



The first fossil hilarimorphid fly (Diptera: Brachycera)



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ABSTRACT

Although recent molecular phylogenetic analyses suggest a great antiquity, going into the Jurassic, for the small modern fly family Hilarimorphidae, no fossil was attributed to this group. The first fossil hilarimorphid *Cretahilarimorpha lebanensis* gen. et sp. nov., is described, based on a specimen from the Lower Cretaceous Lebanese amber. Its external morphology is analysed and compared with that of *Hilarimorpha*, unique modern hilarimorphid genus. The differences concern the wing venation, antenna and especially mouthparts. *Cretahilarimorpha* has very elongate mouthparts, adapted for nectar feeding or (less probably) for predation on other insects. Several other Lower Cretaceous lineages have developed similar elongate mouthparts, viz. nemestrinid and xylomyiid flies, and the Mecoptera: Aneuretopsychina, probably adapted to still unknown deep nectar-producing flowers. A checklist of species belonging to the Hilarimorphidae is given.

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1. Introduction

The Hilarimorphidae Hendel and Beier, 1937 is a small family of flies that comprises only the modern genus *Hilarimorpha* Schiner, 1860 (Table 1). The systematic position of the Hilarimorphidae is controversial, Yeates (1994) considered them as sister group of the Bombyliidae, but the same author (2002) placed them (including *Apystomyia* Melander, 1950, a genus later transferred in its own family Apystomyiidae, see Nagatomi and Liu, 1994), as the sister group of the Eremoneura. Trautwein et al. (2010) considered *Apystomyia* to be the sister group to the Cyclorrhapha based on molecular evidence. Wiegmann et al. (2011) proposed a sister-group relationship of *Apystomyia* to the Cyclorrhapha, and separated this genus from the Hilarimorphidae, which they placed as sister group of the Acroceridae. However, Sinclair et al. (2013) placed *Apystomyia* by itself as the sister group to the Eremoneura. Lastly Lambkin et al. (2013) did not place formally the Hilarimorphidae in their proposal of phylogeny of the infraorders and superfamilies of Diptera, even if they discussed on the potential synapomorphies of this family with the other clades. No fossil is currently known in the Hilarimorphidae. The Albian–Turonian genus *Hilarimorphites* Grimaldi and Cumming, 1999, originally considered as a Hilarimorphidae (Grimaldi and Cumming, 1999), was later transferred into the Apystomyiidae (Grimaldi et al., 2011). The Eocene Baltic

amber genus *Palaeohilarimorpha* Meunier, 1902, originally considered as related to the modern *Hilarimorpha*, was transferred into the Rhagionidae (and even in the genus *Rhagio*) by Hennig (1967).

The discovery of a fly clearly related to the Hilarimorphidae in the Lower Cretaceous amber of Lebanon is of great interest for our knowledge of the age of this family. Wiegmann et al. (2011) dated the sister families Hilarimorphidae and Acroceridae around 160 Myr old, in the Jurassic. A molecular analysis dated the Acroceridae from the Early Jurassic (Winterton et al., 2007), while two Middle–Upper Jurassic flies are currently attributed to the Acroceridae (Karatau in Kazakhstan, see Ussatchov, 1968; Narchuk, 1996).

We describe herein *Cretahilarimorpha lebanensis* gen. et sp. nov. as first fossil belonging to the Hilarimorphidae. A checklist of all species belonging to this family is given.

2. Material and methods

The specimen is preserved in a piece of relatively clear, yellow amber. The amber piece containing the inclusion was cut, shaped, and polished. Then it was prepared between two coverslips with a Canada balsam medium as described in Azar et al. (2003), before being examined and photographed. Fossil was examined and measured under incident light with Olympus SZX9 and Leitz Wetzlar binocular microscopes. We use the wing venation nomenclature and body structure terminology of Webb (1981). Abbreviations for wing venation are as follows: h humeral vein; Sc subcostal; R1, R2 + 3, R4, R5 branches of radius; r–m radial–median crossvein; M1 and M2 branches of media; bm–cu

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Table 1
Checklist of all species belonging to Hilarimorphidae.

Genus	Species	Author
<i>Hilarimorpha</i>	<i>obscura</i>	Bigot, 1887
	<i>orientalis</i>	Frey, 1954
	<i>pusilla</i>	Johnson, 1923
	<i>nigra</i>	Saigusa, 1973
	<i>singularis</i>	Schiner, 1860
	<i>tristis</i>	Egger, 1860
	<i>ussuriensis</i>	Makarkin, 1992
	<i>abuta</i>	Webb, 1974
	<i>bumulla</i>	Webb, 1974
	<i>californica</i>	Webb, 1974
	<i>clavata</i>	Webb, 1974
	<i>singularis</i>	Webb, 1974
	<i>tempa</i>	Webb, 1974
	<i>cunata</i>	Webb, 1974
	<i>desta</i>	Webb, 1974
	<i>kena</i>	Webb, 1974
	<i>lamara</i>	Webb, 1974
	<i>lantha</i>	Webb, 1974
	<i>loisae</i>	Webb, 1974
	<i>stena</i>	Webb, 1974
	<i>mandana</i>	Webb, 1974
	<i>mentata</i>	Webb, 1974
	<i>modesta</i>	Webb, 1974
	<i>parva</i>	Webb, 1974
	<i>pitans</i>	Webb, 1974
	<i>punata</i>	Webb, 1974
	<i>reparta</i>	Webb, 1974
	<i>robertsoni</i>	Webb, 1974
	<i>sidora</i>	Webb, 1974
	<i>ditissa</i>	Webb, 1975
	<i>rivara</i>	Webb, 1975
	<i>mikii</i>	Williston, 1888
	<i>orientalis</i>	Engel and Frey, 1954
<i>Cretahilarimorpha</i> †	<i>lebanensis</i>	Myskowiak, Azar et Nel (this work)

basal medio-cubital crossvein CuA1 and CuA2 branches of cubitus; A1 first anal vein.

