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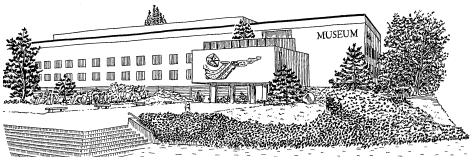

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A new species of "Orthophlebiidae" (Insecta: Mecoptera) from the Middle Jurassic of Inner Mongolia, China

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Abstract
A new species of "Orthophlebiidae", *Orthophlebia riccardii* n. sp., is described from the Middle Jurassic of Inner Mongolia, China. Males of the genus have the last segments of the abdomen enlarged and modified with spurs and projections ending in clamp like dististyli. The new species can be distinguished from all known species by its bigger size and the presence of a distinct organization of the abdomen of the male.

Keywords
Mecoptera, Orthophlebiidae, new species, Middle Jurassic, China.

I. INTRODUCTION

The Mecoptera have a diverse fossil record with respect to their Recent fauna. The "Orthophlebiidae" are an example of the great diversity in the Mesozoic with several tens of species (UEDA, 1991; NOVOKSCHONOV, 2002; HONG & ZHANG, 2004). The group is considered paraphyletic and the exact number of genera and species is difficult to precise because of disagreement by different authors concerning the limits and systematics of the group. The group is typically Mesozoic represented from the Triassic to the Cretaceous mainly in Eurasia and little known in Australia (RIEK, 1950; UEDA, 1991; NOVOKSCHONOV, 2002; HONG & ZHANG, 2004). They have sexual dimorphism in form of a consistently developed dististyli as have recent representatives of some families of Mecoptera like Panorpidae and Panorpodidae (WILLMANN, 1983). This is recorded in some species of *Orthophlebia* (WILLMANN & NOVOKSCHONOV, 1998) and also in the male specimen of the species described below.

We collected the specimen from the lacustrine sedimentary strata of the Jiulongshan Formation in Daohugou Village, Ningcheng County, Inner Mongolia, Northeastern China. The age of the Jiulongshan Formation is considered as Middle Jurassic (Bathonian-Callovian boundary interval, ca.165 Ma) (REN *et al.*, 1995; 2002; TAN & REN, 2002; CHEN *et al*., 2004; GAO & REN, 2006; TAN *et al*., 2007; REN *et al*., 2009). In the last years the Daohugou mecopterofauna is becoming one of the richest in the world (PETRULEVIČIUS *et al.*, 2007; LI *et al*., 2008; LI & REN, 2009; REN *et al*., 2009; YANG *et al*., in press; ZHANG *et al*., in press).

II. MATERIALS AND METHODS

The specimen is housed in the fossil insect collection of the Key Lab of Insect Evolution & Environmental Changes, College of Life Sciences, Capital Normal University, Beijing, China (CNU, Dong REN, Curator). The body terminology used here is that of WILLMANN & NOVOKSCHONOV (1998) and the wing venation nomenclature of fossil and extant Mecoptera follows KUKALOVÁ-PECK (1991) and KUKALOVÁ-PECK & LAWRENCE (2004).

III. SYSTEMATIC PALEONTOLOGY

Insecta LINNAEUS, 1758
Mecoptera PACKARD, 1886
"Orthophlebiidae" HANDLIRSCH, 1906
***Orthophlebia* WESTWOOD *in* BRODIE, 1845**
***Orthophlebia riccardii* n. sp.**
Figs. 1-3

Etymology: The specific name is dedicated to the geologist and paleontologist Alberto C. RICCARDI.
Distribution: Middle Jurassic of Asia.
Holotype: A complete male specimen, CNU-MEC-NN2011001p/c.

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Horizon and type locality. Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China; Jiulongshan Formation.

Diagnosis: RP with 8 terminal branches; MP with 5 terminal branches in fore wing and 4 in hind wing; CuA1+2 distally punctually fused with MP4; biggest species with 38 mm of wing length; basal bifurcation of RP1+2 from that of RP3+4+MA; segments 6 to 9 strongly transversely striated; abdomen segment 6 strongly developed and somewhat dorsally curved with ventral and dorsal broad projections; segment 7 thinner and strongly curved with anterior and posterior faces of articulation at about 45º; segment 8 trapezoidal and short; segment 9 strongly widened and bulbous; dististyli strong and somewhat curved.

