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A new Middle Jurassic caddisfly (Trichoptera, Hydrobiosidae) from China

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Abstract

Material belonging to a new fossil genus and species of caddisfly, *Pulchercylindratus punctatus* n. gen., n. sp., was collected from the Daohugou locality (Middle Jurassic, Jiulongshan Formation; Inner Mongolia, China). The new species is assigned to the Hydrobiosidae according to subcylindrical shape of the 2nd segment of maxillary palp, the forked R_1 (in the forewing, located near apex), and long anal cells (in the forewing). In addition, we propose to transfer the genus *Juraphilopotamus* Wang, Zhao & Ren 2009, known from the same locality, to the family Hydrobiosidae, based on the 1st and 2nd segments of the maxillary palp being cylindrical, shorter than the 3rd segment. A Middle Jurassic origination of family Hydrobiosidae can be established based on the new discovery.

Introduction

The order Trichoptera, so-called "hairy wings", contains three suborders, namely Annulipalpia, Integripalpia, and Spicipalpia, with over 13,000 known extant species. The order is widely distributed around the world, except for the polar regions (Morse 2012), and has an extensive fossil record, with 37 families, 193 genera, and more than 660 species reported to date (Handlirsch 1906–1908, 1939; Meunier 1918; Martynova 1958; Sukastcheva 1968, 1973, 1982, 1990; Erickson 1983; Novokshonov 1993; Botosaneanu 1995; Jarzembowski 1995; Novokshonov et al. 1995; Ansorge 2002; Ivanov & Sukatsheva 2002; Ivanov & Melnitsky 2005; Wichard 2007; Wichard et al. 2009, 2011). In particular, four families of Trichoptera (including nine genera and 15 species) have been documented from China (Hong 1983; Lin 1986; Ren et al. 1995; Wang et al. 2009a, 2009b; Davis et al. 2010).

Among caddisflies, the Spicipalpia consists of five extant families, namely Rhyacophilidae, Hydrobiosidae, Glossosomatidae, Hydroptilidae and Ptilocolepidae (Ross 1956; Schmid 1970; Morse 1997; Malicky 2001, 2005; Ward et al. 2004). The family Hydrobiosidae was first erected by Ulmer (1905) as a subfamily of Rhyacophilidae, and granted with family rank by Schmid (1989). This is a large family of approximately 50 genera (Holzenthal et al. 2007). So far, only three genera and three species of the fossil Hydrobiosidae have been reported (Table 1).

Table 1. Fossil species currently ascribed to the family Hydrobiosidae.

	Species	Age	Locality
1	*Bullivena grandis* Novokshonov, Ivanov & Sukatsheva, 1995	Late Jurassic	Gobi Altai aymak, Mongolia
2	*Palaeohydrobiosis siberambra* Botosaneanu & Wichard, 1983	Late Cretaceous	East Taymyr, Maimetsha River. Russia
3	*Atopsyche perlucida* Wichard, 2007	Tertiary	Dominican amber
4	*Juraphilopotamus lubricus* Wang, Zhao & Ren, 2009	Middle Jurassic	Daohugou, Inner Mongolia, China
5	*Pulchercylindratus punctatus* n. gen., n. sp.	Middle Jurassic	Daohugou, Inner Mongolia, China

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Material and methods

All specimens described here were collected from the Daohugou locality (approximately Bathonian age, or slightly older, ca. 165 Ma; Wang & Ren 2009; Ren et al. 2009, 2010a, 2010b; Rasnitsny & Zhang 2010; Zhao et al. 2011; Shi et al. 2011; Gao et al. 2012; Gu et al. 2012); Middle Jurassic, Jiulongshan Formation; Shantou Township, Ningcheng County, Inner Mongolia, China), and are housed at the Key Laboratory of Insect Evolution & Environmental Changes, Capital Normal University (CNU, Beijing, China).

