



A new lacewing (Insecta: Neuroptera: Grammolingiidae) from the Middle Jurassic of Inner Mongolia, China

YUSHUANG LIU^{1,2}, CHAOFAN SHI² & DONG REN²

¹Paleontological Institute, Shenyang Normal University, Shenyang 110034, China. E-mail: lyshuang@126.com

²College of Life Sciences, Capital Normal University, 105 Xisanhuanbeilu, Haidian District; Beijing 100048; China. E-mail: rendong@cnu.edu.cn

Abstract

A new species of the family Grammolingiidae (Neuroptera) (*Leptolingia imminuta* **sp. nov.**) is described from Daohugou village (Middle Jurassic), Inner Mongolia, China. In this new species, MA forks at the same level as the separation of Rs2 from Rs, close to the middle of forewing, this structure of MA is peculiar in Grammolingiidae and is different from that of all other known species. Moreover, this new species is the smallest species known in the family Grammolingiidae (30 mm wing span).

Key words: *Leptolingia*, Jiulongshan Formation, new species, Daohugou

Introduction

Grammolingiidae Ren, 2002 is a small family of Jurassic Neuroptera found in Central and East Asia. Three genera and nine species were described previously in this family. Among them, eight species were found in the Middle Jurassic deposits of Daohugou Village, Inner Mongolia, China (Ren 2002, Shi *et al.* 2011); only one species (*Leptolingia shartegica* Khramov, 2010) has been found in the Late Jurassic deposits of Sharteg, Mongolia (Khramov 2010). *Leptolingia* was erected by Ren (2002) who described two species; Shi *et al.* (2011) revised this genus, identifying definitive generic characters and added a new species, *L. calonervis*. Until now, four species were assigned in *Leptolingia*. According the revised generic characters, the new species described in this paper, from the Middle Jurassic Jiulongshan Formation of the Daohugou Village, belongs to the genus *Leptolingia* due to Rs arising close to the base of the wing, MP dichotomously branched basally, CuA forked after the fork of CuP, 1A terminated at the posterior margin before the separation of Rs1 from Rs.

In recent years, many Neuroptera fossils (six families, twenty-one genera and thirty-one species) have been found in the deposits of Daohugou Village, Inner Mongolia, China, such as Kalligrammatidae (Makarkin *et al.* 2009), Nymphidae (Ren & Engel 2007), Osmylidae (Wang *et al.* 2009), Psychopsidae (Peng *et al.* 2010) and Polystoechothidae (Ren *et al.* 2002). Notable examples are *Bellinympha filicifolia* Wang, Ren, Liu & Engel, 2010 and *B. dancei* Wang, Ren, Shih, & Engel, 2010, which exhibit pinnate leaf mimesis, and represent a 165 million year old specialization between insects and contemporaneous gymnosperms of the Cycadales or Bennettitales (Wang *et al.* 2010).

Daohugou Village is situated in southeastern Inner Mongolia, which is close to Lingyuan of the western Liaoning Province, northeastern China. The rocks here represent a lacustrine deposit which yields a diverse insect fauna composed of at least seventeen orders. The age of the Daohugou beds is still being debated, ranging from the early Middle Jurassic to the Lower Cretaceous (Ren *et al.* 2002; Liu *et al.* 2004; Ji *et al.* 2005; He *et al.* 2005; Wang *et al.* 2005). Recently, accurate Ar-Ar and SHRIMP U-Pb dating shows that the age of intermediate-acid volcanic rocks overlying the Daohugou fossil-bearing beds (N41° 18.979'E119° 14.318') is about 164-165Ma, and the age of Daohugou beds is older than or equal to 165Ma (Chen *et al.* 2004). Liu *et al.* (2006) also examined by SHRIMP U-Pb dating the Daohugou section (N41° 23.10'E119° 09.61') and drew a similar conclusion giving an average age

of the Daohugou beds as 162 ± 2 Ma. This conclusion, supported by paleontological evidence from conchostracans and insects, provides the most definitive evidence for a Middle Jurassic (Bathonian) age of the Daohugou beds (Gao & Ren 2006).

Material and methods

The fossils described herein were collected from Daohugou Village, Chifeng City, Inner Mongolia, China; Middle Jurassic. They were examined using a LEICA MZ12.5 dissecting microscope, line drawings were processed using CorelDraw 12 graphic software, and the photographs were taken by HP Scanjet 4850 and Canon EOS 350D. Type specimens described here are housed in Paleontological Museum of Liaoning (PMOL), Shenyang Normal University (210057), Shenyang, China.

