A new species of *Lasiosmylus* from the Early Cretaceous, China clarifies its genus-group placement in Ithonidae (Neuroptera)

Bingyu Zheng¹, Dong Ren¹, Yongjie Wang¹

¹ College of Life Sciences, Capital Normal University, 105 Xisanhuanbeilu, Haidian District, Beijing 100048, China

Corresponding author: Yongjie Wang (wangyjosmy@gmail.com)

Academic editor: S. Winterton | Received 7 August 2016 | Accepted 10 November 2016 | Published 24 November 2016

Citation: Zheng B, Ren D, Wang Y (2016) A new species of *Lasiosmylus* from the Early Cretaceous, China clarifies its genus-group placement in Ithonidae (Neuroptera). ZooKeys 636: 41–50. doi: 10.3897/zookeys.636.10103

Abstract

A new species, *Lasiosmylus longus* sp. n., is described from the Early Cretaceous Yixian Formation of Huangbanjigou Village, Liaoning Province, China. Based on the characters of the new species and nine new specimens of *Lasiosmylus newi* Ren & Guo, 1996, the generic diagnosis of *Lasiosmylus* is emended and the taxonomic position of *Lasiosmylus* Ren & Guo, 1996 is re-evaluated, and *Lasiosmylus* should be assigned to the ithonid genus-group.

Keywords

Fossil, Huangbanjigou, ithonid genus-group, taxonomy, Yixian Formation

Introduction

The genus *Lasiosmylus* Ren & Guo, 1996 was initially assigned to the subfamily Spi-losmylinae in Osmylidae. Makarkin et al. (2012, 2014) then transferred it to Ithonidae *sensu lato*, but without discussing the relationship of the genus to other genera within the family. It is evident that the original assignment of *Lasiosmylus* to Osmylidae is questionable since the shared osmylid-like features discussed by the authors (i.e., absence of r1-rs crossvein, fewer crossoveins throughout wing, and absence
of gradate series) are not actual synapomorphies of Osmylidae. Lasiosmylus rather
displays more typical ithonid-like characters, e.g., stout body, retracted head, distinc-

tively narrowed costal space towards the pterostigma area and strongly recurrent
humeral crossvein in forewing; undoubtedly, it is more suitable to attribute this genus
to Ithonidae. At present, although it is widely accepted that Ithonidae comprise three
lineages: ithonid genus-group (moth-lacewings), polystoechotid genus-group (giant
lacewings), and rapismatid genus-group (montane lacewings), the interrelationships
among these groups, especially for fossil taxa, are still not fully resolved (Winterton
and Makarkin 2010, Makarkin et al. 2014, Zheng et al. 2016). As a result, most fossil
taxa have been simply attributed to Ithonidae sensu lato without further systematic
placement (Archibald and Makarkin 2006, Makarkin et al. 2014). Recently Zheng et
al. (2016) proposed diagnostic features for the three lineages of Ithonidae, incorporat-
ing the extant and fossil taxa, which could form the basis for assignment of additional
Ithonidae fossils.

In this study a distinctive new species of Ithonidae, Lasiosmylus longus sp. n., is de-
scribed from the Early Cretaceous of Yixian Formation, China. Additionally, nine new
fossil specimens assignable to Lasiosmylus newi Ren & Guo, 1996 were collected from
the same locality, which allow us to re-evaluate the systematic position of the genus
within Ithonidae. Based on this new information, the genus Lasiosmylus is attributed
to the ithonid genus-group and the diagnostic characters of Lasiosmylus are amended.

Materials and methods

This study is based on ten specimens, which are deposited in the Key Lab of Insect
Evolution and Environmental Change, Capital Normal University, Beijing, China.
Draft drawings were produced using LEICA MZ75 dissecting microscope equipped
with a drawing tube. Drawings were finalized using Adobe Illustrator CC. Photographs
were taken by Leica Digital Camera DFC500 (Figs 1A, C) and Nikon Digital Camera
SMZ25 (Fig. 3A), and produced with Adobe Photoshop CC. Additionally, the part of
one specimen (CNU-NEU-LB2015001P) was fragmented and glued loosely during
collecting, the counterpart of the specimen (CNU-NEU-LB2015001C) is complete.
A composite photograph of the part and counterpart is shown on Fig. 1A, which is
the combination of two photos from both parts of the specimen in dry condition. The
technique of the composite photograph in this study follows that of Béthoux (2015).

