



Systematic revision of the fossil snakefly family Baissopteridae (Insecta: Raphidioptera) from the Lower Cretaceous of China, with description of a new genus and three new species



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ARTICLE INFO

Article history:

Received 24 May 2017

Received in revised form

28 July 2017

Accepted in revised form 3 August 2017

Available online 5 August 2017

Keywords:

Neuroptera

Taxonomy

Yixian formation

Mesozoic

ABSTRACT

The fossil snakefly family Baissopteridae from the Lower Cretaceous (upper Barremian) of the Yixian Formation of Liaoning Province, China is reviewed. Two genera and five species of Baissopteridae are recorded, including a new genus, namely *Microbaissoptera* gen. nov., and three new species, i.e., *Baissoptera bicolor* sp. nov., *Baissoptera sinica* sp. nov., and *Microbaissoptera monosticha* sp. nov. Moreover, *Baissoptera euneura* Ren, 1997 is herein treated as a new junior synonymy of *Baissoptera grandis* Ren in Ren et al., 1995. *Baissoptera minima* Ponomarenko, 1993 is transferred to the presently described new genus *Microbaissoptera* gen. nov. based on the small body-size and the presence of a single gradate series of crossveins in radial and medial areas of posterior part of both fore- and hind wings. A key to genera of Baissopteridae is provided.

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1. Introduction

The extinct snakefly family Baissopteridae is the second predominant group among the Mesozoic Raphidioptera, characterized by the presence of numerous RP branches and crossveins in radial and medial areas of posterior part of both fore- and hind wings (Bechly & Wolf-Schwenninger, 2011; Liu et al., 2014). This family had been present in the Early Cretaceous of Eurasia and South America, and the late Eocene of North America, mostly restricted to three localities, i.e., the Zaza Formation of Russia (Martynova, 1961; Ponomarenko, 1993), the Crato Formation of Brazil (Nel et al., 1990; Oswald, 1990; Martins-Neto & Nel, 1992; Jepson et al., 2011), and the Yixian Formation of China (Ren, 1994, 1997; Ren et al., 1995) (Table 1), with 20 described species in six genera (Engel, 2002; Pérez-de la Fuente et al., 2012; Makarkin & Archibald, 2014). The existing evidence indicates that Baissopteridae appears to be the sister-group of the remaining four families (Mesoraphidiidae, Metaraphidiidae, Raphidiidae and Inocelliidae) of the suborder

Raphidiomorpha (Liu et al., 2014). However, the monophyly of Baissopteridae is still not confirmed.

The known palaeofauna of Baissopteridae from China consists of only three species of the genus *Baissoptera* Martynova (Ren, 1994, 1997; Ren et al., 1995; Engel, 2002). Besides the original descriptions, Ren (1997) provided a revisionary work on these species based on additional fossil materials. Nevertheless, the current knowledge of the Chinese baissopterids is from the studies on totally less than 10 pieces of fossils (Ren, 1994, 1997; Ren et al., 1995, 2010). The morphology and palaeodiversity of Baissopteridae from China await further exploration.

In this study, we examined more than 40 specimens of unidentified baissopterid fossils from the Lower Cretaceous of Yixian Formation of China. The materials include five species of Baissopteridae, i.e., two known species of *Baissoptera* [*B. grandis* Ren in Ren et al., 1995 (*B. euneura* Ren, 1997 is herein synonymized as *B. grandis*) and *B. liaoningensis* Ren, 1994], two new species of *Baissoptera*, and a new species of a new genus *Microbaissoptera* gen. nov. A review of these genera and species of Baissopteridae, with descriptions and detail illustrations, is herein presented. A checklist of the species of Baissopteridae (Table 1), as well as a key to the genera of this family, are also provided.

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Table 1
List of known species of Baissopteridae.

Age	Species	Locality	Reference
Early Cretaceous	<i>Austroraphidia brasiliensis</i> (Nel, Séméria and Vulcano, 1990)	Ceará, Pernambuco, Brazil	Willmann, 1994
Early Cretaceous	<i>Baissoptera bicolor</i> sp. nov.	Beipiao, Liaoning, China	/
Early Cretaceous	<i>Baissoptera brasiliensis</i> Oswald, 1990	Ceará, Pernambuco, Brazil	Oswald, 1990
Early Cretaceous	<i>Baissoptera cellulosa</i> Ponomarenko, 1993	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Baissoptera elongata</i> Ponomarenko, 1993	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Baissoptera grandis</i> Ren in Ren et al., 1995	Beipiao, Liaoning, China	Ren et al., 1995
Early Cretaceous	<i>Baissoptera kolosnitsynae</i> Martynova, 1961	Baisa, Buryat, Russia	Martynova, 1961
Early Cretaceous	<i>Baissoptera liaoningensis</i> Ren, 1994	Beipiao, Liaoning, China	Ren, 1994
Early Cretaceous	<i>Baissoptera lisae</i> Jepson, Ansoerge & Jarzembowski, 2011	Ceará, Pernambuco, Brazil	Jepson et al., 2011
Early Cretaceous	<i>Baissoptera martinsoni</i> Martynova, 1961	Baisa, Buryat, Russia	Martynova, 1961
Early Cretaceous	<i>Baissoptera pulchra</i> (Martins-Neto and Nel, 1992)	Ceará, Pernambuco, Brazil	Engel, 2002
Early Cretaceous	<i>Baissoptera sibirica</i> Ponomarenko, 1993	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Baissoptera sinica</i> sp. nov.	Beipiao, Liaoning, China	/
Early Cretaceous	<i>Baissoptera?</i> <i>Cretaeoelectra</i> Pérez-de la Fuente, Peñalver, Delclòs & Engel, 2012	Moraza, Burgos, Spain	Pérez-de la Fuente et al., 2012
Early Cretaceous	<i>Cretaraphidiopsis bontsaganensis</i> (Ponomarenko, 1988)	Bon-Tsagan Nuur, Bayankhongor, Mongolia	Ponomarenko, 1988; Engel, 2002
Early Cretaceous	<i>Cretoraphidia certa</i> Ponomarenko, 1993	Romanovka, Transbaikalia, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Cretoraphidia macrocella</i> Ponomarenko, 1993	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Cretoraphidia magna</i> Ponomarenko, 1993	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Cretoraphidia reticulata</i> Ponomarenko, 1993	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Lugala longissima</i> (Ponomarenko, 1988)	Bon-Tsagan Nuur, Bayankhongor, Mongolia	Willmann, 1994
Early Cretaceous	<i>Microbaissoptera minima</i> (Ponomarenko, 1993) comb. nov.	Baisa, Buryat, Russia	Ponomarenko, 1993
Early Cretaceous	<i>Microbaissoptera monosticha</i> gen. et sp. nov.	Beipiao, Liaoning, China	/
Late Eocene	<i>Dictyraphidia veterana</i> (Scudder, 1890)	Florissant, Colorado, U.S.A.	Makarkin & Archibald, 2014