Description: A complete male specimen preserved in ventral view; wings almost symmetrically arranged; body length (antennae not preserved) 52 mm; head hypognathous, 7 mm long; eye 0.6 mm wide; thorax not preserved; abdomen strong, with 8 visible segments; segments 6-9 abruptly stronger than 1-5; segments 3-5 with tergum divided from sternum; segments 6-9 strongly transversely striated; segment 6, 6 mm wide and 11 mm long, strongly developed and somewhat dorsally curved with distal broad projections ventral and dorsal; segment 7 thinner and strongly curved with anterior and posterior faces of articulation at about 90º to each other, 2 mm wide and 6.6 mm long; segment 8 trapezoidal and short, 2 mm wide and 3 mm long; segment 9 strongly widened and bulbous, 2.4 mm wide and 4 mm long; dististyli strong and somewhat curved, 1.4 mm wide and 3.6 mm long at the base; anterior and middle legs visible, posterior ones only with femur visible beneath the wings; legs densely haired with short setae; anterior ones shorter, femur 5.6 mm long, tibia 5.4 mm long; middle ones longer, femur 7 mm long, tibia 7.4 mm long; tibia of fore and mid legs with strong spines and two terminal spurs in mid leg; tarsi 5-segmented, basitarsus longest.

Fore wings overlapped to hind wings, length 37.8 mm, width 10.2 mm; costal area narrow basally to humeral vein, distally broadened, ScP ending at the anterior wing margin 10.4 mm before the apex with three branches to anterior wing margin in its distal half; pterostigma not visible, but apical part of RA spoon like and single; R+MA curving posteriad in the basal part just in the bifurcation of RA and RP+MA; RA continuing in the same direction of R and simple; RP+MA diverging posteriorly and branching symmetrically in two veins (after 3 mm), anterior one with 7 pectinate veins (branching after 3 mm), posterior one branching in simple RP and MA after 6.4 mm; so, bifurcation of RP1+2 is basal from that of RP3+4+MA; MP with five terminal veins; MP bifurcated into MP1+2 and MP3+4; MP1+2 branching after 4.4 mm into MP1 and MP2; MP3+4 branching after 1.6 mm into MP3 and double MP4; CuA1+2 joining MP4 just before they separate again; one oblique basal crossvein between MP and CuA; CuA arising from Cu at oblique angle; CuA3+4 continuing the same direction of CuA; CuP simple nearly parallel to CuA; three anal veins, AA3+4, AP1+2 and AP3+4.

Hind wing similar in length and shape to fore wing; veins partly preserved (Fig. 3); ScP ending at the anterior wing margin and shorter than in fore wing with two branches reaching the anterior wing margin in its distal fourth; RA with two branches to wing margin and spoon-like; RP+MA branching symmetrically in two veins, anterior one with 5 pectinate veins, posterior one branching in simple RP and MA; MP basally changing its direction when CuA fusion punctually; CuA branching perpendicular to Cu and perpendicular to itself when touching MP, and continuing same direction of MP; MP with four terminal veins; MP bifurcated into MP1+2 and MP3+4; MP1+2 branching after 4.3 mm into MP1 and MP2; MP3+4 branching after 0.85 mm into MP3 and double MP4; CuA1+2 joining punctually MP4; CuA 3+4 continuing same direction of CuA; Cu short and somewhat straight receiving the AA3+4 before branching into CuA and CuP, AA3+4 separating from CuP somewhat after branching of CuA and runing somewhat parallel to CuP; AP1+2 reaching the wing margin at the same level than that bifurcation of R; AP3+4 reaching the wing margin at the same level that AA reaches Cu.

Discussion: The specimen is attributed to the "Orthophlebiidae" and *Orthophlebia* because of several features and combinations of characters: RP with 8 terminal branches; MP with 5 terminal branches in forewing and 4 in hind wing; CuA basally free in fore wing (attached by a crossvein) and punctually fused in hind wing; CuA1+2 distally and punctually fused with MP4; AA fused for a distance with Cu in hind wing; abdomen of male strongly developed from segment 6 finishing in clamp like dististyli.