Body length was measured from the head apex to the abdomen apex. Interpretation and terminology used herein follow Holzenthal et al. (2007): C, Costa; Sc, Subcosta; R, Radius; R_{1a} and R_{1b}, anterior and posterior branches of anterior Radius, respectively; Rs, posterior branch of R (composed of R_2, R_3, R_4, and R_5); M, media; M_{1+2}, anterior branch of Media, composed on M_1 and M_2; M_{3+4}, posterior branch of Media, composed on M_3 and M_4; Cu, Cubitus; Cu_1, anterior branch of Cubitus (composed of Cu_{1a} and Cu_{1b}); Cu_2, posterior branch of Cubitus; 1A, 2A, and 3A, first, second, and third branches of anal vein; the forks giving rise to R_2 and R_3, R_4 and R_5, M_1 and M_2, M_3 and M_4, CuA_{1a} and CuA_{1b}, are referred to as F1, F2, F3, F4, and F5, respectively; the discoidal cell (dc) is the cell formed by the branching of Rs into R_{2+3} and R_{4+5} and is closed apically by the sectorial crossvein (s); the medial cell (mc) is formed by the branching of M into M_{1+2} and M_{3+4} and is closed apically by the medial crossvein (m); anal cells delimited by 1A, 2A, and 3A.

Systematic paleontology

Order **Trichoptera** Kirby, 1813
Suborder **Spicipalpia** Weaver, 1983
Family **Hydrobiosidae** Ulmer, 1905

Pulchercylindratus n. gen.

Etymology. Genus name is a combination of the Latin *pulcher* ('beautiful') and *cylindratus* ('cylindrical'), gender feminine.

Type species. Pulchercylindratus punctatus n. sp.

Diagnosis. Head round, distinctly narrower than pronotum. Antennae shorter than forewing, filiform, scapus and pedicelli broader than flagellomeres. Maxillary palps five-segmented in both sexes, second segment subcylindrical, all segments of subequal length. Ocelli present. Anterior setal warts and posterolateral setal warts present on the head. Prothorax narrow, a pair of pronotal setal warts visible on pronotum. Wing moderately broad and smoothly rounded distally; R_5 reaching wing apex; R_1 forked distally; discoidal and medial cells closed in forewings, but discoidal cell open in hind-wings; Rs stem nearly twice as long as discoidal cell; Rs and M four-branched, respectively; F_1–F_5 present in forewings; anal cells long. Tibial spurs: 2, 4, 4.

Remarks. The type species of the genus can be assigned to the family Hydrobiosidae by the following combination of features: antenna with stout scapus, shorter than head; maxillary palps 5-segmented, with 2nd segment as short as 1st segment or longer, both segments shorter than following ones; 4th and 5th segments as long as 3rd one, or longer, distally rounded (Fig. 2E); in forewings R_1 forked at apex (reduced or simple in few Hydrobiosidae genera only); long anal cells. The discoidal being open or closed is not conclusive on the familial assignment of the genus, because both states can be found in the Hydrobiosidae.

Pulchercylindratus gen. nov. is characterized by the second segment of maxillary palps being subcylindrical (as opposed to globose), discoidal and medial cells closed, forewing with all F_1–F_5 present, and long anal cells. The new genus appears similar to the extant genus *Rhyacophila* Pictet, 1834 (in the family Rhyacophilidae; Fig. 4C), but it can be distinguished easily from the latter by its maxillary palps with the 2nd segments being globose (in contrast to subcylindrical), and the anal cells short (in contrast to long).

