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Short communication

New fossil caddisfly from Middle Jurassic of Daohugou, Inner Mongolia, China (Trichoptera: Philopotamidae)

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Abstract

A new genus and new species, *Juraphilopotamus lubricus* gen. et sp. nov., from the Middle Jurassic Jiulongshan Formation of Daohugou, Inner Mongolia, China, is described and illustrated. It may be the first record of the family Philopotamidae in China, extending the geographic distribution of this family. A detailed description and illustration of the specimen along with a brief review of the fossil Philopotamidae are given. A proposal on dispersion and migration of Philopotamidae and problems of the paleoenvironment of the Daohugou beds are discussed.

Keywords: Insecta; *Juraphilopotamus*; Philopotamidae; Middle Jurassic; Biogeography

1. Introduction

Trichopterans or caddisflies are small to moderate-size insects, with a near worldwide distribution except for Antarctica. To date, the order contains more than 12,627 extant species and 500 fossil species [1]. Research on fossil caddisflies has a history of more than 100 years. The oldest trichopteran emerged in the permian [2], but the earliest genuine fossil trichopteran is *Liadotaulius maior* from the lower Toarcian of Dobbertin (NE Germany). It has a plesiomorphic set of venation characters which hinder familial placement [3]. Basal Trichoptera began to diverge from necrotauliid ancestors during the Late Triassic and Early Jurassic [4]. Some basal families appeared in the Jurassic period, such as Dysoneuridae, Rhyacophilidae, Baissoferidae and Vitimotauliidae [5], while Philopotamidae is another family of putative Jurassic age [4].

Since Botosaneanu summarized fossil species of Philopotamidae [6], six more new species have been reported (not including the species described in this paper). They were *Dolophilodes* (*sortosella*) *shurabica* Sukatsheva, 2004 [7]; *Wormaldia pheromonia* Melnitsky et Ivanov, 2005 [8], *Wormaldia vlipla* Ivanov et Melnitsky, 2005 and *Wormaldia Sukatsheva* Melnitsky et Ivanov, 2005 [8]; *Wormaldia myanmar* Wichard & Poinar, 2005 [9]; *Chimarra palaenova* Wichard, 2007 [10]. To date, 11 genera and 30 fossil species of this family were described [6–10], and they are summarized in Table 1.

A new and unique imago specimen from the Middle Jurassic Jiulongshan Formation of the Daohugou beds allows us to carry out a detailed study because of its excellent preservation. Based on some particular characters, we established *Juraphilopotamus lubricus* gen. et sp. nov.

2. Materials and methods

The fossil described herein was collected from the Middle Jurassic of Daohugou Village, Wuhua Township, Ningcheng County, Inner Mongolia, China. It was examined

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Table 1
Fossil records of family Philopotamidae.