The terminology of venation in general follows Barnard (1981), except the termi-
nology of humeral plate follows Oswald (1993):

- Sc Subcosta;
- R1 first branch of Radius (R);
- Rs Radial sector;
- MA anterior branches of Media (M);
- MP posterior branches of Media;
- CuA anterior Cubitus (Cu);
- CuP posterior Cubitus;
- 1A–3A Anal veins;
- hp humeral plate;
- hv humeral veinlet.
Systematic paleontology

Order Neuroptera Linnaeus, 1758
Family Ithonidae Newman, 1853 *sensu* Winterton & Makarkin, 2010

Genus *Lasiosmylus* Ren & Guo, 1996

**Type species.** *Lasiosmylus newi* Ren & Guo, 1996.

**Species included.** *Lasiosmylus newi* Ren & Guo, 1996, *Lasiosmylus longus* sp. n.

**Amended diagnosis.** Body stout (ca. 11–17 mm long), covered with dense setae; head hypognathous, protruding from pronotum partly; antenna filiform (ca. 2–5 mm, incompletely preserved); compound eye large, ocelli absent; thorax robust, long setae concentrated on pronotum. Forewing ca. 12–23 mm long, 5–8 mm wide, membranous area with many fuscous spots; humeral plate distinct; dense setae along the veins, especially on the wing margin; trichosors and nygmata undetectable; costal space dilated basally and narrowed distally; humeral veinlet recurrent, with several simple branches; costal cross-veins simple, moderately curved distally in the apical half of the costal space; Sc and R1 separate distally, entering the margin before the wing apex; one or two sc-r1 crossveins; R1 with four to eleven pectinate branches distally; the origin of Rs distant from the wing base, with seven to thirteen branches regularly arranged; relatively few crossveins present in radial area; MA simple, dichotomously branched terminally; MP first fork distant from wing base. Hind wing ca. 11–18 mm long, 4–8 mm wide, partly preserved, venation similar to forewing except for the following characters: costal space narrow, only slightly expand in proximal portion.

**Remarks.** *Lasiosmylus* shows a superficial similarity with osmylids, sharing plesiomorphic features such as the fork of MP in forewing usually between the separation of MA and first Rs branch, sometimes opposite the separation of MA; wings not falcate, with few crossveins (Ren and Guo 1996). However, all these characters do not well support the assignment of *Lasiosmylus* to Spilosmylinae, or Osmylidae in general because they also frequently occur in other families (e.g., Ithonidae, Berothidae, some Mantispidae). The subsequent transfer to Ithonidae by Makarkin et al. (2012, 2014) seems reasonable; moreover, recently it was classified further as belonging to the poly-stoechotid genus-group by Zheng et al. (2016).

Herein, nine new-collected specimens are examined in this study. All these specimens are placed in *Lasiosmylus* based on the following characters: numerous dispersed spots on the forewing, simple costal crossveins, two subcostal crossveins, Rs less than ten branches (about six to eight branches), MP distant from the wing base and beyond MA fork, MP1 and MP2 simple, one mp1-mp2 crossvein, CuA dichotomously branched distally (in particular, obs. CNU-NEU-LB2015001P/C and CNU-NEU-LB2015002, see Figs 1, 2; and Ren and Guo 1996: fig. 5, fig. 10, pl. 3, fig. 11, pl. 2). Noticeably, during checking the specimens, we found some variable characters that are distinctly different from the type specimen, e.g., humeral veinlet and separated Sc and R1. A recurrent humeral veinlet is considered as a synapomorphy for Ithonidae
Figure 1. New materials of Lasiosmylus newi: CNU-NEU-LB2015001P/C, CNU-NEU-LB2015002. A composite photographs of habitus of part and counterpart (CNU-NEU-LB2015001P/C) hp, humeral plate (CNU-NEU-LB2015001C) B line drawing (CNU-NEU-LB2015001C) C habitus photograph, hp, humeral plate (CNU-NEU-LB2015002) D line drawing (CNU-NEU-LB2015002). Scale bars: 5 mm (A–D).

(Yang et al. 2012, Makarkin et al. 2013, Zheng et al. 2016). However, this character is absent in the line drawing of L. newi (Ren and Guo 1996: fig. 5), although some trace of recurrent humeral veinlet can be detected in the photograph of Lasiosmylus (Ren and Guo 1996: fig. 11, pl. 4). Regrettfully, the holotype of L. newi was not available for examination during this study (possibly lost). However, it is reasonable to assume now that the recurrent humeral veinlet occurs in Lasiosmylus newi according to these new specimens.

In addition, the distally separated Sc and R1 were regarded as a synapomorphic character of Ithonidae (Zheng et al. 2016). In the original illustration of L. newi, Sc and R1 were drawn with fused termination. Unfortunately, the photograph of L. newi is too obscure for us to discern the condition of Sc and R1 (Ren and Guo 1996: fig. 10,
A new species of *Lasiosmylus* from the Early Cretaceous, China clarifies its genus-group...