The new taxon is to be compared with known fossil Hydrobiosidae. Compared with the genus *Bullivena* Novokshonov et al., 1995, the new genus has no particular thickening of R, lacks the crossvein connecting R_5 with M_{1+2}, and has a closed discoidal cell (in contrast to an open discoidal cell). Compared with the genus *Palaeohydrobiosis* Botosaneanu et al., 1983, the new genus has a closed discoidal cell, and F_1 longer than F_2 (as opposed to F_1 shorter than F_2). Compared with the genus *Atopsyche* Wichard, 2007, the new genus has maxillary palps with the terminal segment being not particularly elongate (as opposed to very elongate), a median cell open, M fork located at the first third of

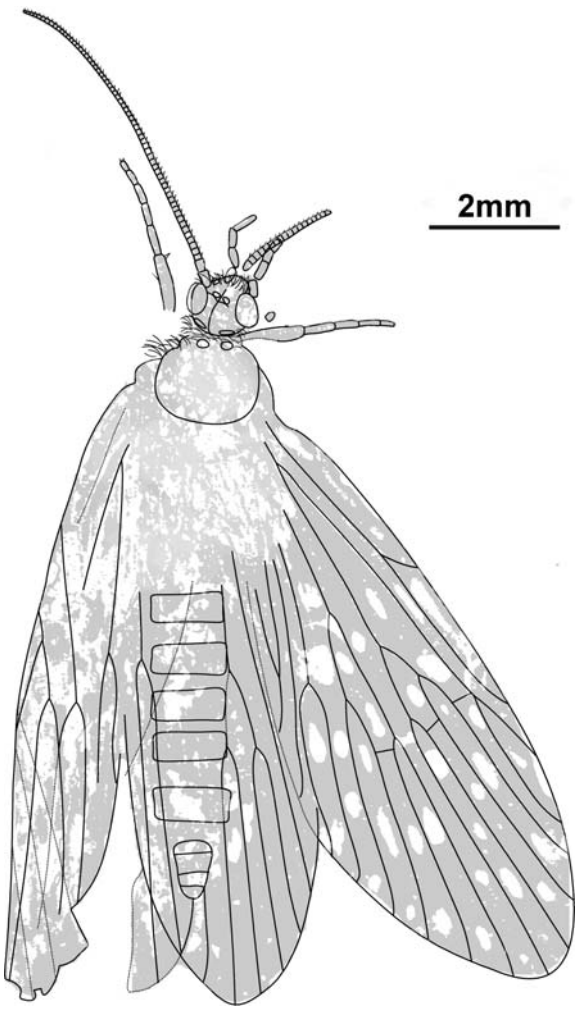

Figure 1. *Pulchercylindratus punctatus* n. gen., n. sp. Line drawing of holotype, CNU-Tri-NN2011003.