The new species is the biggest of all known species of *Orthophlebia*. It differs from all other species of the genus with known male abdomen in its unique configuration, i. e., segment 6 strongly developed and somewhat dorsally curved with ventral and dorsal broad projections; segment 7 thinner and strongly curved with anterior and posterior faces of articulation at about 90º to each other; segment 8 trapezoidal and short; segment 9 strongly widened and bulbous; dististyli strong and somewhat curved. This abdomen has some similarities with that of *O. elenae, i. e.,* the segment 6 wide, strong and short, the segment 7 thinner and curved, but differs in that *O. elenae* has the segment 8 thinner and the segment 9 smaller and the clamps thinner. Another difference is that the latter species has a metatarsal organ in hind basitarsus (WILLMANN & NOVOKSCHONOV, 1998), a structure which is absent in our species. Other *Orthophlebia* species have the abdomen of the male much different (see WILLMANN & NOVOKSCHONOV, 1998).

Other species represented only by wings could be compared by the wing venation. Nevertheless the species here described has the biggest wings so we

Fig. 1: Photographs of the holotype CNU-MEC-NN2011001p/c of *Orthophlebia riccardii* sp. nov., the body and the overlapped fore and hind wings are seen. A: part. B: counterpart. Scale bars = 6 mm.

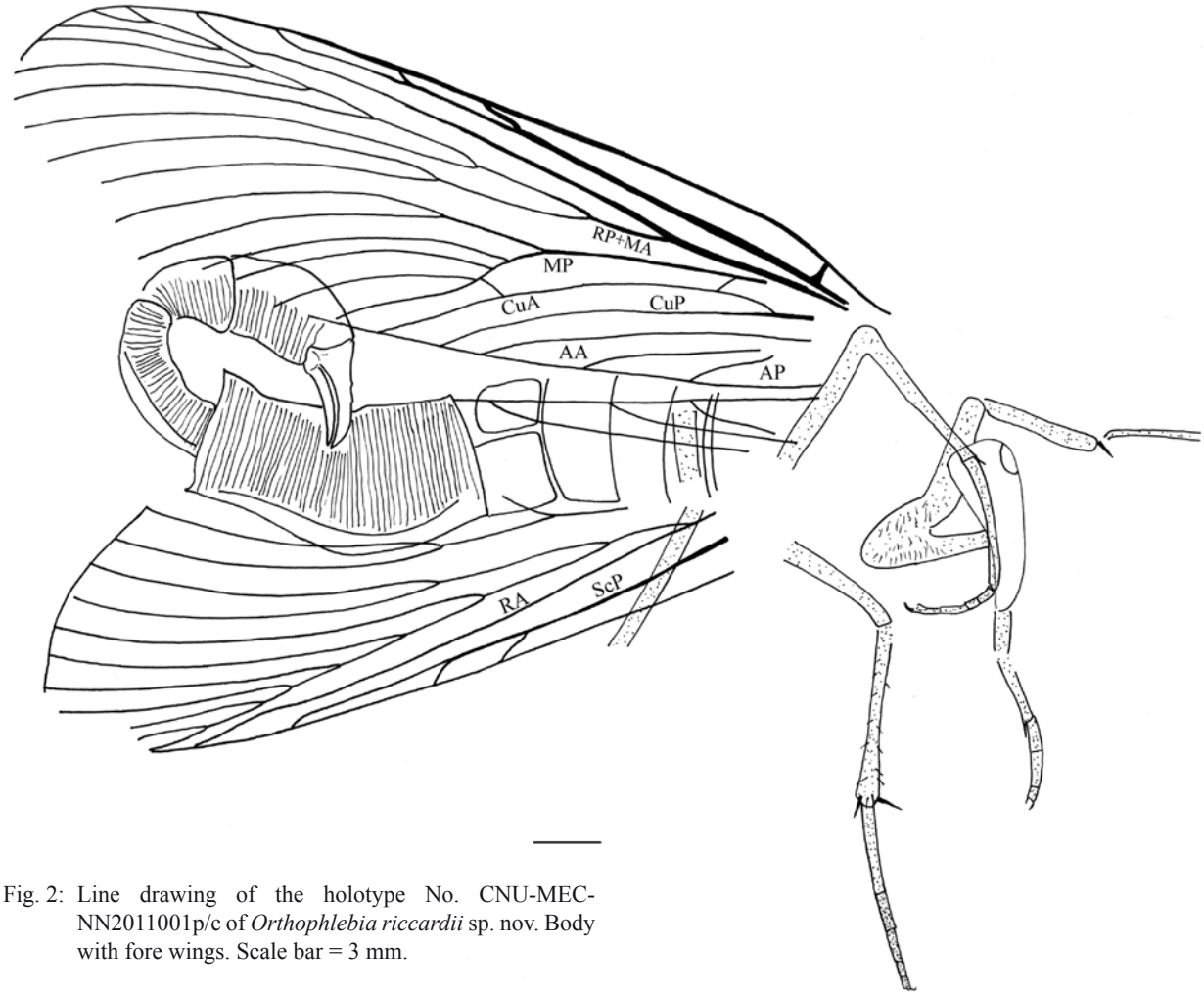

Fig. 2: Line drawing of the holotype No. CNU-MEC-NN2011001p/c of *Orthophlebia riccardii* sp. nov. Body with fore wings. Scale bar = 3 mm.

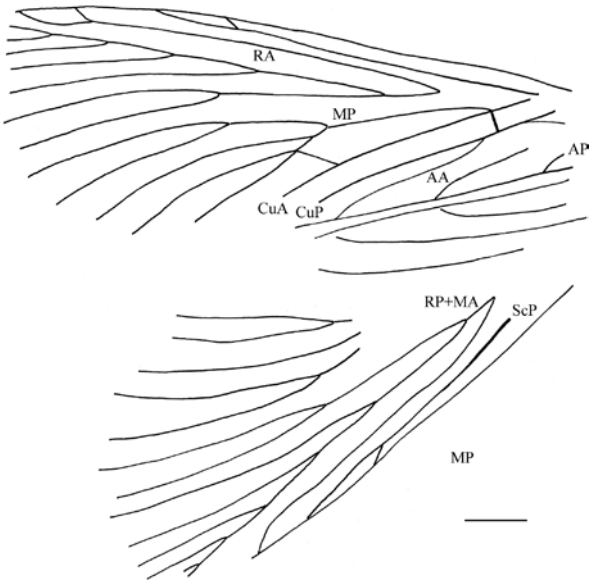

