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Research article

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A new mesoserphid wasp from the Middle Jurassic of northeastern China (Hymenoptera, Proctotrupeoidea)

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Abstract. A new genus and species of Mesoserphidae (Hymenoptera), *Juraserphus modicus* gen. et sp. nov., is described based on a well-preserved fossil specimen from the Middle Jurassic Jiulongshan Formation of northeastern China. It is characterized by the following forewing features: the forking of Rs+M located approximately one-third of the distance between 1m-cu and 2r-rs, both 1cu-a and 2cu-a antefurcal; 1-M more than twice as long as 1m-cu and hind wing with cells r and rm closed. In addition, it has a short ovipositor, only extending slightly beyond the metasomal apex. Its new morphological characters broaden the diversity of Mesoserphidae in the Mesozoic and provide new insights into the evolution and relationships of Mesoserphidae.

Keywords. Mesoserphidae, new taxon, taxonomy, Daohugou, Jiulongshan Formation.

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Introduction

The superfamily Proctotrupeoidea, a basal group of Prototrupoidea within Apocrita, includes 11 extant families and one extinct family (Grimaldi & Engel 2005). Mesoserphidae was erected by Kozlov (1970), representing the only extinct family of Proctotrupeoidea. Fossil records of mesoserphids can be traced back to the Middle Jurassic according to the earliest fossil from the upper Middle Jurassic Jiulongshan Formation of northeastern China (Shih *et al.* 2011). This family was once considered to comprise two subfamilies: Mesoserphinae Kozlov, 1970 and Karataoserphinae Rasnitsyn, 1994 (Grimaldi & Engel 2005). However, the latest research based on a phylogenetic analysis indicated that these two subfamilies are paraphyletic and should be abandoned (Li *et al.* 2016).

So far, 22 fossil genera with 53 species have been described worldwide (including their locality, stratigraphic level, external morphological characteristics and body measurements), mostly distributed in

Kazakhstan, Transbaikalia and China (Kozlov 1968; Rasnitsyn 1983, 1986, 1990, 1994; Zhang & Zhang 2000; Shih *et al.* 2011; Shi *et al.* 2013; Zhang *et al.* 2013; Li *et al.* 2016). Among these mesoserphids, 19 species were recorded from the Middle Jurassic, 23 from the Late Jurassic and 11 from the Early Cretaceous (Li *et al.* 2016). Studies have demonstrated the Mesoserphidae to be highly morphologically divergent, such as in body length (from 1.7 mm to 12.8 mm), forewing length (from 1.5 mm to 10.4 mm), number of antennomeres, wing venation, morphology of the external ovipositor, etc. (Zhang & Zhang 2000; Shih *et al.* 2011; Shi *et al.* 2013; Li *et al.* 2016).

The new, well preserved specimen was collected from the Jiulongshan Formation (Daohugou, Inner Mongolia, China), famous for its rich fossil insect fauna, including Hymenoptera (Shih *et al.* 2011; Wang *et al.* 2014), Coleoptera (Pan *et al.* 2011; Liu *et al.* 2015), Diptera (Chen *et al.* 2014; Shi *et al.* 2015), Odonata (Zhang *et al.* 2008; Nel & Huang 2015) and others (Ren *et al.* 2009; Chen *et al.* 2015, 2016). The geological age of this Formation is the latest Middle Jurassic (late Callovian, ca 165–164 Ma), measured by $^{40}\text{K}/^{40}\text{Ar}$, Ar-Ar and SHRIMP U-Pb (He *et al.* 2004; Liu *et al.* 2006; Li *et al.* 2013).

Material and methods

The fossil specimen studied herein was collected from the upper Middle Jurassic Jiulongshan Formation at Daohugou Village, Wuhua Town, Ningcheng City, Inner Mongolia, China and is housed in the Shandong Tianyu Museum of Nature in Pingyi County, Shandong Province, China.

