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A primitive moth from the earliest Eocene Fur Formation ("Mo-clay") of Denmark (Lepidoptera: Micropterigidae)

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A b s t r a c t : A fossil micropterigid moth (Zeugloptera: Micropterigoidea) is described and figured from a well preserved forewing of the Fur Formation ["Mo-clay": earliest Eocene (Early Ypresian)] of Denmark. *Moleropterix kalbei* nov.gen. et nov.sp. is distinguished from other fossil micropterigids as well as modern counterparts.

K e y w o r d s : Micropterigoidea, Zeugloptera, Denmark, Tertiary, paleontology, taxonomy.

Introduction

The fossil record of Lepidoptera is unfortunately poorly documented and the sparsely available specimens have not been critically reviewed and only limitedly synthesized into analyses with their modern counterparts (GRIMALDI & ENGEL 2005). This is largely hampered by the fact that some of the most critical structures for understanding lepidopteran phylogeny and evaluating the taxonomic placement of specimens are minute and/or internalized and therefore frequently not preserved. Nonetheless, some remarkably interesting taxa have been discovered and even with a paucity of characters they have shed considerable understanding on the various phases of lepidopteran evolution (GRIMALDI & ENGEL 2005). Fortunately, basal relationships among the order have been exceptionally well studied and are remarkably stable (KRISTENSEN & SKALSKI 1999), permitting a careful evaluation of primitive forms preserved as compressions and in amber.

Herein we record a primitive group of moths from the earliest Eocene Fur Formation of Denmark. This is the first record of the superfamily Micropterigoidea from these deposits. Admittedly the placement of compression fossil moths into the basal, non-glossatan families of Lepidoptera is challenging owing to the aforementioned dearth of discernible details or the absence of critical apomorphies since few defining features are preserved in the wing venation alone. Nonetheless, assignment to Micropterigidae seems relatively safe owing to the combination of the forking of Sc and R, the forking of Rs_{1+2} into Rs_1 and Rs_2 , the presence of only three branches of M, the termination of Rs_4 nearly at the wing apex (very slightly anterior to the apex), and sc-r present. The families Agathiphagidae and Heterobathmiidae can be excluded owing to the presence of a 3-branched medial vein (4-branched in agathiphagids) and forked Sc and R veins (simple in heterobathmiids), respectively. Similarly, eriocranoids can be excluded owing to the

formation of Rs_1 and Rs_2 . This species may eventually be discovered to be part of a stem group to modern Micropterigidae, as is likely the case for genera such as *Undopterix*, *Auliepterix*, *Daiopterix*, and *Gracilepterix*. Given the age of our species and that definitive micropterigids are already known from the Eocene of Europe (e.g., SKALSKI 1990, 1995) as well as the Early Cretaceous (WHALLEY 1978; COCKERELL 1919), placement basal to Micropterigoidea would appear unlikely.

Geological Setting

The Fur Formation comprises approximately 60 meters of porous diatomites and tephra layers (ca. 180 layers in total) in the northern Jutland of Denmark (LARSSON 1975; PEDERSON & SURLYK 1983). The Fur Formation and the underlying Ølst Formation (those sediments below ash layer -33/-34) constitute the "Mo-clay" (PEDERSON & SURLYK 1983; HEILMANN-CLAUSEN et al. 1985). The depositional environment was the North Sea precursor and was largely inland, although it was at times briefly open to the Atlantic (HEILMANN-CLAUSEN et al. 1985; BONDE 1997). The Paleocene-Eocene boundary (ca. 55.8 Ma) is near the base of the Ølst Formation (SCHMITZ et al. 2004). The insects largely originate from layers dating around 54 Ma, or Early Ypresian (KNOX 1997), and have been documented from as long ago as the end of the 18th century (RUST 1999). Although a remarkable abundance and diversity of specimens have been recovered, representing at least 14 insect orders, they remain largely understudied (LARSSON 1975; RUST 1999).

Material and Methods

A single specimen of a nearly complete forewing (Fig. 1) was collected by Mr. Johannes KALBE from the Mo-clay. The specimen was at times studied under a small level of distilled water or ethanol added to the fossil surface in order to improve contrast between the veins and the surrounding matrix. Photomicrography was undertaken using a Nikon D1x digital camera attached to an Infinity[®] K2 long-distance microscopic lens. Measurement of the wing was made using an ocular micrometer on an Olympus SZX12 stereomicroscope.

Systematic Paleontology

Moleropterix gen.nov.

Type species: *Moleropterix kalbei* nov.sp.

