Cretaceous Research 61 (2016) 86–90

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

The discovery of the hindwing of the Early Cretaceous dragonfly *Sinaktassia tangi* Lin, Nel & Huang, 2010 (Odonata, Aktassiidae) in northeastern China

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ARTICLE INFO

Article history:
Received 23 October 2015
Received in revised form
22 December 2015
Accepted in revised form 27 December 2015
Available online 28 January 2016

Keywords:
Sinaktassia tangi
Dragonfly
Hindwing
Yixian Formation
Earliest Aptian
China

ABSTRACT

A well-preserved female hindwing of the petalurid dragonfly *Sinaktassia tangi* Lin, Nel & Huang, 2010 is described from the Lower Cretaceous Yixian Formation of Inner Mongolia, China. The discovery of this hindwing allows to complete the description of this Chinese Cretaceous taxon, provides distinctive features from other Aktassiidae, and indicates a comparatively wide distribution of this dragonfly in northeast China.

1. Introduction

The insect order Odonata comprises three suborders: Anisoptera (dragonflies), Zygoptera (damselflies) and Anisozygoptera (damsel-dragonflies) (Zhang et al., 2013). The Petaluridae is a relatively small family of modern Anisoptera that belongs to the broader clade Petalurida with several Mesozoic families. Although comparatively rare in the fossil record, this clade was widely distributed in Europe, Central Asia, China, and South America in the Mesozoic (Nel and Paicheler, 1992; Nel et al., 1998, 2001; Bechly, 2000; Petrulevičius and Nel, 2003; Nel and Bechly, 2009; Coram and Nel, 2009; Lin et al., 2010; Li et al., 2012). Nel et al. (1998) proposed a phylogenetic analysis of the fossil and modern Petalurida with the following subdivisions: Protolindeniidae + Cretapetaluridae + (Aktassiidae + Petaluridae). The Aktassiidae comprises two sister-subfamilies: Pseudocymatophlebiinae and Aktassiinae (Nel et al., 1998). The extinct subfamily Aktassiinae is composed of three Mesozoic genera: *Aktassia*, *Aeschnogomphus*, and *Sinaktassia* (Nel et al., 1998; Lin et al., 2010).

Until now, only two petalurid species have been described from the Mesozoic of China: *Sinaktassia tangi* Lin, Nel & Huang, 2010 from the Lower Cretaceous Yixian Formation of western Liaoning Province (Lin et al., 2010), and *Pseudocymatophlebia boda* Li, Nel & Ren, 2012 from the Lower Cretaceous Yixian Formation of Liutiaogou Village, Inner Mongolia (Li et al., 2012). *S. tangi* was established just based on a forewing and here we describe a well-preserved petalurid hindwing from the Liutiaogou outcrop and attribute it to this species. The recent discovery of this hindwing allows us to better define and systematically place this genus.

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http://dx.doi.org/10.1016/j.cretres.2015.12.015
0195-6671/

The phylogenetic position of the clade Petalurida remains rather controversial. Nel et al. (1998) put it in a basal position of the Anisoptera based on the phylogenetic analysis. The modern Petaluridae are considered to be the sister group of all the extant Anisoptera based on the characters of the wing (Trueman, 1996) or the whole body (Rehn, 2003). The molecular phylogeny indicates a controversial position of the Petaluridae with other modern anisopteran families (Blanke et al., 2013), although a recent work puts the Petaluridae as the sister to the Gomphidae (Carle et al., 2015). These recent works do not help to place the strictly fossil petaluridan families. Here we follow Nel et al. (1998) who placed the Aktassiidae as sister group of the Petaluridae.

2. Geological setting

The specimen described herein was collected from the lower Yixian Formation in Liutiaogou Village, Ningcheng County, Chifeng City, Inner Mongolia, China (Fig. 1).

The fossils from the Liutiaogou outcrop are preserved in grey or yellow silty mudstone. Besides abundant insects (Wang et al., 2012), some well-preserved vertebrates have been discovered here (Chang et al., 2006; Evans and Wang, 2010). The horizon of this locality is thought to be equivalent to either the Jianshangou Bed or the Dawangzhangzi Bed of the Yixian Formation (Evans and Wang, 2010; Wang et al., 2012), which are dated at ~124–123 Ma (earliest Aptian; Chang et al., 2009; Zhang et al., 2010; Cohen et al., 2013).

3. Material and methods

The specimen was examined dry using a Nikon SMZ1000 stereomicroscope. Photographs were prepared using a Canon 5D digital camera, and the line drawings were prepared from photographs using image-editing software (CorelDraw X7 and Adobe Photoshop CS6). The specimen is housed at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS).