3. Systematic palaeontology

Order Diptera Linnaeus, 1758

Family Hilarimorphidae Hendel and Beier, 1937

Type genus. *Hilarimorpha* Schiner, 1860, other genus. *Cretahilarimorpha* gen. nov.

Genus *Cretahilarimorpha* gen. nov.

3.1. Type species

C. lebanensis sp. nov., here designated

3.2. Etymology

Named after the Cretaceous period and the genus name *Hilarimorpha*; it is feminine in gender, like the base name.

3.3. Diagnosis

Adult male characters. Seven flagellomeres and no apical style; elongation of two-segmented palpi, labium, hypopharynx, and labrum; broad emargination of inner eye margin at and below level of antennae; costal vein ending distal of vein R4 + 5; R2 + 3 ending on C close to apex of R1; part of R4 + 5 basal of r-m longer than basal stem of Rs; part of M between r-m and bm-cu very long and angular; discal medial cell absent; crossvein dm-cu absent; vein M3 absent; CuA2 and A1 not touching; cell cup very long, ending distal to apex of cell bm; a short peg on anterior face of hind coxa; empodium rudimentary; gonocoxites ventrally fused.

C. lebanensis sp. nov. (Figs. 1–3)

3.4. Etymology

Named after Lebanon.

4. Material

Holotype specimen number HAM-1614 D (male, with a small Hymenoptera: Chalcidoidea above it), coll. Dany Azar, stored at the Natural History Museum of the Lebanese University, Faculty of Sciences II, Fanar, Lebanon.

4.1. Horizon and locality

Lower Cretaceous, ante-Bedoulian (late Barremian, lowermost Aptian), amber of Hammana-Mdeyrij, Caza (= District) Baabda, Mohafazat Jabal Loubnan (Governorate Mont Lebanon), central Lebanon.

4.2. Diagnosis

As for the genus (*vide supra*).

4.3. Description

Head suboval, 0.31 mm long and 0.44 mm wide; face and frons not tumid; antenna with scape and pedicel conical, large, with numerous strong setae on dorsal parts, seven flagellomeres, last one very long and acute without apical style but with a series of small setae; proboscis very long, i.e. labium very long, 0.64 mm long, with elongate labella, 0.1 mm long, both pilose, but without any tooth at apex, long stylate hypopharynx and laciniae visible inside labium, labrum very long, 0.53 mm long, slightly shorter than labium, palpi long but shorter than proboscis, two-segmented, and with palpal pits possibly present, visible as a small rounded bubble at apex of palpus; three ocelli disposed on a subtriangular pad prominent on vertex, with several short fine erect setae around them; eyes very large, 0.24 mm long and 0.34 mm wide, extensively holoptic, nearly contiguous from vertex to base of antenna, with facets divided into two regions, large facets dorsally and small ones ventrally; eye inner margin with a broad indentation below level of antennal bases.

Thorax 0.91 mm long and 0.52 mm wide, several short fine erect setae on dorsal surface; scutellum short and subtriangular; tergite and mediotergite not bare; prealar bristles not visible, probably absent.

Wings 2.21 mm long and 0.94 mm wide; wing membrane hyaline, covered with microtrichia, veins brown; anal angle invisible; C circumambient, broader along anterior margin up to wing apex and midway between apex of R5 and that of M1; Sc simple, reaching C well basal of crossvein r-m; R1 simple, ending in C slightly distal of middle of wing; Rs with three branches, R2 + 3 ending on C close to apex of R1, part of R4 + 5 basal of r-m long, 0.07 mm long, distal part of R4 + 5 before separation into R4 and R5 0.27 mm long, R4 short and straight, R5 slightly longer, ending not far of wing apex; part of M between r-m and bm-cu long and angular, 0.04 mm long; distal part of median stem before division into M1 and M2 0.14 mm, M1 and M2 very long, M1 being slightly longer than M2, M3 absent; crossvein dm-cu absent; CuA2 and A1 not touching, cell cup very long, ending distal to apex of cell bm.

Legs with femora slightly swollen in middle; fore and mid coxae adjacent, hind tibia with coxal-trochanteral articulation facing anteriorly (hind legs apparently held forward); tibiae long and slender (slightly shorter than respective femur); metatibia slightly bowed, as if to fit tightly against ventral surface of femur; presence on all legs of apical strong setae but weaker than normal spurs; hind coxal peg present; empodium rudimentary, not pulvilliform; pulvilli well visible rather large.

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