Species	Location	Age
Prophilopotamus asiaticus Sukatsheva, 1973	Kyrgyzstan	Lower Triassic
Dolophilodes (sortosella) shurabica Sukatsheva, 2004	Kyrgyzstan	Lower Jurassic to Middle Jurassic
Baga bakharica Sukatsheva, 1992	Mongolia	Middle Jurassic
Baga pumila Sukatsheva, 1992	Mongolia	Middle Jurassic
Juraphilopotamus lubricus gen. et sp. nov.	China	Middle Jurassic
Archiphilopotamus luxus Sukatsheva, 1985	Siberia	Middle Jurassic
Archiphilopotamus maneus Sukatsheva, 1985	Siberia	Middle Jurassic
Dajella tenera Sukatsheva, 1988	Southeastern Siberia	Lower Cretaceous
An unnamed species[a]	Kazakhstan	Upper Cretaceous
An unnamed species[a]	Taimyer peninsula	Upper Cretaceous
Arkharia oblimata Sukatsheva, 1982	Far eastern Russia	Upper Cretaceous
Wormaldia praecursor Botosaneanu, 1995	New Jersey amber	Upper Cretaceous
Wormaldia praemissa Cockerell, 1916	Tennessee amber	Upper Cretaceous
Wormaldia myanmari Wichard & Poinar, 2005	Burmese amber	Upper Cretaceous
An unnamed species[a]	Baltic amber	Oligocene
Electracanthinus klebsi Ulmer, 1912	Baltic amber	Oligocene
Ulmerodina impar Ulmer, 1912	Baltic amber	Oligocene
Wormaldia pheromonia Melnitsky & Ivanov, 2005	Baltic amber	Oligocene
Wormaldia vlipla Ivanov & Melnitsky, 2005	Baltic amber	Oligocene
Wormaldia sukatchevae Melnitsky & Ivanov, 2005	Baltic amber	Oligocene
Wormaldia aequalis Hagen, 1956	Baltic amber	Oligocene
Wormaldia congenera Ulmer, 1912	Baltic amber	Oligocene
Wormaldia media Ulmer, 1912	Baltic amber	Oligocene
Wormaldia angularia Mey, 1986	Saxonian amber	Miocene
Wormaldia contigua Mey, 1986	Saxonian amber	Miocene
Chimarra weitschati Wichard,1983	Dominican amber	Miocene
Chimarra resinae Wichard, 1983	Dominican amber	Miocene
Chimarra palaeodominicana Wichard, 1983	Dominican amber	Miocene
Chimarra dommeli Wichard, 1983	Dominican amber	Miocene
Chimarra succini Wichard, 1983	Dominican amber	Miocene
Chimarra palaenova Wichard, 2007	Dominican amber	Miocene

[a] From Botosaneanu L., 1995 [6], without names of species and genus, only location and age.

using a Leica MZ12.5 dissecting microscope and illustrated with the aid of a drawing tube attachment. Line drawings were made with CorelDRAW 12 graphic software. Photographs were taken by Nikon Digital Camera DXM 1200C.

The type specimen described here is housed in the Key Laboratory of Insect Evolution and Environmental Change, College of Life Science, Capital Normal University, Beijing, China.

The body length was measured from the apex of the head to the apex of the abdomen. The wing length was measured from the basal to the apex of the wing.

Morphological terms used here are explained by Holzenthal et al. [11].

3. Systematic paleontology

Order Trichoptera Kirby, 1815
Suborder Annulipalpia Martynov, 1924
Superfamily Philopotamoidae Stephens, 1829
Family Philopotamidae Stephens, 1829
Genus Juraphilopotamus gen. nov.
Type species: *J. lubricus* sp. nov.

Etymology: Generic name derived from "Jurassic" and "*philopotamus*" (a genus of Philopotamidae).

Species included: Type species *J. lubricus* gen. et sp. nov.

Diagnosis: The apex of the forewing is located in the terminal of R_5. Sc is long with a humeral cross-vein and an oblique crossvein leading to costal margin. R_1 forks at the apex. MC and DC are closed, the stem of Rs is nearly two times that of DC. Rs and M are four-branched, respectively. Rs forks before 1/2 of the forewing length, M forks a little earlier than Rs, and Cu_1 deeply forks at the same level of Rs. F1–F5 are complete, and F3 is a petiolate. Cu_2 is bent terminally. Cu_2 and 1A reach posterior wing margin at the same point. An oblique crossvein appears basally between 1A and 2A. Hindwing, crossveins r and m-cu are present, F4 is absent, and DC is closed.

Comparison: This new genus differs from the genus *Prophilopotamus* Sukatsheva, 1973 [12], by terminally forked R_1, petiolate F3, location of forewing apex and shorter 3A; differs from the genus *Arkharia* Sukatsheva, 1982 [13], by forked R_1, the gap between the terminal of Cu_2 and 1A, location of forewing apex; differs from the genus *Archiphilopotamus* Sukatsheva, 1985 [14], by distally forked R_1 and petiolate F3.