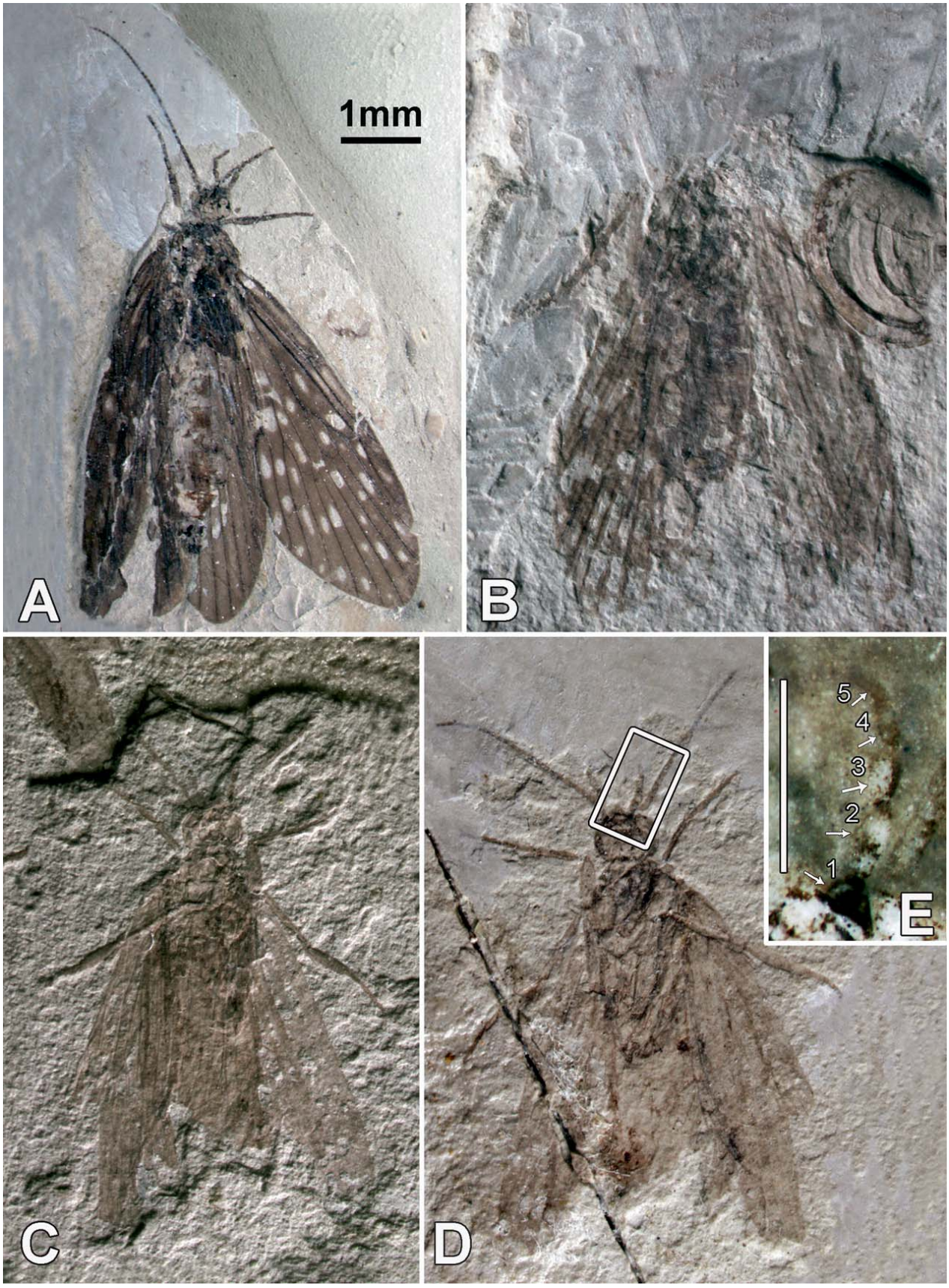

Figure 2. Photographs of *Pulchercylindratus punctatus* n. gen., n. sp.; **A.** CNU-Tri-NN2011003; **B.** CNU-Tri-NN2011005; **C**–**D.** CNU-Tri-NN2011004PC; **E.** Maxillary palps.