Wing nomenclature and abbreviations used in the text and figures are as follows: C, costa; Sc, subcosta; R, radius; R1, first branch of R; Rs, radial sector; Rs1, first branch of Rs; Rs2, second branch of Rs; M, media; MA, anterior media; MP, posterior media; Cu, cubitus; CuA, anterior cubitus; CuP, posterior cubitus; 1A–3A, first to third anal veins.

Systematic paleontology

Order Neuroptera Linnaeus, 1758

Family Grammolingiidae Ren, 2002

Genus *Leptolingia* Ren, 2002

Leptolingia imminuta sp. nov.

(Figs. 1–2)

Type material. Holotype, CHINA: Inner Mongolia, Chifeng City, Daohugou Village; Middle Jurassic; PMOL-AI00522A-B. Well-preserved part and counter part of wings.

Diagnosis. Costal area with two rows of cells basally, finishing at the middle of fore wing, and with only one row of cell distally; Rs1 originates at approximately one-fourth of the forewing's length; MA forks at the same level as the separation of Rs2 from Rs. MP forks near base of wing, opposite separation of MA from Rs. CuA forks almost opposite separation of Rs1 from Rs; CuP bifurcates slightly before the separation of Rs1 from Rs, 1A terminates on posterior margin, opposite fork of CuP.

Description. *Forewing.* The left and right forewings almost overlap with each other completely, from the photo (Fig. 2A), they look like one forewing; but in fact, they are in different planes which preserved a part of left or right forewing respectively.

Length 25 mm, width 10 mm (preserved part), the estimated total length 30 mm. conspicuous wide banded markings and white annulets distributed irregularly are well preserved. Costal area with two rows of cells basally, finishing at the middle of fore wing, and with only one row of cell distally, costal and subcostal veinlets are numerous and simple. Sc runs parallel with R1 for a considerable distance, Rs arising close to base of wing, four branches preserved, Rs1 originates at approximately 1/4 of wing's length. MA coalesced basally with Rs for a very short distance and then separating from it, MA forks at same level as origin of Rs2 from Rs, about at middle of wing's length; MP forks near base of wing, opposite separation of MA from Rs, anterior branch of MP simple, maybe with short branches close to wing margin; posterior branch of MP first forks distal to fork of MA. CuA forked distal to fork of CuP, almost opposite separation of Rs1 from Rs; CuP relatively long, forked slightly before separation of Rs1 from Rs, and close to first fork of CuA. 1A long, terminates on posterior margin opposite fork of CuP, 2A relatively long, terminates on posterior margin obviously beyond separation of MA from Rs, clear intercalary vein between 1A and 2A, not reaching margin of wing and producing three rows of cells between 1A and 2A on base of wing; 3A poorly developed. Crossveins at posterior margin interlinked by veinlets. Dense crossveins present over entire wing, the main longitudinal veins with many minute trichobothria close to the wing margin.



FIGURE 1. *Leptolingia imminuta* sp. nov. Photograph of the holotype, PMOL-AI00522B. Scale bars represent 5 mm.

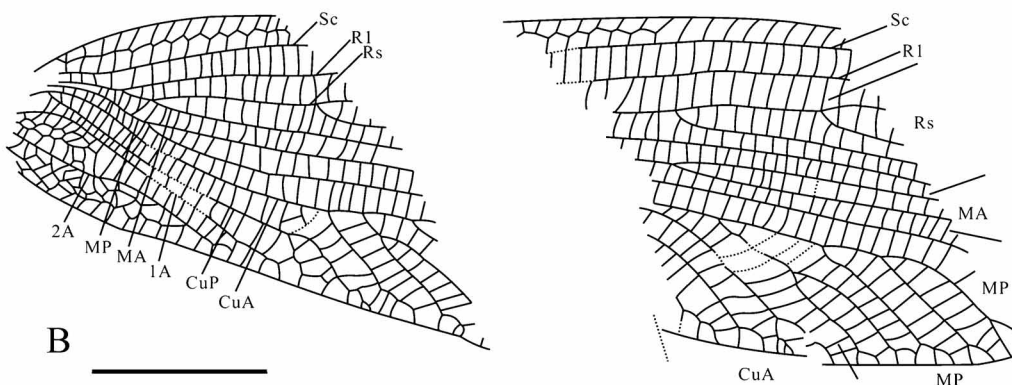


FIGURE 2. *Leptolingia imminuta* sp. nov. A, photograph of forewings of the holotype PMOL-AI00522B. B, the venation of forewings of the holotype PMOL-AI00522B. Scale bars represent 5 mm.

Hindwing. Well-preserved, length 29 mm, width 11 mm, also with wide banded markings and white annulets (Fig. 3). One row of cells in costal area, veinlets unforked, except for a few forked distally. As in the forewing, Sc and R1 parallel and equidistant to wing margin close to apex, Rs with 6–7 pectinate branches. Other veins are difficult to observe clearly due to overlapped left and right hindwings. Distal parts of branches preserved with end twigging evident.