The nomenclature of the dragonfly wing venation used in this paper is based on the interpretations of Riek (1976) and Riek and Kukalová-Peck (1984), as modified by Nel et al. (1993) and Bechly (1996). Wing abbreviations are as follows: AA, anterior anal; Arc, arculus; Ax0, Ax1, Ax2, primary antenodal crossveins; Bqs, bridge-crossveins; CuAa, distal branch of anterior cubitus; CuAb, proximal branch of anterior cubitus; IR1, IR2, intercalary radial veins; MA, anterior median; MP, posterior median; Msp1, median supplement; N, nodus; 'O', oblique vein; PsA, pseudo-anal vein; Pt, pterostigma; RA, anterior radius; RP, posterior radius; Rsp1, radial supplement; ScP, posterior subcosta; Sn, subnodal crossvein; T, discoidal triangle.

The higher classification of fossil and extant Odonatoptera, as well as family and generic characters followed in the present work, are based on the phylogenetic system proposed by Bechly (1996, 2014) and Nel et al. (1998) for Mesozoic Petalurida. All measurements are given in mm.

4. Systematic palaeontology

Order Odonata Fabricius, 1793
Clade Petalurida Bechly, 1996
Superfamily Petaluroidea Needham, 1903
Family Aktassiidae Pritykina, 1968
Subfamily Aktassiinae Pritykina, 1968 (sensu Nel et al., 1998)

Genus *Sinaktassia* Lin, Nel & Huang, 2010
Type species: *Sinaktassia tangi* Lin, Nel & Huang, 2010, by monotype.

Sinaktassia tangi Lin, Nel & Huang, 2010
(Figs. 2–3)

New material. NIGP 161882, imprint of a slightly damaged female hindwing, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.
Locality and horizon. Liutiaogou Village, Ningcheng County, Chifeng City, Inner Mongolia, China; Jianshangou Bed of the Yixian Formation, Lower Cretaceous (lowermost Aptian).
Emended diagnosis. Based on forewing and female hindwing characters, body unknown. (1) Wings falcate, slender and longer than 70 mm; (2) postnodal space very narrow, with many cells distal of Pt; (3) Pt elongate; (4) pterostigmal brace present and displaced slightly basal to Pt; (5) IR1 basally strongly zigzagged, long; (6) only one row of cells between RA and RP1 at level of Pt; (7) space

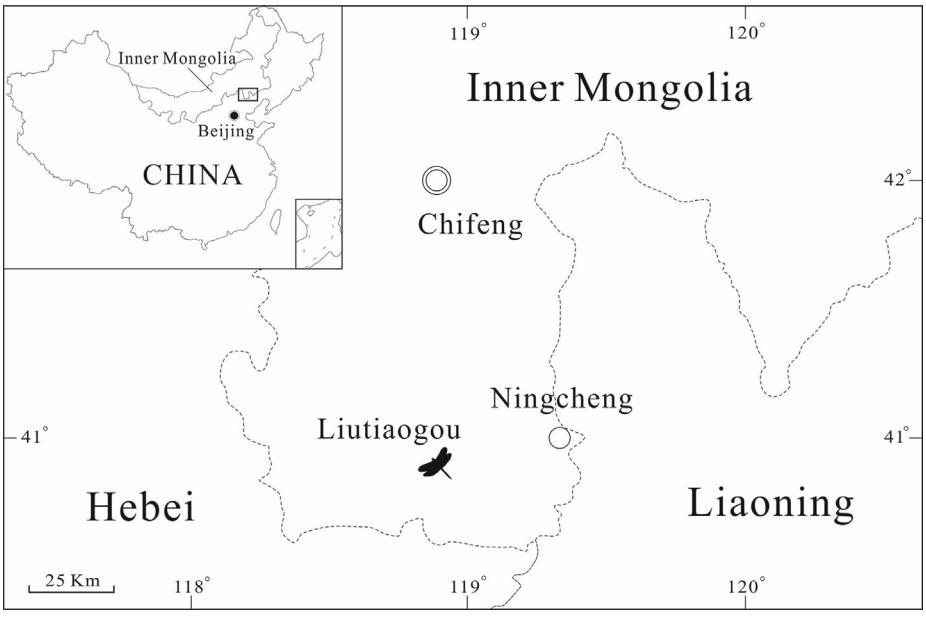

Fig. 1. Sketch map showing the location of the Liutiaogou outcrop.