The fossil was examined and photographed, both dry and in ethanol, using a VHX 5000 digital microscope platform. Line drawings were prepared with CorelDRAW 14.0 and Adobe Photoshop CS5. The specimen was quantitatively measured using the NIH ImageJ software (<http://rsb.info.nih.gov/ij/>). The morphological terminology used herein follows Huber & Sharkey (1993) and Rasnitsyn & Zhang (2004). Venation symbols: main longitudinal veins are C (costa), R (radius), Rs (radial sector), M (media), Cu (cubitus) and A (anal vein); crossveins are r-rs (radial crossvein), m-cu (mediocubita crossvein) and cu-a (anal crossvein); cells are r, m-cu and cua.

Results

Order Hymenoptera Linnaeus, 1758
Suborder Apocrita Gerstaecker, 1867
Superfamily Proctotrupoidea Latreille, 1802
Family Mesoserphidae Kozlov, 1970

Juraserphus gen. nov.

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Type species

Juraserphus modicus gen. et sp. nov., designated herein.

Diagnosis

Forewing 1-Rs as long as 1-M; 1-M more than twice as long as 1m-cu; 2r-rs arising from middle of pterostigma, its width more than twice as long as width of pterostigma; 1cu-a antefurcal, 2cu-a antefurcal; forking of Rs+M located approximately one-third of distance between 1m-cu and 2r-rs, closer to 1m-cu; cell 1m-cu complete trapezoid and less than half of cua. Hind wing with cells r and rm closed. Metasoma spindle-shaped, with elongated segments. Short ovipositor, only extending slightly beyond metasomal apex.

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Etymology

The generic name is composed of the prefix ‘Jura’ from the Jurassic period and the suffix of the genus name ‘serphus’. The gender is masculine.

Species included

Type species only.

Juraserphus modicus gen. et sp. nov.

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Figs 1–2

Diagnosis

As for genus.

Etymology

The specific epithet is an adjective derived from the Latin word ‘modicus’, which means ‘moderate, average’, indicating that both the body and forewing lengths are medium.