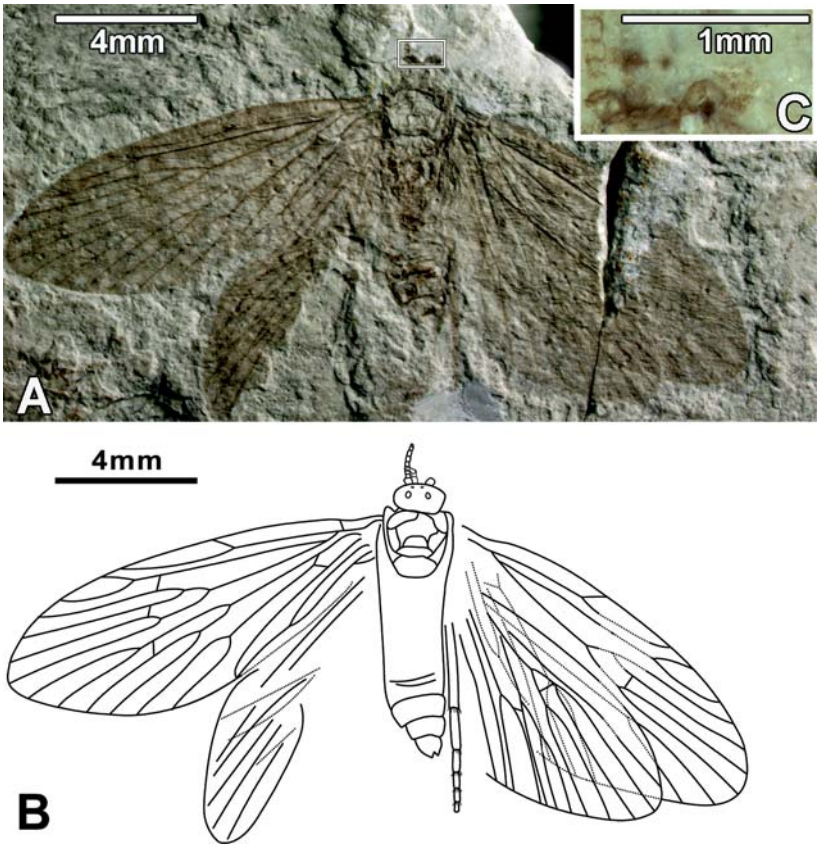

Figure 3. *Juraphilopotamus lubricus* Wang, Zhao & Ren 2009. **A**–**B.** specimen CNU-Tri-NN–2007001 (holotype), photograph **(A)** and line drawing **(B)**; **C.** Maxillary palps (under ethyl alcohol).

forewing length (as opposed to located at the forewing mid-length), and F_1 longer than F_2 (as opposed to F_1 shorter than F_2).

Pulchercylindratus punctatus n. sp.

Figures 1–3, 4A

Etymology. Name derived from the Latin *punctatus* ('spotted').

Locality and horizon. Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China (N 41°18.979′, E 119°14.318′); Jiulongshan Formation, Middle Jurassic.

Material. Holotype, ♂, CNU-Tri-NN2011003; paratypes, CNU-Tri-NN2011004PC (dorsoventrally compressed, part and counterpart), CNU-Tri-NN2011005 (laterally compressed).

Diagnosis. Two pairs of setal warts in dorsal view, anterior setal warts small and symmetrical; posterolateral setal warts prolate and obscure. Antennae with stout scapus and slender flagellomeres, many spines distributed on inner side of antennae.

Wings (Fig. 4A): forewings, Sc straight, with an oblique crossvein, reaching anterior wing margin before half of wing length; Rs forked basal to wing mid-length; stem of Rs nearly twice as long as discoidal cell; F_1 parallel to F_2; M fork located opposite the first third of forewing length; medial cell longer than discoidal cell; Cu_1 and Rs forked at the same level; Cu_2 and anal vein A_{1+2+3} distinct.

Measurements (in mm). Holotype, ♂, CNU-Tri-NN2011003 (Figs 1, 2A): Body length 10.47, maximal width of body 8.24; head length 0.88, width 1.06; length antennal segments (scapus, pedicelli, flagellomeres): 0.29, 0.18, 3.88; Maxillary palp I–V: 0.12, 0.29, 0.35, 0.35, 0.41; compound eye length 0.53, 0.35; thorax length 1.35, width 1.53; forewing length 9.06, width 3.47, Sc 5.47, R_1 6.17, Rs 3.17, R_{2+3} 0.73, R_{4+5} 1.17, M 2.83, M_{1+2} 2.13, M_{3+4} 1.13, Cu_1 3.73, Cu_2 5.00 , 1A 1.77, 2A 1.40, 1A + 2A 0.87; dc 1.43, mc 2.23, F_{1-5} 3.83, 4.33, 3.77, 3.53, 2.80, hind-wing length 4.71, width 2.65; length fore leg: tibia 1.00, tar-

