct gradate series. Cu divided into CuA and CuP rather close to wing base, opposite 1m-cu. CuA somewhat zigzagged, with 3 pectinate branches. CuP short, with deep terminal fork. Five crossveins between CuA and CuP. 1A arched, with deep terminal fork. 2A simple, arched. 3A probably simple (incompletely preserved).



FIGURES 1, 2. *Longicellochrysa yixiana* **gen. et sp. nov.** Holotype, general view of the specimen.1, part CNU-NEU-LJ2009012P; 2, counterpart CNU-NEU-J2009012C.

Hind wing: 50 mm preserved length (estimated length 51 mm; 0.83 times as long as forewing). Costal space narrowed to wing apex, with simple subcostal veinlets. Pterostigma distinct. Veinlets of Sc+R1 distal to pterostigma connected by crossveins. Subcostal space narrow, crossveins not detected. Radial space poorly

preserved, apparently similar to that of forewing. M poorly preserved; MA apparently simple for most of length; MP occupying greater space, at least with two deep forks. CuA short, with 3-4 branches. 1A well developed. 2A, 3A not preserved.

Material. Holotype CNU-NEU-LJ2009012P (part), CNU-NEU-J2009012C (counterpart). An incomplete specimen in dorsal aspect. Housed at the Key Laboratory of Insect Evolutionary and Environmental Change, College of Life Sciences, Capital Normal University, Beijing, China.

Type locality and horizon. Chaomidian Village, Shangyuan Township, Beipiao City, Liaoning Province, NE China. Early Cretaceous Yixian Formation (see Ren & Makarkin 2008).

Etymology. The specific epithet is derived from the Yixian Formation.