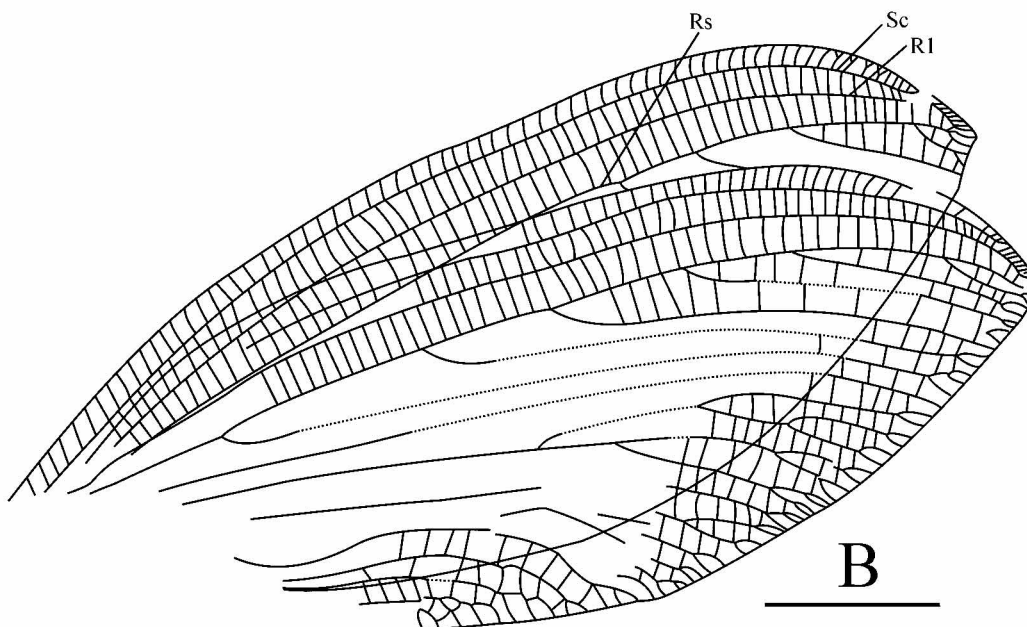


FIGURE 3. *Leptolingia imminuta* sp. nov. A, photograph of hind wings of the holotype PMOL-AI00522B. B, the venation of the hind wings of the holotype PMOL-AI00522B. Scale bar represents 5 mm.

Etymology. From the Latin *imminuta*, meaning diminished, in reference to the small size of the wings (approximately half the size as other known grammolingiids)”. .

Remarks. *Leptolingia imminuta* **sp. nov.** is much smaller than all other species of *Leptolingia*, which, for example, have the following wing lengths: *L. jurassica* Ren with 40 mm long forewings, *L. tianyiensis* Ren with 41 mm long forewings, *L. calonervis* Shi, Yang & Ren with 47 mm forewing and *L. shartegica* Khramov with 54 mm long forewing.

Leptolingia imminuta **sp. nov.** shares with *L. tianyiensis* two rows of cells in the basal costal area only of the forewing, and one row of cells in the distal part. Also, 1A terminates on the posterior margin at about the same level of the separation of Rs1 from Rs. It differs from *L. tianyiensis* by MP forked at approximately the same level as the separation of MA from Rs, MA forks at the same level as Rs2 from Rs, the venation pattern of MP, and the two longer rows of cells in the costal area, which terminate at about the same level as Rs2 from Rs. *Leptolingia imminuta* **sp. nov.** is easy to distinguish from *L. jurassica*, *L. calonervis* and *L. shartegica* by having two rows of cells only present in the basal part of costal area (two rows of cells present along the entire costal area in the latter three species), MA forks at the same level of separation as Rs2 from Rs (MA with forking close to the wing margin in the latter three species), and 1A terminating on the posterior margin at approximately the same level as the fork of CuP (1A terminated on the posterior margin distal to the forks of CuP in the latter species). In addition, it differs from *L. jurassica* by a relatively long 2A terminating on the posterior wing margin distinctly distal of the fork of MP. It differs from *L. shartegica* by MP being forked at approximately the same level as the separation of MA from Rs (MP forked distal of the separation of MA from Rs), and CuA is not dichotomously branched. It differs from *L. calonervis* by CuP without obvious pectinate branches, and 1A terminating on posterior margin opposite fork of CuP (CuP with 4 main pectinate branches, and 1A terminating on posterior margin distinctly distal to the fork of CuP in latter species).