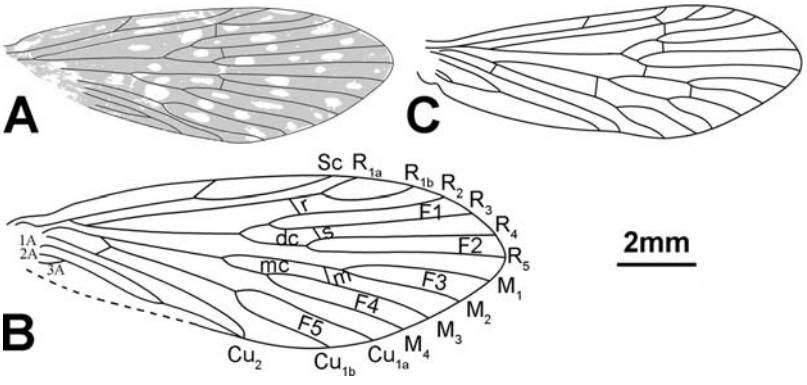

Figure 4. Forewing line drawings **A.** *Pulchercylindratus punctatus* n. gen., n. sp.; **B.** *Juraphilopotamus lubricus* Wang, Zhao & Ren 2009. $\mathbf{F_{1-5}}$ – apical forks 1–5; **dc** – discoidal cell; **mc** – median cell; **C.** *Rhyacophila chandleri* Denning, 1956 (based on Giersch 2002).

someres I–V: 0.53, 0.41, 0.35, 0.29, 0.18; abdomen length 4.24, width 1.18; ovipositor length 0.88; Paratype, CNU-Tri-NN2011004PC (dorsoventrally compressed, part and counterpart (Figs 2C, D)) body length 6.04, maximal width of body 2.55; head length 0.94, width 1.11; length antennae 3.74; Maxillary palp I–V: 0.12, 0.29, 0.35, 0.35, 0.41; thorax length 1.19, width 1.53; forewing length 7.40, width 1.96; length fore leg: tibia 1.00, tarsomeres I–V: 0.53, 0.41, 0.35, 0.29, 0.18; abdomen length 4.24, width 1.18; Paratype, CNU-Tri-NN2011005 body length 5.78, maximal width of body 1.96; length pronotum 0.77, width 0.54; length fore leg: tibia 2.55, tarsomeres 1.45; forewing length 7.82, width 2.89; abdomen length 5.70, width 0.55.

Discussion

Wang, Zhao & Ren (2009b) erected the species *Juraphilopotamus lubricus* based on a single specimen from the Daohugou locality, and placed it to the family Philopotamidae, based on wing venation characters. The argument proposed by Wang et al. (2009b; Fig. 3) for this assignment, based on family diagnosis in Carpenter (1992, p. 363), was 'discoidal cell and medial cell closed'. It is worth mentioning that traditionally the wing venation characters are widely used for the taxonomy of fossil Trichoptera. However these characters can prove insufficient for family diagnoses, and should ideally be complemented by body characters (Ivanov & Melnitsky 2006; also, the polarity of wing characters was never tested).

Regarding the current case, the family Philopotamidae is characterized by 5-segmented maxillary palps in both sexes, with the 1st segment being the shortest, the 2nd one being provided with a mesodistal brush of setae, and the 5th segment long, annulate and flexible, usually at least twice as long as preceding segment (Neboiss 1991; Wiggins 2008). Reinvestigation of the material described by Wang et al. (2009b) reveals that only the basal three segments of one maxillary palp are preserved, with the 1st and 2nd segments being cylindrical and shorter than the 3rd segment (Fig. 3C). This suggests that the species does not belong to the Philopotamidae, but more likely to the family Hydrobiosidae (in which the 1st and 2nd segments cylindrical and shorter than the 3rd segment). Therefore we propose to transfer *J. lubricus* from the family Philopotamidae to the Hydrobiosidae.

As previously documented, the first appearance of the Hydrobiosidae is Late Jurassic, with *Bullivena grandis* Novokshonov et al., 1995. Ivanov & Sukatsheva (2002) also postulated a Late Jurassic origination of the family. Thanks to discovery of *Pulchercylindratus punctatus* n. gen., n. sp., a Middle Jurassic origination can be established.

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