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Some anisopodoids (Insecta: Diptera: Anisopodoidea) from late Mesozoic deposits of northeast China

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Abstract

Three new species of anisopodoids from the Daohugou (Inner Mongolia) and Haifanggou (Liaoning) formations, are described from six almost complete specimens, namely: *Protorhyphus neimonggolensis* sp. nov., *P. liaoningicus* sp. nov. and *Megarhyphus rarus* sp. nov. *Protorhyphus neimonggolensis* and *P. liaoningicus* are assigned to the Protorhyphidae, and *Megarhyphus rarus* to the Anisopodidae (Anisopodoidea, Diptera). The family designations of all Chinese specimens described previously within the Anisopodoidea are questionable; those of *Brachyopteryx weichangensis* Hong, *Eoanisopoditis fushunensis* Hong, *Hongocaloneura plectilis* (Hong), *Limnorhyphus haifanggouensis* Hong, *Mesobrachyopteryx shandongensis* Hong and Wang and *Sinorhyphus arcuatus* Hong are reassessed here.

Keywords: Palaeoentomology; Diptera; Protorhyphidae; Anisopodidae; New species; Late Mesozoic; Daohugou biota; Haifanggou Formation; China

1. Introduction

The Protorhyphidae (Nematocera: Anisopodoidea) is a small, extinct family composed of a dozen species referable to three genera that range from the Triassic to the Upper Jurassic–Lower Cretaceous. These are: *Archirhyphus asiaticus* Rohdendorf, 1964, *A. geinitzi* Handlirsch 1939, *Protorhyphus arcuatus* (Hong, 1983) comb. nov., *P. major* Kovalev, 1990, *P. ovisimilis* Bode, 1953, *P. sibiricus* Kovalev, 1985, *P. simplex* (Geinitz, 1888), *P. stigmaticus* Handlirsch, 1920 (see Handlirsch, 1939), *P. turanicus* Rohdendorf, 1964, *Vymrhyphus tuomikoskii* Blagoderov, 1995, *V. triassicus* Blagoderov, 1995 and *V. blagoderovi* Krzeminski, 2003. *Acritorhyphus ramosus* Bode, 1953, *Heterorhyphus analivarius* Bode, 1953 and *H. latus* Bode, 1953 were originally placed in the Protorhyphidae but later transferred to other families by Blagoderov (see Shcherbakov et al., 1995). The family position of the Chinese species *Brachyopetryx weichangensis* Hong, 1984, previously associated with the Protorhyphidae, is revised here.

The Anisopodidae (Nematocera: Anisopodoidea) is a primitive, cosmopolitan, extant group consisting of small to moderate-sized flies (2–18 mm). Its fossil record includes more than 30 species referable to five extinct and four extant genera (Evenhuis, 1994; Ansorge and Krzeminski, 1995; Grimaldi and Amorim, 1995; Shcherbakov et al., 1995; Ansorge, 1996). The status of the following Chinese taxa assigned to the family is reassessed below: *Hongocaloneura plectilis* (Hong, 1981) (originally *Caloneura plectilis* Hong, 1981); *Mesobrachyopteryx shandongensis* Hong and Wang, 1990; *Sinorhyphus arcuatus* Hong, 1983; and *Eoanisopoditis fushunensis* Hong, 2002.

The Limnorhyphidae contains only a single genus and species, *Limnorhyphus haifanggouensis* Hong, 1983, placed in the Rhyphoidea (=Anisopodoidea). However, the description might be inaccurate, and its subordinal placement is uncertain (see discussion below).

Wing venational terminology here follows Wootton and Ennos (1989), and Shcherbakov et al. (1995). The vein traditionally named 1A is, in fact, CuP, as noted by these authors.

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2. Systematic paleontology

Order: Diptera Linnaeus, 1758
Suborder: Nematocera Latreille, 1825
Superfamily Anisopodoidea Knab, 1912
Family: Protorhyphidae Handlirsch, 1906
Genus *Protorhyphus* Handlirsch, 1906

Type species. *Phryganidium simplex* Geinitz, 1888

Species included. *Protorhyphus simplex*, Lower Jurassic, Germany (Handlirsch, 1906–08); *P. major*, Upper Jurassic or Upper Jurassic–Lower Cretaceous, Siberia, Russia (Kovalev, 1990); *P. sibiricus*, Middle Jurassic, Siberia (Kovalev, 1985); *P. stigmaticus*, Lower Jurassic, Germany (Handlirsch, 1939); *P. turanicus*, Lower Jurassic, Kyrgyzstan (Rohdendorf, 1964); *P. arcuatus*, Middle Jurassic–lowermost Upper Jurassic, Liaoning, China (Hong, 1983; see discussion below); and *P. neimonggolensis* sp. nov. and *P. liaoningicus* sp. nov., uppermost Middle Jurassic–lowermost Cretaceous of Inner Mongolia and Liaoning, China, respectively.

Protorhyphus neimonggolensis sp. nov.
Figs. 1A, B, 2A–E

Derivation of name. After Inner Mongolia (=Nei Monggol Autonomous Region), where the fossil was collected.