D i a g n o s i s : Forewing oval, apex rounded (similar to some *Paramartyria* and other micropterigids), not narrow lanceolate (narrow lanceolate is the typical condition of most micropterigids) (Figs 1-2), more than twice as long as wide, faint evidence of at least two pale patches present (Fig. 1); first extending from just apical of divergence of Rs_1 and Rs_2 , broadening posteriorly to encompass fork of Rs_3 and Rs_4 , base of M_1 , and ending at M_3 ; second patch slightly smaller and proximad first patch (there may also be a third

small patch apical to the larger patch but it is exceedingly faintly indicated and may be an artifact); Sc forked, stem Sc_{1+2} long, preserved portion at least as long as Sc_2 (Fig. 2); sc-r present, faint and oblique, originating near midpoint of Sc_2 and terminating on R_{1+2} before fork; R forked, stem R_{1+2} long, slightly more than twice length of R_2 (Fig. 2); Rs first forking in apical portion of median cell, at least apical quarter and approximately opposite M_2 - M_3 fork, with all branches terminating on costa, Rs_4 terminating only slightly before wing apex; Rs_{1+2} and Rs_{3+4} short, latter slightly longer than former; rs-rs crossvein (i.e., inter-Rs crossvein) not evident (this vein is typically very faint in modern species and given that, if present, it would be positioned within the larger of the pale patches it may simply be impossible to discern; as such, it should not be considered definitively absent); M with three branches (Fig. 2); m-cua not evident; CuA forked, CuA_1 and CuA_2 faint, short; CuP simple and faint; anal loop evident, faint.

Etymology: The new generic name is a combination of Moler, the term for the form of diatomite particular to northern Denmark, and the suffix -pterix commonly used for primitive moth genera (a form of pteryx, meaning "wing"). The name is feminine.

Comments: This fossil apparently intermingles traits of the *Micropterix* and *Sabatinca* groups of micropterigid genera. While R in the forewing is forked, as in the *Sabatinca* group, Rs_4 terminates on the costa instead of slightly posterior to the wing apex, like those species of the *Micropterix* group.

***Moleropterix kalbei* nov.sp. (Figs 1-2)**

H o l o t y p e : Forewing (Fig. 1), KU-NHM-ENT FFD-002, Denmark: Stolleklint, Insel Fur, J. Kalbe, 20 November 1990; Fur (Moler) Formation, Early Eocene (Ypresian). The holotype is deposited in the Fossil Insect Collection, Division of Entomology, University of Kansas Natural History Museum, Lawrence, Kansas.

D i a g n o s i s : As for the genus (vide supra).

D e s c r i p t i o n : The generic diagnosis characterizes both the genus and the species (ICZN, 1999: Art. 13.4) to which we add the following additional metrics: Preserved length 6.2 mm (total length likely about 7-7.5 mm), maximum width 3.0 mm.

E t y m o l o g y : The specific epithet is a patronymic honoring Mr. Johannes KALBE, collector of the holotype and who kindly permitted its deposition in the Fossil Insect Collection of the University of Kansas Natural History Museum.

Acknowledgements

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Zusammenfassung

Eine fossile eozäne Micropterigiden-Art, *Moleropterix kalbei* nov.gen. et nov.sp. (Zeugloptera: Micropterigoidea), gefunden in Dänemark, wurde nach einem gut erhaltenen Vorderflügel beschrieben und abgebildet.

Literature

- BONDE N. (1997): A distinctive fish fauna in the basal ash-series of the Fur/Ølst Formation (U. Paleocene, Denmark). — In: THOMSEN E. & S.A.S. PEDERSEN (eds), *Geology and Palaeontology of the Mo-clay*. Aarhus Geoscience 6, Aarhus Universitet, Aarhus, Denmark: 33-48.
- COCKERELL T.D.A. (1919): Two interesting insects in Burmese amber. — *Entomol.* **52**: 193-195.
- GRIMALDI D. & M.S. ENGEL (2005): *Evolution of the Insects*. — Cambridge University Press, Cambridge, XV+755 pp.
- HEILMANN-CLAUSEN C., NIELSEN O.B. & F. GERSNER (1985): Lithostratigraphy and depositional environments in the upper Paleocene and Eocene of Denmark. — *Bull. Geol. Soc. Denmark* **33**: 287-323.
- ICZN (1999): *International Code of Zoological Nomenclature*. — International Trust for Zoological Nomenclature, London, XXIX+306 pp.
- KNOX R.W.O. (1997): The late Paleocene to early Eocene ash layers of the Danish Mo-clay (Fur Formation). Stratigraphic and tectonic significance. — In: THOMSEN E. & S.A.S. PEDERSEN (eds), *Geology and Palaeontology of the Mo-clay*. Aarhus Geoscience 6, Aarhus Universitet, Aarhus, Denmark: 7-11.
- KRISTENSEN N.P. & A.W. SKALSKI 1999. Phylogeny and palaeontology. — In: KRISTENSEN N.P. (ed.), *Lepidoptera, Moths and Butterflies: Volume 1: Evolution, Systematics, and Biogeography*. *Handbuch der Zoologie* [Band IV: Arthropoda: Insecta, Teilband 35], Walter de Gruyter, Berlin: 7-25.
- LARSSON S.G. (1975): Palaeobiology and mode of burial of the insects of the Lower Eocene Mo-Clay of Denmark. — *Bull. Geol. Soc. Denmark* **24**: 193-209.
- PEDERSEN G.K. & F. SURLYK (1983): The Fur-Formation, a late Paleocene ash-bearing diatomite from northern Denmark. — *Bull. Geol. Soc. Denmark* **32**: 43-65.
- RUST J. (1999): Fossil insects from the Fur and Ølst Formations ("mo-clay") of Denmark (upper Paleocene/lowermost Eocene). — In: VRŠANSKÝ P. (ed.), *Proceedings of the First Palaeoentomological Conference, Moscow 1998*. AMBA Projects International, Bratislava: 135-139.
- SCHMITZ B., PEUCKER-EHRENBRINK B., HEILMANN-CLAUSEN C., ÅBERG G., ASARO F. & C.-T. LEE (2004): Basaltic explosive volcanism, but no comet impact, at the Paleocene-Eocene boundary: High-resolution chemical and isotopic records from Egypt, Spain and Denmark. — *Earth Planet. Sci. Lett.* **225**: 1-17.
- SKALSKI A.W. (1990): An annotated review of fossil records of lower Lepidoptera. — *Bull. Sugadaira Montane Res. Center, Univ. Tsukuba* **11**: 125-128.
- SKALSKI A.W. (1995): Study on the Lepidoptera from fossil resins. Part XI. *Baltimartyria*, a new genus for *Micropteryx proavittella* REBEL, 1936, with redescription of this species (Lepidoptera, Zeugloptera, Micropterigidae). — *Amber & Fossils* **1**: 26-37.
- WHALLEY P.E.S. (1978): New taxa of fossil and recent Micropterigidae with a discussion of their evolution and a comment on the evolution of Lepidoptera (Insecta). — *Ann. Transvaal Mus.* **31** (8): 71-86.

