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New fossil trichocerid Diptera from the Middle Jurassic of Jiyuan Basin, China

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Abstract

The dipteran nematoceran Tricoceridae ?*Mailotrichocera jiyuanensis* **sp. nov.** is illustrated and described from the Middle Jurassic of Jiyuan Basin, China, based on a well-preserved wing. This small trichocerid constitutes the second representative of this family to be discovered from the same locality of Jiyuan Basin.

Key words: Mesozoic, Tipulomorpha, Henan Province, Yangshuzhuang Formation

Introduction

Trichoceridae (winter crane flies), are long, thin, delicate nematoceran Diptera presenting similar morphological characters as Tipulidae, Tanyderidae, and Ptychopteridae. The presence of ocelli distinguishes the Trichoceridae from these other families. With approximately 160 known extant species, this family is today relictual to a group of flies which was probably much more diverse in the past. The adults can be found flying in the fall and the spring and some are active even during winter, hence their vernacular name. The adults live in moist places close to lakes, rivers, or streams. Most of them feed on plant fluids (Yang 2009); while the larvae live in moist or wet terrestrial biotopes and feed on plant debris, decaying leaves in forests, mushrooms and animal droppings (Dahl & Alexander 1976) or take cankered plants or animal bodies as food (Yang 2009; Dong et *al*. 2014).

Trichoceridae comprise four subfamilies: Trichocerinae Rondani, 1841 and Paracladurinae Krzemińska, 1992b for extant and fossil species; and the extinct Ewauristinae Shcherbakov & Azar, 2019 and Kovalevinae Krzemińska, Krzemiński & Dahl, 2009. Trichoceridae constitute a small, 'archaic' and ancient family recorded since the earliest Jurassic (Krzemińska & Lukashevich 2018). Their known fossil record is confined to Laurasia for the Mesozoic (Dong *et al*. 2014): Jurassic and Early Cretaceous of Siberia, Kazakhstan, Mongolia, Kyrgyzstan, China, Lebanon, Germany, and England (Kalugina & Kovalev 1985; Kalugina 1986; Zhang 2006; Krzemińska & Lukashevich 2009, 2018; Shcherbakov & Azar 2019), plus Cenozoic fossils from United States and Europe, including Baltic amber (Dahl 1971; Podenas 2001). Mesozoic trichocerids are usually not abundant, except for a few compression fossil localities in Transbaikalia and one bizarre species constituting a subfamily for its own from the lower Barremian amber of Lebanon (Shcherbakov & Azar 2019). Most fossil Trichoceridae known to date were treated in the comprehensive monograph by Krzemińska, Krzemiński & Dahl (2009), including phylogeny for all extinct and living genera of the family. There are 80 fossil species classified within thirteen genera: *Cladoneura* Scudder, 1864; *Eotrichocera* Kalugina, 1985; *Ewaurista* Shcherbakov & Azar, 2019; *Karatina* Krzemińska, Krzemiński, Dahl & Lukashevich, 2009; *Kovaleva* Krzemińska, Krzemiński & Dahl, 2009; *Mailotrichocera* Kalugina, 1985; *Paleotrichocera* Kalugina, 1986; *Paracladura* Brunetti, 1911; *Rasnitsynina* Krzemińska, Krzemiński & Dahl, 2009; *Tanyochoreta* Zhang, 2006; *Trichocera* Meigen, 1803; *Undaya* Krzemińska, Krzemiński & Dahl, 2009; and *Zherikhinina* Krzemińska, Krzemiński & Dahl, 2009. The oldest trichocerid, *Mailotrichocera praedicta* Krzemińska & Lukashevich, 2018 is Lower Jurassic (Sinemurian, Sogyuty, near lake Issyk-Kul, Kyrgyzstan).

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The Trichoceridae are currently considered as sister group of the other Tipulomorpha (Ci & Kang 2021). Nevertheless, of all fossil Tipulomorpha, Limoniidae are most similar to Trichoceridae in the wing venation and some may be mistaken, especially when the anal portion of the wing is missing (Krzemińska *et al.* 2009). The risk of error is extreme in ancient fossils, because the venation of early Jurassic Limoniidae is often comparable to Trichoceridae (Krzemińska *et al*. 2009). Moreover, most Trichoceridae extinct or extant have consistency and uniformity in the general structure of the wing venation, which makes differentiation (based only on wings) between species rather challenging. Some morphometrics on wing landmarks were applied to the diagnoses of fossil genera and species, because wings, being the structures most frequently found in fossil state, are often the sole source of information on the fossil Trichoceridae (Krzemińska 1992a). Krzemińska (1992a) has shown that from all the landmarks in the trichoceran wing, the position of fork of Rs into R_{2+3+4} and R_5 is most significant in discriminating between the genera. After this author, the position of fork Rs is usually not influenced by sexual dimorphism. The characters that have been examined by quantitative analysis and show taxonomic significance are the length of Sc; length of radial cell (r), length of discal cell (dm), position of fork Rs, and length of A_1 (A_2 after Krzemińska 1992a), all in relation to wing length (Wl) which for commodity is measured from the base of humeral crossvein (h) to the outermost point on the distal wing margin. Lengths of veins are taken along a straight section connecting their origin and end. The only exception in this unified system is made for the vein A_1 (which appeared a difficult character due to its basal position and various shapes), which is measured starting from its most proximal point preserved to its tip.