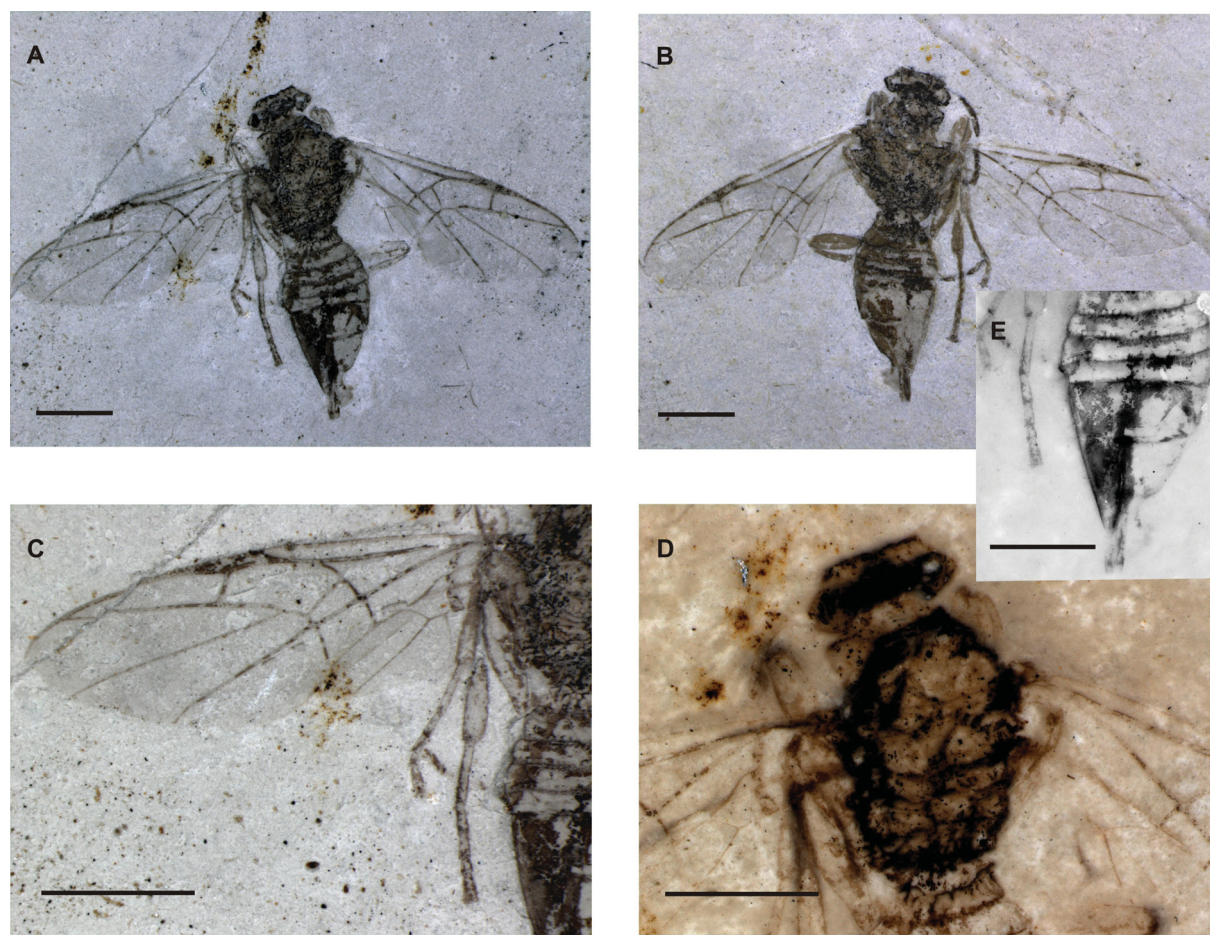


Fig. 1. Holotype of *Juraserphus modicus* gen. et sp. nov. **A.** Part. **B.** Counterpart. **C.** Left forewing and left hind wing of part. **D.** Head and mesosoma of part (in ethanol). **E.** Metasoma of part. Scale bars = 2 mm.

Material examined

Holotype

CHINA: part and counterpart, female in dorsal view (TYNM-48-1244 a–b).

Locality and age

CHINA: Daohugou Village, Ningcheng County, Inner Mongolia; Callovian (latest Middle Jurassic), Jiulongshan Formation.

Description

Body length 8.66 mm. Head transversely ovoid, length 1.31 mm and width 0.63 mm. Eye large, ovoid and protruding. Antenna filiform, thin, with nine antennomeres preserved, the first flagellomere long, subsequent flagellomeres gradually decreasing in length from base to apex.

Mesosoma about as wide as head; pronotum trapezoid, extremely short and obviously narrower than head and about 3.6 times as wide as long (length 0.96 mm; width 0.27 mm); mesoscutum subquadrate, 0.86 mm long and 0.37 mm wide; mesoprescutum length 0.52 mm and width 0.43 mm; notauli present and reaching transverse mesonotal suture; mesoscutellum triangular; mesopostnotum rectangular, 0.5 times as wide as long; metascutellum preserved and almost as long as wide. Metasoma spindle-shaped,