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References

- Chen, W., Ji, Q., Liu, D.Y., Zhang, Y., Song, B. & Liu, X.Y. (2004) Isotope geochronology of the fossil-bearing beds in the Daohugou, Ningcheng, Inner Mongolia. *Geological Bulletin of China*, 23, 1165–1169 [in Chinese, English summary].
- Gao, K.Q. & Ren, D. (2006) Radiometric dating of Ignimbrite from Inner Mongolia provides no indication of a Post–Middle Jurassic Age for the Daohugou Bed. *Acta Geologica Sinica*, 80, 41–45.
- He, H.Y., Wang, X.L., Zhou, Z.H., Zhu, R.X., Jin, F., Wang, F., Ding, X. & Boven, A. (2005) Reply on comment by Liu and Liu on “40Ar/39Ar dating of ignimbrite from Inner Mongolia, northeastern China, indicates a post-Middle Jurassic age for the overlying Daohugou Bed”. *Geophysical Research Letters*, 32, L12315, doi: 10.1029/2005GL022787.
- Ji, Q., Liu, Y.Q., Chen, W., Ji, S.A., Lv, J.C., You, H.L. & Yuan, C.X. (2005) On the geological age of Daohugou Biota. *Geological Review*, 51, 609–612 [in Chinese, English summary].
- Khramov, A.V. (2010) A New Lacewing (Insecta: Neuroptera: Grammolingiidae) from the Upper Jurassic of Mongolia. *Paleontological Journal*, 44, 188–191.
- Linnaeus, C. (1758) *Systema Nature per Regna Tria Nature, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis* (tenth edn, revised). Salviae, Holmiae, Sweden, 824pp.
- Liu, Y.Q., Liu, Y.X., Li, P.X., Zhang, H., Zhang, L.J., Li, Y. & Xia, H.D. (2004) Daohugou biota-bearing lithostratigraphic succession on the southeastern margin of the Ningcheng Basin, Inner Mongolia, and its geochronology. *Geological Bulletin of China*, 23(12), 1180–1187 [in Chinese, English summary].
- Liu, Y.Q., Liu, Y.X., Ji, S.A. & Yang, Z.Q. (2006) U–Pb Zircon age for the Daohugou biota at Ningcheng of Inner Mongolia and comments on related issues. *Chinese Science Bulletin*, 51, 2634–2644 [in Chinese with English abstract].
- Makarkin, V.N., Ren, D. & Yang, Q. (2009) Two new species of Kalligrammatidae (Neuroptera) from the Jurassic of China, with comments on venational homologies. *Annals of the Entomological Society of America*, 102, 964–969.

- Peng, Y.Y., Makarkin, V.N., Yang, Q. & Ren, D. (2010) A new silky lacewing (Neuroptera: Psychopsidae) from the Middle Jurassic of Inner Mongolia, China. *Zootaxa*, 2663, 59–67.
- Ren, D. (2002) A new lacewing family (Neuroptera) from the Middle Jurassic of Inner Mongolia, China. *Entomologia Sinica*, 9, 53–67.
- Ren, D., Engel, M.S., & Lu, W. (2002) New giant lacewings from the Middle Jurassic of Inner Mongolia, China (Neuroptera: Polystoechotidae). *Journal of the Kansas Entomological Society*, 75, 188–193.
- Ren, D., Gao, K.Q., Guo, Z.G., Ji, S.A., Tan, J.J. & Song, Z. (2002) Stratigraphic division of the Jurassic in the Daohugou Area, Ningcheng, Inner Mongolia. *Geological Bulletin of China*, 21, 584–591 [in Chinese, English summary].
- Ren, D. & Engel, M.S. (2007) A split-footed lacewing and two epismylinines from the Jurassic of China (Neuroptera). *Annales Zoologici*, 57, 211–219.
- Shi, C.F., Yang, Q. & Ren, D. (2011) Two new fossil lacewing species from the Middle Jurassic of Inner Mongolia, China (Neuroptera: Grammolingiidae). *Acta Geologica Sinica (English Edition)*, 85, 801–808.
- Wang, X.L., Zhou, Z.H., He, H.Y., Jin, F., Wang, Y.Q., Zhang, J.Y., Wang, Y., Xu, X. & Zhang, F.C. (2005) Stratigraphy and age of the Daohugou bed in Ningcheng, Inner Mongolia. *Chinese Science Bulletin*, 50(19), 2127–2135.
- Wang, Y.J., Liu, Z.Q. & Ren, D. (2009) A new fossil lacewing genus from the Middle Jurassic of Inner Mongolia, China (Neuroptera: Osmylidae). *Zootaxa*, 2034, 65–68.
- Wang, Y.J., Liu, Z.Q., Shih, C.K., Zhao, Y.Y., Engel, M.S. & Ren, D. (2010) Ancient pinnate leaf mimesis among lacewings. *Proceedings of the National Academy of Sciences*, 107, 16212–16215.