The Trichoceridae were not recognized as a family separate from Tipulidae *sensu lato* until the immature stages of *Trichocera* became known (Keilin 1912). This discovery resulted in grouping trichocerids first with Anisopodidae (Bezzi 1914), later also with Perissommatidae and Scatopsoidea (Anisopodomorpha *sensu* Krivosheina 1988), and finally with Psychodidae as well (Psychodomorpha *sensu* Wood & Borkent 1989). However, in most systematic treatments, the family Trichoceridae is still united with Tipuloidea into the infraorder Tipulomorpha as defined by Hennig (1954), and the larval characters shared with Anisopodidae and other families are considered symplesiomorphic (Edwards 1926; Dahl & Alexander 1976: 8; Oosterbroek & Theowald 1991: 217; Starý 1992; Shcherbakov *et al*. 1995: 105).

Liu & Huang (2020) studied a fossil trichocerid wing from the Mid-Jurassic of Jiyuan Basin, China and they attributed it to *Eotrichocera* (*Archaeotrichocera*) *ephemera* Zhang, 2006. Here we describe a small trichocerid well preserved wing from the same locality of Jiyuan Basin.

Geological setting

The Yangshuzhuang Formation has been divided from the upper parts of the Anyao Formation that defined as a set of dark green to grayish claystone underlid the Ma'ao Formation by a disconformity. The Yangshuzhuang Formation has yielded diverse fossils, including bivalves, gastropods, ostracods, conchostracans, insects, fish fragments, and plants (Henan Provincial Bureau of Geology and Mineral Resources 1997; Liao *et al*. 2023. Among these, insect fossils are particularly abundant in the uppermost shale and mudstone of this formation. The age of the Yangshuzhuang Formation was suggested for the latest Middle Jurassic to earliest Late Jurassic (Huang 2019). When the Middle Jurassic-Late Jurassic boundary is identified as 163.5 Ma, the fossil layers would be the earliest Late Jurassic. Considering the newly revised International Commission on Stratigraphy of September 2023, the entirety of the Yangshuzhuang Formation could likely be assigned into the Middle Jurassic (*i.e*., Callovian; Xu & Huang 2023).

Material and methods

The type material was collected in upper most layer of the Yangshuzhuang Formation near the Anyao Village, Chengliu Township, Jiyuan City, Henan Province, Central China (for locality map, see Huang *et al*. 2023).

The studied material was manually prepared with a needle, then examined with an Olympus SZX7 stereomicroscope and photographed with a digital camera attached to a Zeiss AxioZoom V16 stereomicroscope. Line drawing was made using camera lucida attached to a Zeiss Discovery V12 stereomicroscope. The figures and illustrations were processed with Helicon Focus 8 and Adobe Photoshop CC 2019 softwares. The type material is deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

The recent standard wing venation nomenclature of De Jong (2017) in the 'Manual of Afrotropical Diptera' is followed and the classical one (proposed by Lukashevich 2004; Krzemińska 1992a and Krzemińska *et al*. 2009) is also given between brackets when necessary.

Results

Order Diptera Linnaeus, 1758
Suborder Nematocera Duméril, 1805
Infraorder Tipulomorpha Rodendorf, 1961
Family Trichoceridae Rondani, 1841
Subfamily Trichocerinae Rondani, 1841
Tribe Trichocerini Krzemińska et al., 2009

Genus ?*Mailotrichocera* Kalugina, 1985

Type species. *Mailotrichocera jurassica* Kalugina, 1985, from Tansbaikalia, Uda, Late Jurassic.

?*Mailotrichocera jiyuanensis* sp. nov.
urn:lsid:zoobank.org:act:EEADABE9-6C83-45D0-802D-155C3017B833

Material. Holotype NIGP206136, well preserved isolated wing.

Etymology. After Jiyuan Basin in Henan Province, where the studied material was found.