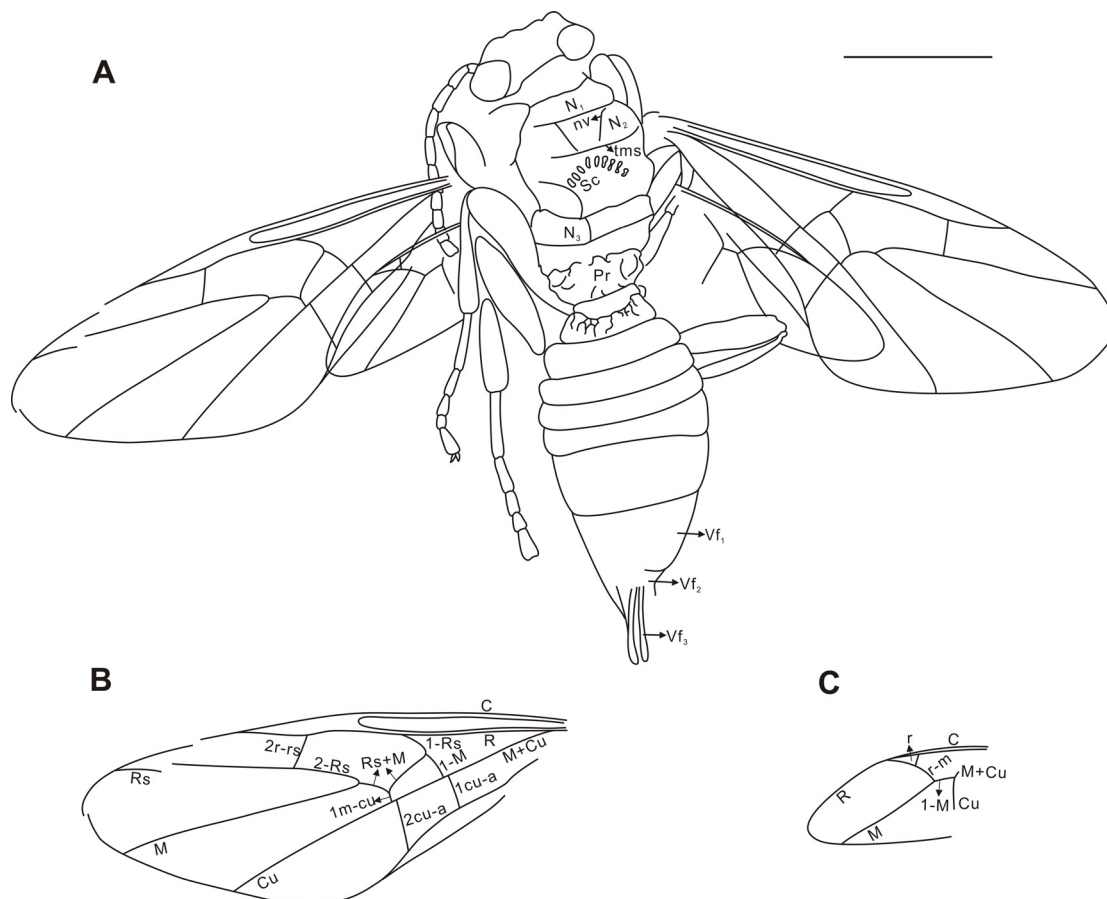


Fig. 2. Line drawings of *Juraserphus modicus* gen. et sp. nov. **A.** Habitus. **B.** Left forewing. **C.** Left hind wing. Abbreviations: N_1 = pronotum; N_2 = mesonotum; N_3 = metanotum; nv = notaulus; tms = transverse mesonotal suture; Sc = mesoscutellum; Pr = propodeum; Vf_1 = valvifer 1; Vf_2 = valvifer 2; Vf_3 = valvula 3. Scale bar = 2 mm.

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with seven segments, first observed segment very short, subtrapezoidal; second to fifth segments similar to first in shape and length, but gradually increasing in width; sixth segment reversely trapezoidal and about twice as long as fourth segment; seventh segment about as long as sixth segment; valvifer 1, valvifer 2 and valvula 3 clearly discernible; ovipositor short, slightly stretched out of metasomal apex.

Left foreleg with only femur preserved, small. Left midleg well preserved, with femur wider than tibia; tibia slender; tarsus thin, with basitarsus longest and about twice as long as 2nd tarsomere, 3rd tarsomere obviously shorter than 2nd, 4th shorter and thinner than 3rd, 5th twice as long as 4th and possessing two short claws. Left hindleg with femur narrow basally and widened apically, with a spindle-like shape; tibia thicker than midtibia; tarsi similar to midtarsi.

Forewing length 7.05 mm, width 2.73 mm. Pterostigma long and slightly oblique apicad, six times as long as wide. 1-Rs and 1-M equal in length; 1-M more than twice as long as 1m-cu; 2r-rs arising from middle of pterostigma, oblique, about 2.5 times as long as pterostigmal width. Cell 1+2r five-sided and surrounded by R, 1-Rs, 1-Rs+M, (2-Rs+M) + (2-Rs) and 2r-rs; M+Cu straight and distinct, M and Cu straight basally, slightly curved apically; 1-Rs origin at a distance from pterostigma (about twice as long as 1-Rs), and 2r-rs arising from middle of pterostigma; forking of Rs+M located approximately one-third of distance between 1m-cu and 2r-rs; both 1cu-a and 2cu-a antefurcal; cell 1mcu subtrapezoidal, 1.8 times as long as wide basally; 1cu-a slightly longer than 1-M and two-thirds of 2cu-a in length. Hindwing with long, oblique r-m meeting Rs near its base; cell r long and closed; M+Cu and Cu partly tubular; M tubular.