**Figure 2.** New materials of *Lasiosmylus newi*. Line drawings of CNU-NEU-LB2015001P/C, **A** left forewing **B** right forewing **C** right hind wing **D** left hind wing. Line drawings of CNU-NEU-LB2015002 **E** left forewing **F** right forewing **G** left hind wing **H** right hind wing. Scale bars: 5 mm (**A–H**).

In extant members of the polystoechotid genus-group Sc and R1 are closely approximated but are actually not fused, e.g., *Fontecilla* Navás, 1931, *Platystoechotes* Carpenter, 1940, *Polystoechotes* Burmeister, 1839 (see Winterton and Makarkin 2010). While this character was not fully investigated in the fossil lineages, most fossil polystoechotid genera were illustrated with the fused Sc and R1.

During the examination of the new materials, it is clear that all specimens assigned to *Lasiosmylus* (Figs 1, 2) show a separate Sc and R1. Furthermore, nine specimens (CNU-NEU-LB2015001P/C, CNU-NEU-LB2015002, CNU-NEU-LB2016001P/C, CNU-NEU-LB2016002, CNU-NEU-LB2016003, CNU-NEU-LB2016004, CNU-NEU-LB2016005, CNU-NEU-LB2016006, CNU-NEU-LB2016007) exhibit the typically venation with *L. newi* with exception for the incompatible conditions of Sc and R1. These nine specimens are considered to be *L. newi*. 
It is concluded here that the genus *Lasiosmylus* most commonly has the separated Sc and R1 that is consistent with other moth lacewings. The exception of Sc and R1 in the holotype of *L. newi* possibly represents a particularly individual variation, inaccuracy in line drawing or obscurity in the specimen. Based on this we consider *Lasiosmylus* is unquestionably assigned to the ithonid genus-group by the following combination of characters: robust and hairy body, retracted head under pronotum, costal space dilated basally and narrowed disproportionately distally, separated Sc and R1 reaching the anterior margin straightly before the wing apex, MP first fork distant from the wing base and beyond the divergence of MA.

**Lasiosmylus longus** sp. n.
http://zoobank.org/66865D0B-21B0-42C4-BDD5-98CE8AE31A2D
Figs 3, 4

**Material.** Holotype, CNU-NEU-LB2015003, a partly preserved specimen. Body barely preserved, but four overlapping, sub-complete wings, partially folded, with visible features.

**Diagnosis.** Humeral veinlet recurrent, with a few branches; numerous markings present on the forewing; a distinct oblique stripe parallel to the outer margin; costal crossveins simple; one basal subcostal crossvein; Sc and R1 separate distally, Sc terminating in costal margin 2/3 length of wing; R1 with numerous anteriorly directed branches; Rs with more than ten branches; MP fork level with origin of MA; CuA pectinately branched, CuP with three distal branches.

**Description.** **Body:** ca. 16.3 mm long; head hypognathous, retracted into pronotum partly; antenna filiform (ca. 4.0 mm) and incompletely preserved; compound eye large, ocelli absent; pronotum quadrate, numerous long setae concentrated laterally; mesonotum and metanotum stout; abdomen and legs indiscernible.

**Fore wing:** ca. 22.7 mm long, 7.9 mm wide; slender and membranous with numerous fuscous spots; humeral plate discernible (Fig 3A); veins covered by dense setae, particular along wing margin; trichosors and nygmata undetectable; costal space broad basally (maximum width = 2.1 mm), narrowed distally; recurrent humeral veinlet with several branches; costal crossveins simple and with the occasional distal dichotomous forks, densely arranged distally; Sc and R1 separated distally; one subcostal crossvein close to the origin of Rs; R1 with many pectinately branches distally, entering the anterior margin; Rs branches regularly arranged with about thirteen branches; few crossveins present between branches of Rs; MA simple; MP first fork distant from wing base, close to the MA divergence from Rs; one mp1-mp2 crossvein detected; CuA branched near the middle of wing, with ten pectinate branches; CuP with three simple branches; anal veins partly preserved, 1A with three branches and forked proximally, 2A proximally forked. **Hind wing:** ca. 18.0 mm long, 7.3 mm wide, partly preserved, venation similar to forewing except costal space narrow; cubitus veins and anal veins not well preserved (Figs 3, 4).
A new species of Lasiosmylus from the Early Cretaceous, China clarifies its genus-group...