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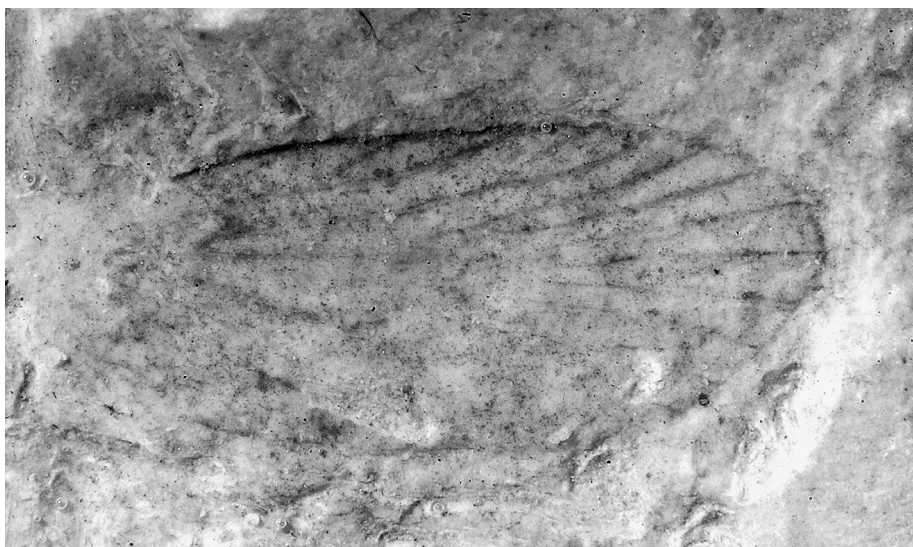


Fig. 1: Photomicrograph of of holotype forewing of *Moleropterix kalbei* nov.gen. et sp. (KU-NHM-ENT FFD-002).

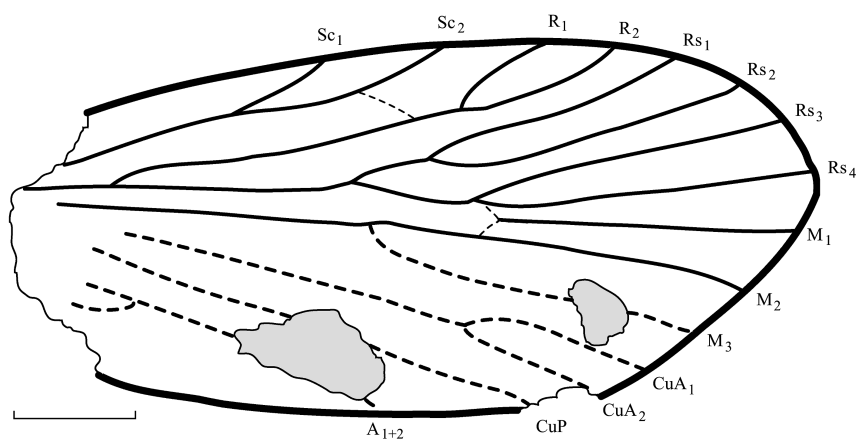


Fig. 2: Line drawing of holotype forewing of *Moleropterix kalbei* nov.gen. et sp. (KU-NHM-ENT FFD-002). Dashed lines indicate those veins present but very faintly preserved and difficult to see in the specimen; marginal setae and patterning of wing (there are at least two pale patches, the larger is medially on the wing surrounding the forking of Rs_{3-4} , the origin of M_1 , and surrounding areas: vide Fig. 1) omitted. Scale bar = 1 mm.

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