Remarks: The forked Sc and R_1 of the new genus resemble *Rhyacophila* of family Rhyacophilidae, but the D cell and M cell are different, they are closed in the new genus but open in *Rhyacophila* [15]. The forked R_1 of the forewing is similar to some genera of the extant family Ecnomidae [16]. However, no setal warts are present in the mesoscutum of the new species, whereas the family Ecnomidae have a pair of setal warts in the mesoscutum [16]. A mesoscutum without setal warts, closed D cell and M cell, wing shape and small hyaline areas are all important characteristics of the family Philopotamoidae [16], though the forked R_1 is seldom present in the family. The forked R_1 is present in the fossil *Wormaldia praecursor* Botosaneanu, 1995 [6], it was referred to as the species of Philopotamoidae according to the characteristics of genitalia, maxillary palpus and formula of spurs [6]. Therefore, we tentatively

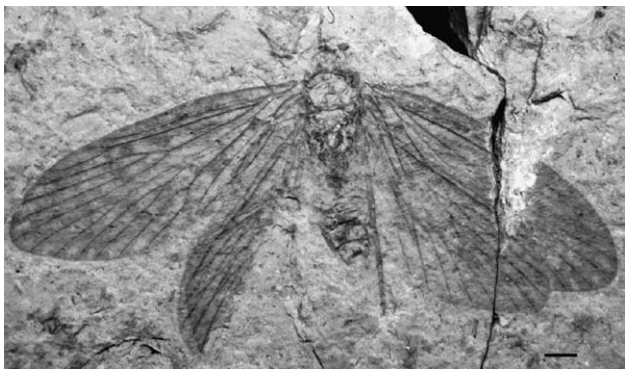

Fig. 1. Photograph of the whole body of *Juraphilopotamus lubricus* gen. et sp. nov. Holotype, No. CNU-T-NN-2007001. Scale bar represents 1 mm.

place the specimen in a new genus of the family Philopotamoidae rather than of Ecnomidae or Rhyacophilidae.

Juraphilopotamus lubricus sp. nov. (Fig. 1).

Entomology: From Latin "lubricus", highlighting that most venations are smooth and without waves.

Materials: Holotype, male. CNU-T-NN-2007001, a well-preserved specimen with wings and part of the body.

Description: Body (Fig. 2)—length 8 mm; antenna slender, filiform, partially preserved, the basal segment of the antenna is stout but shorter than the head. A pair of symmetrical setal warts on the dorsal view of the head are visible. Several clusters of hairs are visible between antennae. The prothorax is narrow and long, no setal warts are visible on the pronotum. The mesoscutum is without setal warts; the scutellum is narrow anteriorly and broad posteriorly.

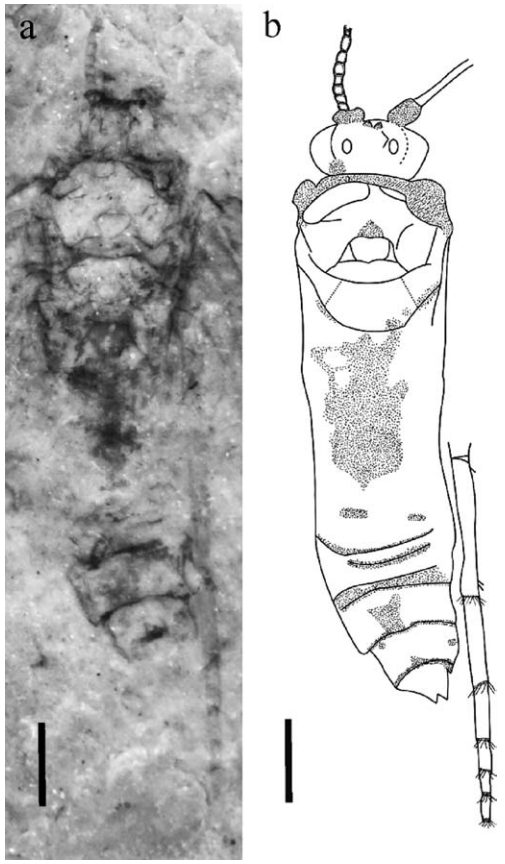

Fig. 2. Body of *Juraphilopotamus lubricus* gen. et sp. nov. Holotype, No. CNU-T-NN-2007001. Scale bar represents 1 mm. (a) Photograph and (b) linedrawing.