Figure 3. Lasiosmylus longus sp. n. (holotype CNU-NEU-LB2015003). A habitus photograph B hp, humeral plate (left hindwing) C line drawing. Scale bars: 5 mm (A, C), 1 mm (B).
Figure 4. *Lasiosmylus longus* sp. n. (holotype CNU-NEU-LB2015003), line drawings. **A** right forewing **B** left hind wing **C** right hind wing. Scale bars: 5 mm (**A–C**).

**Etymology.** The species name is from the Latin ‘*longus*’, referring to the slender wing of this moth lacewing.

**Type locality.** Huangbanjigou Village, Beipiao City, Liaoning Province, China.
**Type horizon.** Yixian Formation, Barremian-early Aptian (129.7–122.1 Ma), Early Cretaceous.

**Remarks.** Lasiosmylus longus sp. n. can be distinguished from L. newi by the distinct oblique stripe close to the outer margin, multiple Rs branches, and pectinate CuA branches.

**Acknowledgments**

We thank Dr. Chungkun Shih (College of Life Sciences, Capital Normal University) for improving the manuscript. This work was supported by National Science Foundation of China (grants 31230065, 31272352, 31301905, 31672323, 41372013 and 41272006), Research Fund for the Doctoral Program of Higher Education of China (grant 20131108120005), Beijing Natural Science Foundation (grant 5132008), and Program for Changjiang Scholars and Innovative Research Team in University (IRT13081).

**References**

Archibald SB, Makarkin VN (2006) Tertiary giant lacewings (Neuroptera: Polystoechotidae): revision and description of new taxa from western North America and Denmark. Journal of Systematic Palaeontology 4(2): 119–155. doi: 10.1017/S1477201906001945

Barnard PC (1981) The Rapismatidae (Neuroptera): montane lacewings of the oriental region. Systematic Entomology 6: 121–136. doi: 10.1111/j.1365-3113.1981.tb00430.x

Béthoux O (2015) The Late Carboniferous Triplosoba pulchella is not a fly in the ointment but a stem-mayfly. Systematic Entomology 40(2): 342–356. doi: 10.1111/syen.12103

Burmeister HCC (1839) Handbuch der Entomologie (Zweiter Band) – Besondere Entomologie. Zweite Abtheilung – Kaukerfe – Gymnognatha (Zweite Hälfte; vulgo Neuroptera). Enslin, Berlin, 1050 pp.

Carpenter FM (1940) A revision of the Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae and Dilaridae (Neuroptera). Proceedings of the American Academy of Arts and Sciences 74: 193–280. doi: 10.2307/20023398

Linnaeus C (1758) Systema naturae per regna tria naturae, secundum classes, irdines, genera, species, cum characteribus, differentiis, synonymis, locis. Editio decima. Laurentius Salvius, Holmiae, 824 pp.

Oswald JD (1993) Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). Journal of the New York Entomological Society 101(2): 143–299.

Makarkin VN, Wedmann S, Weiterschan T (2014) First record of the family Ithonidae (Neuroptera) from Baltic amber. Zootaxa 3796(2): 385–393. doi: 10.11646/zootaxa.3796.2.10

Makarkin VN, Yang Q, Peng YY, Ren D (2012) A comparative overview of the neuropteran assemblage of the Early Cretaceous Yixian Formation (China), with description of a
new genus of Psychopsidae (Insecta: Neuroptera). Cretaceous Research 35: 57–68. doi: 10.1016/j.cretres.2011.11.013

Navás L (1931) Insectos de Papudo (Aconcagua) recogidos por don Arturo Fontecilla en Febrero de 1930. Revista Chilena de Historia Natural 35: 71–73.

Newman E (1853) Proposed division of Neuroptera into two classes – Zoologist (Vol. 11).

John Van Voorst Paternoster Row, London, 181–202.

Ren D, Guo ZG (1996) On the new fossil genera and species of Neuroptera (Insecta) from the Late Jurassic of northeast China. Acta Zootaxonomica Sinica 21(4): 461–479.

Winterton SL, Makarkin VN (2010) Phylogeny of moth lacewings and giant lacewings (Neuroptera: Ithonidae, Polystoechotidae) using DNA sequence data, morphology and fossils. Annals of the Entomological Society of America 103(4): 511–522. doi: 10.1603/AN10026

Yang Q, Makarkin VN, Winterton SL, Khramov AV, Ren D (2012) A remarkable new family of Jurassic insects (Neuroptera) with primitive wing venation and its phylogenetic position in Neuropterida. PLoS ONE 7(9): e44762. doi: 10.1371/journal.pone.0044762

Zheng BY, Ren D, Wang YJ (2016) Earliest true moth lacewing from the Middle Jurassic of Inner Mongolia, China. Acta Palaeontologica Polonica. doi: 10.4202/app.00259.2016