Diagnosis. (Based on wing only) Wing small, 3.04 mm long, rounded; medium discal cell (dm) nearly triangular, 0.23 of wing length (Wl, *i.e.*, distance from the base of humeral vein (h) to the tip of wing as defined by Krzemińska *et al*., 2009), a little less than a quarter of the wing, with m-cu in the fork of M_{3+4} (contacting dm cell); A_1 short, not wavy and curved to wing margin, constituting 0.19 of wing length (Wl); relatively short Sc (0.58 times wing length as defined before, *i.e.*, measurements effectuated from humeral vein); cell m_1 short.

Locality and horizon. Yangshuzhuang Formation near the Anyao Village, Chengliu Township, Jiyuan City, Henan Province, China; late Middle Jurassic.

Description. Wing rounded, 3.04 mm long and 1.15 mm wide. Humeral vein at 0.43 mm from wing base; Sc ending wing margin at anterior margin proximad to R2, at 2.01 mm from wing base, beyond the level of the fork of Rs and very slightly before the level of fork of R_{2+3+4}, Sc 0.58× Wl (Wl being measured from humeral vein (h)); sc-r position at 1/3 of length of Rs; R_1 reaches wing margin at 2.58 mm from wing base; R_2 (r-r) at 2.19 mm from wing base; Rs branching from R at 1.12 mm from wing base; fork Rs into R_{2+3+4} and R_5 0.52× Wl; R3, R4 and R5 reach apical wing margin respectively at 2.84, 2.98 and 3.04 mm from wing base; r-m cross vein 0.10 mm long, situated at 1.84 mm from wing base, r-m 0.15x of length of the dm cell; dm cell 0.6 mm long, 025 mm wide, 0.23× Wl; m_1 cell short 0.34 mm long; M1, M2, M3 and M4 reach posterior wing margin respectively at 2.94, 2.84, 2.67 and 2.46 mm apically; CuA and CuP reach posterior wing margin respectively at 2.15 and 1.75 mm apically; A_1 rather short, 0.19× Wl and 0.17× entire wing length, nearly parallel curving to posterior margin.

Discussion

After the keys proposed by Krzemińska *et al.* (2009) ?*Mailotrichocera jiyuanensis* **sp. nov.** could be assigned to the subfamily Trichocerinae Rondani, 1841 within the family Trichoceridae, owing to its large to medium discal cell (dm), with m-cu in the fork of M_{3+4} (contacting dm cell), and to A_1 [A_2 *sensu* Krzemińska *et al.* 2009] short and not wavy. The wing venation patterns of Trichocerinae are to great extent alike, and it is usually not possible to recognize the genera by wings only, and this frustrating phenomenon is observed both in extinct and extant species (Krzemińska *et al.* 2009). The similarity of wings to a particular tribe of Trichocerinae and the more so, to a genus (Krzemińska *et al.* 2009). For these reasons we proceed in what follows by elimination.

After the keys proposed by Krzemińska *et al.* (2009: 23) ?*Mailotrichocera jiyuanensis* **sp. nov.** cannot be attributed to the genus *Cladoneura* Scudder 1894, because A_1 is not long, neither wavy. It cannot be assigned to the genus *Eotrichocera* Kalugina, 1985, because A_1 is short, much less than 0.27× the wing length as in *Eotrichocera*; it cannot neither be assigned to *Rasnitsynina* Krzemińska *et al.*, 2009, because Sc is ending apically beyond the fork of Rs and A_1 is not extremely short as in *Rasnitsynina*. ?*Mailotrichocera jiyuanensis* **sp. nov.** cannot be ascribed to the genera *Karatina* Krzemińska *et al.*, 2009, *Trichocera* Meigen, 1803, and *Paleotrichocera* Kalugina, 1986 due to Sc is not at least 0.6× Wl. ?*Mailotrichocera jiyuanensis* **sp. nov.** cannot be attributed to *Tanychoreta* Zhang, 2006 nor to *Zherikhinina* Krzemińska *et al.*, 2009 neither to *Undaya* Krzemińska *et al.*, 2009 because Sc is less than 0.6× Wl.

?*Mailotrichocera jiyuanensis* **sp. nov.** can be assigned (with precaution however) to the genus *Mailotrichocera* Kalugina, 1985 within the tribe Trochocerini after the keys of Krzemińska *et al.* (2009), since Sc (in comparison to Wl) is 0.58× Wl, very close to the range proposed by the keys, which is 0.25–0.56× Wl. Moreover, ?*Mailotrichocera jiyuanensis* shares with the genus *Mailotrichocera* the following characters: Sc is ending between the levels of forks of Rs and R_{2+3+4}, Rs about the middle size of Wl, dm cell 0.23× Wl within the proposed range (0.19–0.25× Wl) of Krzemińska *et al.* (2009) and A1 short and nearly parallel to wing margin.