Fig. 3: Line drawing of the holotype CNU-MEC-NN2011001p/c of *Orthophlebia riccardii* sp. nov. Hind wings. Scale bar = 3 mm.

could attribute it to a new species. HONG & ZHANG (2004) made three subgenera within the genus taking into account the position of the bifurcation of the RP1+2 from the RP3+4+MA. Here we use this character which is actually convenient but we are not sure about its importance in the evolution of the genus into three subgenera as supported these authors. Our species has a basal bifurcation of RP1+2 from that of RP3+4+MA, the same type that of *O. liassica* (MANTELL), *O. grandis* MARTYNOV, *O. pectipennis* TILLYARD, *O. venosa* MARTYNOV, *O. confusa* WILLMANN, *O. vernacula* MARTYNOVA, *O. broderi* (MARTYNOV) and *O. haradai* UEDA. *Orthophlebia liassica* can be excluded because it has a MP with 6 branches in fore wing (8 in *O. riccardii*), a CuA completely fused with MP4 in fore wing (mainly unfused in *O. riccardii*) and a CuA simple in hind wing (double in *O. riccardii*). *Orthophlebia grandis* can be excluded because it has a smaller fore wing (30 mm *contra* 37.8 mm in *O. riccardii*), the coloration pattern is different (banded *contra* big spots in *O. riccardii*), and the ScP has two terminal branches (three terminal branches in *O. riccardii*). *Orthophlebia vernacula* can be

excluded because it is smaller (17 mm long) and has the CuA1+2 fused with the MP4. *Orthophlebia pectipennis* can be excluded because it is also smaller (13 mm) and by other several characters, *i. e*., ScP single, RP with 5 terminal veins.

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