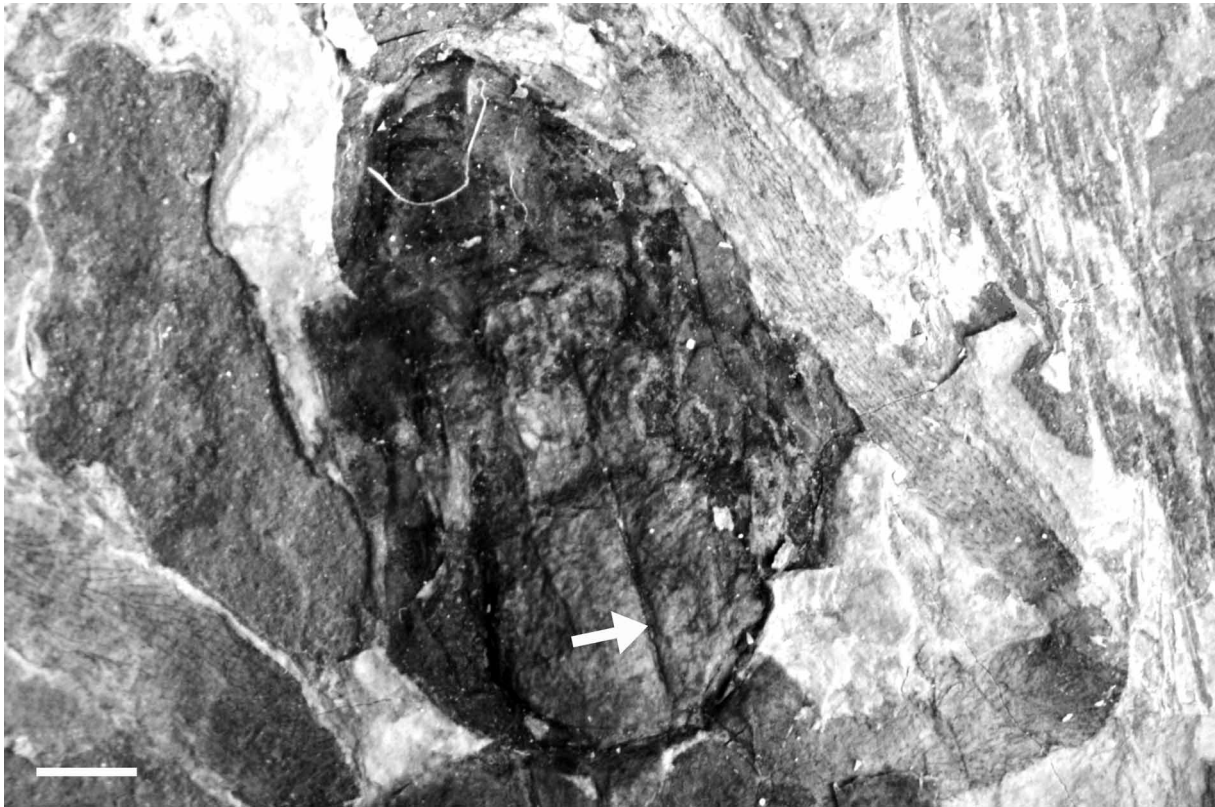


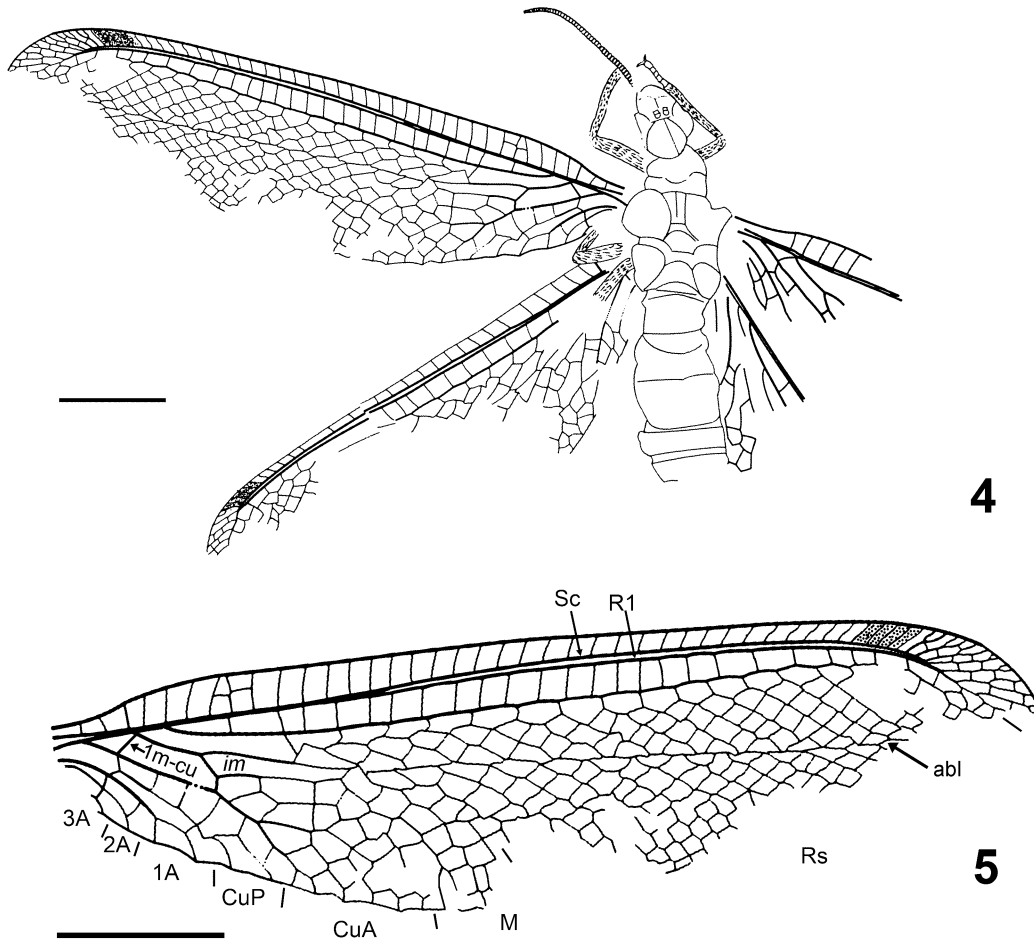
FIGURE 3. *Longicellochrysa yixiana* gen. et sp. nov. Head of the holotype (part CNU-NEU-LJ2009012P) showing epicranial suture (arrow). Scale bar = 1 mm.

Systematic position of *Longicellochrysa* gen. nov.

Nel *et al.* (2005) found that the mesochrysopid-like genera form a monophyletic clade, but classified them as three distinct families: Mesochrysopidae, Allopteridae Zhang, 1991 and Tachinymphidae Nel *et al.*, 2005. We consider that this monophyletic clade represents a single family as in Makarkin & Menon (2005), and we interpret these three families as being subfamilies of Mesochrysopidae: Mesochrysopinae (*Mesochrysopa* Handlirsch, 1906, *Aristenymphes* Panfilov, 1980, *Macronymphes* Panfilov, 1980 and *Protoaristenymphes* Nel et Henrotay, 1994); Allopterinae (*Allopterus* Zhang, 1991, *Triangulochrysopa* Nel *et al.*, 2005, *Karenina*, *Armandochrysopa* Nel *et al.*, 2005 and *Cratovoluptia* Martins-Neto et Rodrigues, 2009); Tachinymphinae (*Tachinymphes* (= *Siniphes* Ren et Yin, 2002), ?*Nanochrysopa* Nel *et al.*, 2005). It is impossible to classify the genera *Mesotermes* Haase, 1890 and *Mesascalaphus* Ren in Ren *et al.* 1995 until a re-examination of their types has been completed.