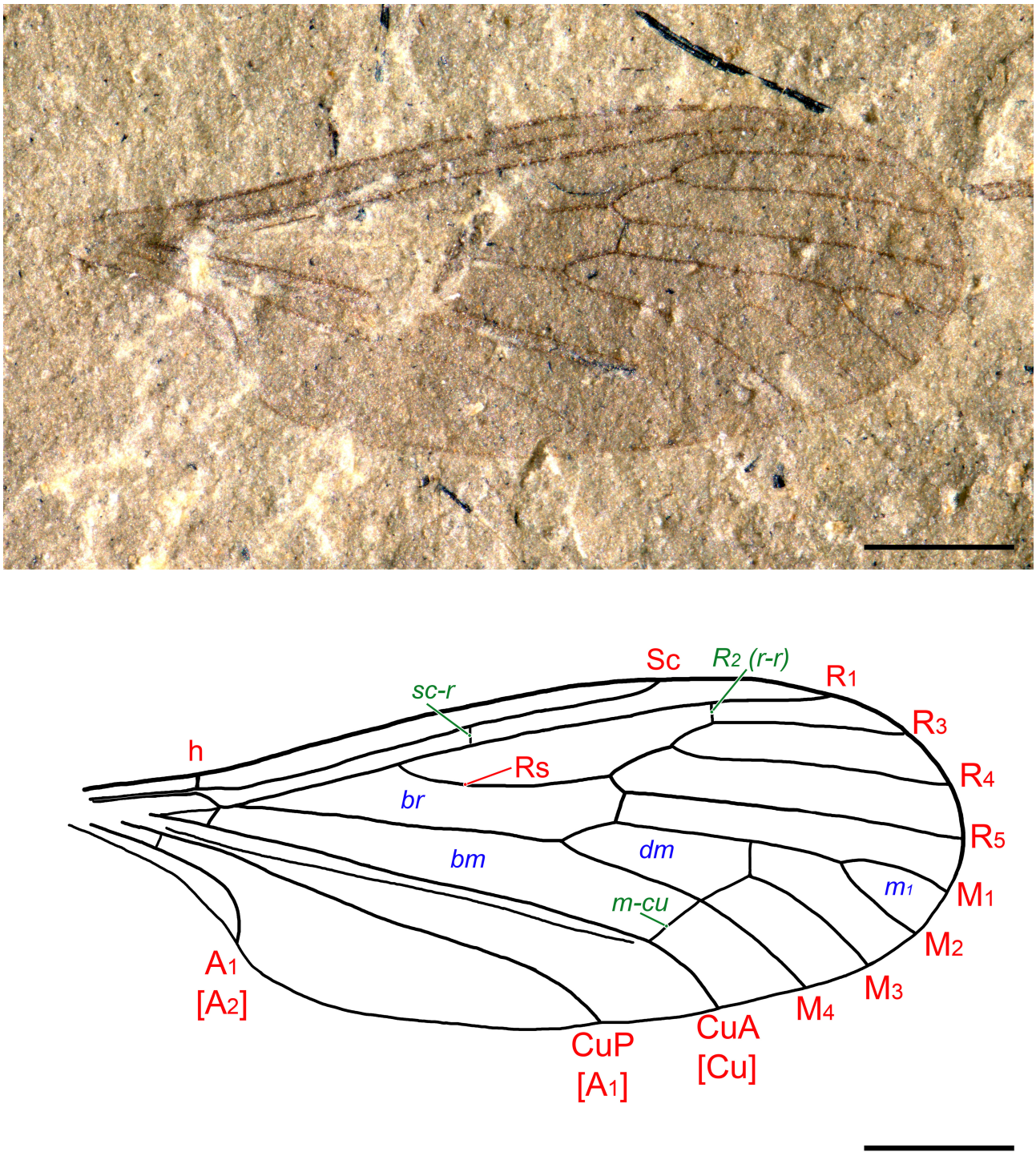

Figure 1. *Mailotrichocera jiyuanensis* **sp. nov.**, Middle Jurassic Jiyuan Basin, holotype, NIGP206136. **A,** microphotograph of wing; **B,** line drawing of wing. Scale bars = 0.5 mm.

?*Mailotrichocera jiyuanensis* **sp. nov.** can be distinguished from all the known representatives of the genus *Mailotrichocera* from the Lower Jurassic, Jurassic and Cretaceous boundary by the size of the wing and the wing venation proportions.

The discovery of ?*Mailotrichocera jiyuanensis* **sp. nov.** from the Middle Jurassic Jiyuan Basin represents the second trichocerid taxa to be discovered from this locality and increases our knowledge on the palaeobiodiversity of the Trichoceridae during the Jurassic.

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