2. Material and methods

All fossil specimens examined herein are deposited in the Key Laboratory of Insect Evolution and Environmental Changes, College of Life Sciences, Capital Normal University (CNU), Beijing. They are derived from the upper Barremian (126.1 ± 1.7 to 124.6 ± 0.1 Ma), Lower Cretaceous of Jiashangou Member (Bed), Yixian Formation (Wang and Zhou, 2008; Walker et al., 2013), the Huangbanjigou locality ($41^{\circ}36'44''\text{N}$, $120^{\circ}49'48''\text{E}$) (see Wang et al., 2015: fig. 1), Sihetun area, Beipiao City, Liaoning Province, China. The Yixian Formation has a lithology of gray, greenish and purplish tinged, fine-grained sandstones and volcanic tuffs. The Jiashangou Member (Bed) ranges from 50 to 80 m in thickness and yields abundant fossil insects (Ren, 1998; Gao et al., 2013; Yang et al., 2014; Yao et al., 2014).

All specimens were examined using a Zeiss Discovery V12 stereo microscope, photographed with a Nikon D800 digital camera, and illustrations compiled in Adobe Photoshop CC. The terminology of wing venation generally follows Aspöck et al. (1991) and Kukulová-Peck & Lawrence (2004).

Abbreviations used for wing veins and spaces are: A, anal; ac, anal cell; C, costa; Cu, cubitus; CuA, cubitus anterior; CuP, cubitus posterior; dc, discal cell; doi, discoidal cell; M, media; MA, media anterior; MP, media posterior; m, medial cell; pt, pterostigma; R, radius; RA, radius anterior; RP, radius posterior; r, radial cell; ScP, subcosta posterior; sr, subradial cell.

All taxonomic acts established in the present work have been registered in ZooBank (see below), together with the electronic publication under urn:lsid:zoobank.org:pub:D37B79AE-3328-4B84-B93C-01A1574BD8AB.

3. Systematic palaeontology

Order Raphidioptera Navás, 1916
Suborder Raphidiomorpha Engel, 2002
Family Baissopteridae Martynova, 1961

Genus *Baissoptera* Martynova, 1961
Type species: *Baissoptera martinsoni* Martynova, 1961

Revised diagnosis. Body medium- to large-sized for the family (body length 14.6–38.6 mm, forewing length 8.7–27.7 mm) (Table 2). Head elongate, twice as long as wide, tapering caudad or not. Ocelli present (sometimes invisible, but probably due to poor preservation as two states of presence/absence of ocelli in a same snakefly genus are unlikely). Pronotum rectangular, slightly shorter than head length. Legs slender. Wings broad, approximately three to four times as long as wide; ScP terminating into costal margin posterior wing midpoint; a single scP-ra crossvein present; pterostigma proximally approximating ending point of ScP and distally ended at an anterior RA veinlet, usually with one or two pterostigmal crossveins (occasionally absent) (Martynova, 1961: figs. 6, 7; Oswald, 1990: figs. 1–4); rich numbers of crossveins in radial and medial areas forming three or more closed radial cells, two or more medial cells and more than seven discoidal cells. Forewing: More than four pectinate RP branches present; MA originating close to first MP branching point; diverging point between CuA and M obviously distad separation between R and M + CuA. Hind wing: MA stem originating from R and coalescent with RP for a short distance.

Baissoptera grandis Ren in Ren et al., 1995

Fig. 1

Baissoptera grandis Ren in Ren et al., 1995: 97
Baissoptera euneura Ren, 1997: 173. syn. nov.

Revised diagnosis. Body large-sized (body length 18.4–38.6 mm, forewing length 15.6–27.7 mm) (Table 2). Head rectangular. Ocelli present. Pronotum elongate, rectangular. Legs slender, dark-colored throughout. Wings broad, approximately three to four times as long as wide; uniformly colored pterostigma long, ca one-fifth to one-fourth of wing length, with a single pterostigmal crossvein at distal 1/3; crossveins in radial and medial areas forming three gradate series in posterior part of wing. Forewing: Five pectinate RP branches present, each simple or forked.

Materials examined. Holotype: LB93001 & LB93002 (c/p), a well preserved specimen (sex unknown) compressed laterally with thorax, legs and a piece of forewing. Additional materials: LB95101 [holotype of *B. euneura* syn. nov.], a well preserved almost complete female compressed dorsoventrally; CNU-RAP-LB-2017020c/p, a well preserved almost complete female compressed laterally; CNU-

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