Material. Holotype DHG200386, paratype DHG200387, two impressions of female protorhyphids, from the Middle Jurassic–Early Cretaceous Daohugou Formation in the vicinity of Daohugou, Ningcheng, Inner Mongolia (for detailed discussion of its age, see Zhang, 2006); deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPCAS).

Diagnosis. Venation similar to that of *P. simplex*, *P. stigmaticus* and *P. sibiricus*, r-m closer to R_4 than R_{2+3}, but Pt present; R_{2+3} straight or nearly so, subparallel to R_1 terminally; R_5 smoothly curved downward; m-m meeting fork of M_{1+2}; m-cu some four times as long as bM_4.

Description. Medium-sized protorhyphids, body covered with long hairs. Head suboval in lateral aspect. Eyes large, suboval. Antennae 16-segmented, more than three times longer than head length, with scape slightly shorter; thinner than first flagellomere, pedicel short, basal ten flagellomeres as long as, or slightly shorter than, wide, terminal four clearly longer than wide. Thorax massive, suboval. Wing nearly 2.3 times longer than wide; Pt elongate-oval, not reaching R_{2+3}; Sc one-third and R_1 two-thirds of wing length; Rs furcated just a little distad of Sc end and M fork; R_{2+3} straight or nearly so, subparallel to R_1 terminally, slightly shorter than R_4; r-m closer to R_4 than R_{2+3}; bR_{4+5} nearly twice as long as dR_{4+5}; R_{4+5} furcated basad of both midwing, fork of M_{1+2}; m-m just meeting fork of M_{1+2}; CuP straight, long, convergent to CuA terminally, ending at hind margin of wing; cell d pentagonal, nearly 3.2 times longer than wide, with bM_{1+2}, M_{3+4} respectively longer than dM_{1+2} and bM_3, latter two convergent terminally; m-cu some four times as long as bM_4. Legs with clavate femora, thicker, shorter than tibiae; latter covered with at least three or four rows of short setae, tibial spurs well developed; basitarsi slightly shorter than remaining tarsomeres combined. Abdomen massive.

Measurements in mm: length of head, 0.5, antenna, 1.6, thorax, 1.9–2.2, abdomen, 4.1–5.0; length of wing, 5.6–5.8, width, 2.4–2.7; length of midleg tibia, 1.7, tarsus, 1.9 (0.9:0.4:0.3:0.2:0.1), tibiae of hindleg, 2.5, tarsus, 2.1 (1.0:0.5:0.3:0.2:0.1).

Remarks. This new species differs from *P. simplex*, *P. stigmaticus* and *P. sibiricus* by the crossvein m-m just meeting the fork of M_{1+2}; and the long m-cu, about four times longer than bM_4.

Protorhyphus liaoningicus sp. nov.
Figs. 1C, D, 2F, G

Derivation of name. After Liaoning, where the fossil was collected.

Material. Holotype DHG200388 and 200389, part and counterpart, of a male from the Haifanggou Formation in the vicinity of Yushudonggou, Beipiao, Liaoning; deposited in the collections of NIGPCAS.

Diagnosis. Distinguished by wings with r-m closer to R_4 than R_{2+3}; Pt present; R_{2+3} distinctly sigmoid, convergent to R_1 terminally; R_{4+5} furcated distad of both midwing, fork of M_{1+2}; R_4 nearly straight; R_5 clearly curved downward at midway; m-m meeting M_2 beyond fork of M_{1+2}; dM_{1+2}, bM_3 subparallel; m-cu about twice length of bM_4.

Description. Small protorhyphids, body covered with a few long hairs (possibly poorly preserved). Head suboval in lateral aspect. Eyes apparently large, but poorly preserved. Antennae 16-segmented, about 3.7 times longer than head length, with scape slightly shorter, thinner than first flagellomere, pedicel slightly short, basal eight flagellomeres shorter than wide, terminal six nearly twice (or more) longer than wide. Thorax suboval. Wing nearly 2.2 times longer than wide; Pt large, elongate-oval, reaching R_{2+3}; Sc one-third and R_1 little more than two-thirds of wing length; Rs furcated just a little distad of Sc end, but just at level of M fork; R_{2+3} distinctly sigmoid, convergent to R_1 terminally, clearly shorter than R_4; bR_{4+5} 1.2 times longer than dR_{4+5}; R_{4+5} furcated distad of both midwing, fork of M_{1+2}; bM_{1+2} 1.3 times longer than dM_{1+2}; m-m meeting M_2 beyond fork of M_{1+2}, bM_2 about one-half length of m-m; CuP curved, parallel to CuA terminally, not reaching hind margin of wing; cell d hexagonal, nearly 3.8 times longer than wide, with M_{3+4} distinctly shorter than bM_3; dM_{1+2}, bM_3 subparallel; m-cu about twice length of bM_4. Legs with coxae large, nearly two-thirds length of femora, latter thicker, shorter than tibiae; tibiae covered with one or two rows of short setae, tibial spurs not visible (probably