Discussion

Various morphological characters of Mesoserphidae have been recorded from the latest Middle Jurassic to Early Cretaceous (Zhang & Zhang 2000; Shih *et al.* 2011; Shi *et al.* 2013; Li *et al.* 2016). Compared with other mesoserphids, *Juraserphus* gen. nov. has the rare combination of both 1cu-a and 2cu-a being antefurcal in the forewing, and cells rm and r closed in the hindwing. Additionally, *Juraserphus* gen. nov. is unique among Mesoserphidae in having a female metasoma with five basal terga very short and jointly occupying only half of metasoma's length, whilst the other half is formed by terga 6 and 7 only.

Juraserphus gen. nov. resembles *Beipiaoserphus* Zhang & Zhang, 2000 and *Basiserphus* Li *et al.*, 2016 with both 1cu-a antefurcal and 2cu-a antefurcal in the forewing, but differs from them in having the forking of Rs+M located at a distance of one-third between 1m-cu and 2r-rs, and 1-M about twice as long as 1m-cu (vs one half and 1-M much shorter than 1m-cu in *Beipiaoserphus*; one-sixth or one-quarter and 1-M slightly longer than 1m-cu in *Basiserphus*). *Juraserphus* gen. nov. has long crossvein 2r-rs, which is more than twice as long as the width of the pterostigma. The length of 2r-rs, however, is less than 1.5 times the width of the pterostigma in *Codoserphus* Shi *et al.*, 2013 and more than five times as long as the width of the pterostigma in *Turgoerphus* Rasnitsyn, 1990 (Rasnitsyn 1990; Shi *et al.* 2013). 1cu-a and 2cu-a of the forewing offer significant characteristics. *Juraserphus* gen. nov. has both 1cu-a and 2cu-a antefurcal, as in *Campturoserphus* Rasnitsyn, 1986, *Scoliuoserphus* Rasnitsyn, 1986 and *Basiserphus* Li *et al.*, 2016, but is different from the latter two and from *Lordoserphus* Rasnitsyn, 1994 and *Sinoserphus* Shih *et al.*, 2011 in the 1cu-a and 2cu-a being interstitial, from *Apiciserphus* Li *et al.*, 2016 in 1cu-a and 2cu-a postfurcal, and from *Amboserphus* Li *et al.*, 2016 and *Yanliaoserphus* Shih *et al.*, 2011 in 1cu-a postfurcal and 2cu-a antefurcal (Li *et al.* 2016). Furthermore, the position of the Rs+M forking in the forewing could be taken as a key feature. The forking of Rs+M is located one-third of the distance between 1m-cu and 2r-rs in *Juraserphus* gen. nov., whereas it is about one-fifth of this distance in *Mesoserphus* Kozlov, 1968, *Sinoserphus* Shih *et al.*, 2011 and *Basiserphus* Li *et al.*, 2016, and approximately one half in *Amboserphus* Li *et al.*, 2016 and *Beipiaoserphus* Zhang & Zhang, 2000.

The ovipositor of Mesoserphidae demonstrates significant variations, especially in its length, among the fossils described. The ovipositor in *Juraserphus* gen. nov. is similar to the one in *Novserphus* Li *et al.*, 2016 and *Ozososerphus* Li *et al.*, 2016 in being short, extending beyond the metasomal apex. In contrast, the ovipositor in some other genera (for example, *Apiciserphus* Li *et al.*, 2016, *Amboserphus* Li *et al.*, 2016, *Udaserphus* Rasnitsyn, 1983 and *Choriserphus* Li *et al.*, 2016) does not extend beyond the metasomal apex. On the other hand, *Sinoserphus* Shih, Feng & Ren, 2011 (especially *S. grossus* Shih, Feng & Ren, 2011; *S. flexilis* Shih, Feng & Ren, 2011 and *S. wui* Shih, Feng & Ren, 2011) has a much longer ovipositor, albeit not exceeding half of the metasomal length. Furthermore, the ovipositor in *Mesoserphus* Kozlov, 1968 is longer than the metasoma.

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