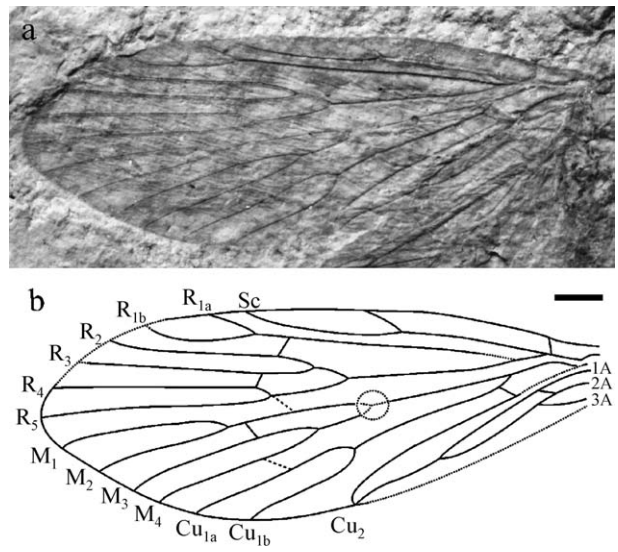

Fig. 3. Forewing of *Juraphilopotamus lubricus* gen. et sp. nov. Holotype, No. CNU-T-NN-2007001. Scale bar represents 1 mm. (a) Photograph and (b) linedrawing.

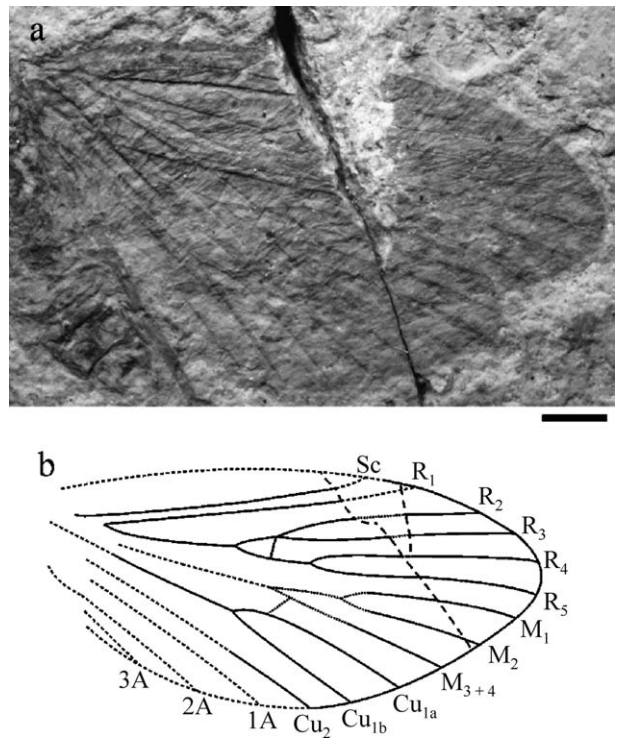

Fig. 4. Hindwing of *Juraphilopotamus lubricus* gen. et sp. nov. Holotype, No. CNU-T-NN-2007001. Scale bar represents 1 mm. (a) Photograph and (b) linedrawing.