Recently, Mesochrysopinae, Allopterinae and Tachinymphinae were included as subfamilies in Chrysopidae (Engel & Grimaldi 2008), but this is unjustified because a distinction between Chrysopidae and

Mesochrysopidae (*s.l.*) is well defined. Chrysopidae possess the following character states lacking in Mesochrysopidae (*s.l.*): Banksian lines (folds) are absent in both wings; the jugal lobe in the forewing and the humeral lobe and frenulum in the hind wing are present (reduced in most derived taxa); CuP, 2A and 3A in the hind wing are well developed.



FIGURES 4, 5. *Longicelochrysa yixiana* gen. et sp. nov. Holotype CNU- NEU-LJ2009012P. 4, drawing of the specimen as preserved; 5, forewing venation. Scale bar = 10 mm.

According to Nel *et al.* (2005), the clade *Mesotermes* + Mesochrysopidae + Allopteridae + Tachynymphidae [=Mesochrysopidae *s.l.*] is supported by only two character states: the forewing costal space is not broadened, and Sc and R1 are distally fused. Both these conditions occur in other families of different lineages, especially the latter. In our opinion, the genera of Mesochrysopidae *s.l.* share the following additional synapomorphies: in both wings, [1] one or two Banksian lines (folds) are present (a putative autapomorphy of the family; secondarily lost in some derived genera, for example in the hind wings of *Allopterus* Zhang, 1991, in the forewings of *Tachynymphes ascalaphoides* Ponomarenko, 1992; evolved independently in Myrmeleontidae and Palaeoleontoidea); [2] the crossveins of remigium form several regular gradate series or reticulation (evolved independently in few Chrysopidae and Myrmeleontoidea); [3] jugal lobe lost (shared with Ascalochrysidae; probably evolved independently in Myrmeleontoidea and some fossil families in other lineages); in the forewing, [4] MA short, entering margin at or before wing mid-point (shared with Chrysopidae; probably evolved independently in Mantispidae); [5] the basal crossvein m-cu very long with its anterior tip inclined toward wing apex, rarely perpendicular to Cu, and located at (or near to) the apparent origin of M (shared with Chrysopidae; probably evolved independently in Mantispidae); in the hind wing, [6] CuP is reduced to a part of apparent basal crossvein between CuA and 1A (shared with

Ascalochrysidae); [7] 2A and 3A are entirely lost (or strong reduction) (shared with Ascalochrysidae); [6] the humeral lobe and frenulum of coupling apparatus are lost or poor developed (shared with Ascalochrysidae; probably evolved independently in Myrmeleontoidea, and some fossil families in other lineages).

The systematic position of the genus *Longicellochrysa* gen. nov. is problematic. It displays a mixture of the character states of Mesochrysopinae and Allopterinae. On one hand, its forewing venation is similar to that of the Mesochrysopinae genera in having a long intramedian cell connected by a long crossvein with CuA, the veinlets of Sc+R1 being long and forked, and the forewing is not markedly longer than the hind wing (hind/forewing length ratio 0.83). On the other hand, it is similar to Allopterinae by the structure of mediocubital spaces (the presence of ‘a well-defined vein MPsp1’ of Nel *et al.* (2005) [=a branch of MP or CuA of Makarkin & Menon (2005)]) and the absence of a long hypostigmatic cell. Therefore, it is not possible to assign this genus to any subfamily with certainty.

Epicranial suture on the head of *Longicellochrysa*

The most interesting character detected in *Longicellochrysa* is the presence of distinct epicranial suture on the head. Although this feature is apparently plesiomorphic in the order (present at least in some genera of Ithonidae, Coniopterygidae, Berothidae, Mantispidae, Dilaridae, Psychopsidae, Myrmeleontidae, Ascalaphidae), its occurrence in mesochrysopids is quite important. Previously, this family was not known to possess this suture. In *Karenina longicornis* Makarkin & Menon, 2005 the head is orientated in the dorsal aspect and appears to be well preserved, but there is no indication of the epicranial suture (Makarkin & Menon, 2005: Figs. 1, 2). The head in other mesochrysopids is either poorly preserved or not preserved at all. This suture is also absent in Chrysopidae. Ascalochrysidae was previously only known from a hind wing (*Ascalochrysa magna* Ren & Makarkin, 2009); a recently discovered new specimen (undescribed) of this species unfortunately lacks the head. Therefore, this is first record of the epicranial suture in the superfamily Chrysopoidea comprising Chrysopidae, Mesochrysopidae and Ascalochrysidae (Ren & Makarkin, 2009).

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