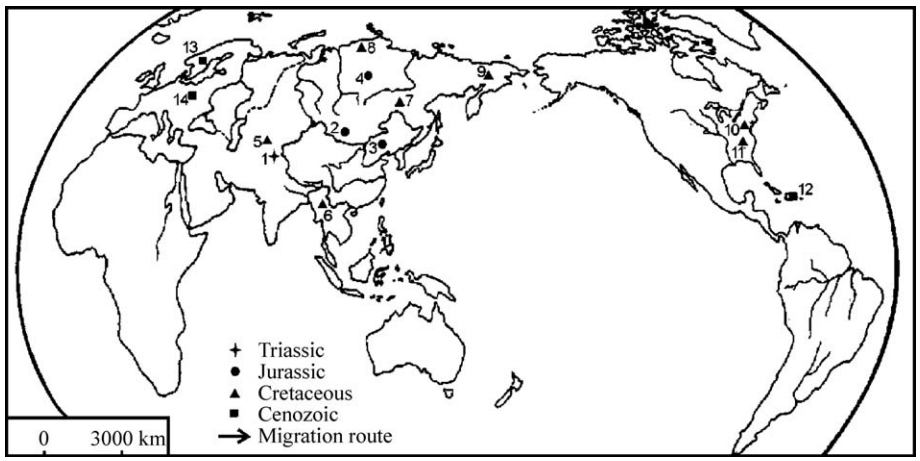

Fig. 5. Map of the geographic position of fossil Philopotamidae. 1, Kyrgyzstan; 2, Mongolia; 3, China; 4, Siberia; 5, Kazakhstan; 6, Burmese amber; 7, South Siberia; 8, Taimyer Peninsula; 9, Far eastern Russia; 10, New Jersey Amber; 11, Tennessee Amber; 12, Dominican Amber; 13, Baltic Amber; and 14, Saxonian Amber.

Forewing (Fig. 3)—length 11–12 mm, ovate and elongate; venation is complete. Sc is slightly curved terminally. Costal area is broad with a humeral crossvein and an oblique crossvein leading to costal margin. R branched proximally, R_1 straight and forks distad. Rs branches a little before mid-length. F1 is paralleled to F2, and F1 forks before F2. DC is closed by crossvein r, stem of Rs is nearly twice that of DC. MC is closed, narrow, a little longer than DC. Cu_1 forks deeply, at the same level of Rs fork. Some obscure imprints visible between R_{4+5} and M_{1+2}, M_4 and Cu_{1a}, we cannot make sure whether crossveins r-m, m-cu exist. F3 petiolate. Cu_2 is simple and slightly bent terminally. Crossvein cu appears between the basal part of Cu_1 and Cu_2. Anal area poorly preserved in the left forewing, but it was clearly preserved in the right. 1A and Cu_2 reach the hind margin of the forewing at the same point, where it is concave. 2A four times as long as 3A, 3A looped into 2A basally. An oblique crossvein between 1A and 2A present proximally. Anal loop stalk of 2A and 3A paralleled to 1A.

Hindwing (Fig. 4)—length about 10 mm, broader but shorter than the forewing. Anterior and posterior margins were destroyed, so it was difficult to discern costal vein and anal veins. Sc close to R_1, both are straight, it is impossible to distinguish their terminals. DC closed by crossvein r. Crossvein m-cu_{1a} is present but it is indistinct. F4 is lacking, F1 and F2 are narrow and long, F2 is a little shorter than F1. Cu_1 bifurcates deeply; base of F5 is pointed, Cu_2 simple and maybe straight. Anal vein area is folded. From the preserved condition, we can conclude that 2A and 3A reach posterior margin, respectively.

Abdomen (Fig. 2)—dorsal view of the last several segments was visible, genitalia were poorly preserved, but we can conclude the gender of this insect was male.

Legs (Fig. 2)—parts of the hind legs are preserved, tarsus 5 segmented, each articulate of tarsus covered with hairs. Three tibial spines are visible.

Comparison: *J. lubricus* gen. et sp. nov. is similar to species *W. praecursor* Botosaneanu, 1995 [6]. The former differs from the latter in size of insect, location of crossvein m and location of the apex of F1.

4. Discussion

From Table 1, we can conclude that during the Triassic and Jurassic period most of the species were distributed in Middle Asia, East Asia and part of Siberia, and they appeared in far eastern Russia, northern Russia, North America and Burma in the Upper Cretaceous. In the Cenozoic era, fossils of Philopotamidae were reported in Europe and from Dominican amber [17] (Fig. 5). According to the fossil records, we propose that Philopotamidae first appeared in Asia, some migrated to North America in the Upper Cretaceous through Russia, some spread to Europe during the Cretaceous or later, and some spread to southern Asia in the Cretaceous. More fossil material is needed to further test these proposed migration routes.

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