Discovery of a new genus of Leptophlebiidae: Leptophlebiinae (Ephemeroptera) in Cretaceous amber from New Jersey

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Abstract

Aureophlebia sinitshenkovae, a new genus and species of Leptophlebiidae (Leptophlebiinae) is described from a specimen collected in New Jersey amber. The species is based on a single female subimago in good condition.

Introduction

We recently received a specimen of the subfamily Leptophlebiinae in New Jersey amber from the Upper Cretaceous Turonian period dated at 92 Ma (Grimaldi *et al.*, 1997). The specimen is a female subimago which clearly belongs to this subfamily and thus represents the first incontestable record of the subfamily dating from this period. Many Cretaceous fossils once thought to belong to Leptophlebiidae were recently moved to Siphlonuridae with the transfer of the subfamily Mesonetinae by Kluge (1993). Others are known from incomplete nymphs (such as *Leptoneta calyptrata* Sinitshenkova, 1989 or Leptophlebiidae spp. of McCafferty, 1990) where familial placement may be inferred or contested (Kluge, 1993). Kluge (1994b) doubted the existence of Cretaceous Leptophlebiidae, although the present distribution of the family shows several lineages with Gondwanian patterns which would require at minimum a mid-Cretaceous origin (Hubbard and Savage, 1981; Peters, 1988; Towns and Peters, 1996; Peters, 1997).

Recently McCafferty (1997) described from Lebanese amber *Conovirilus poinari*, a new genus and species from the Lower Cretaceous (120-135 Ma), which he ascribed to Leptophlebiidae: Atalophlebiinae. While the photographs and illustrations provided by McCafferty (1997) appear to be leptophlebiid-like, assignment of this specimen to the family and subfamily remains questionable as no description of the wing venation and compound eye structure were given. If indeed the specimen is a true Atalophlebiinae, then it is not closely related to the *Atalophlebioides* lineage as stated by McCafferty (1997), but is similar to the *Terpides* lineage as defined by Savage (1986) and Peters (1997) based on the fused penes and similar claws.

The New Jersey specimen is positioned in the corner of a 3 mm slice of amber with other inclusions and consists of an intact head, much of the pro- and mesothorax with fore and middle legs, the right forewing, most of the left hind wing, a scrap of the left forewing and the exuviae of the abdominal sterna. The exuviae is stretched between the mesofurcasternum and abdominal segment 3, but is otherwise intact. Most of the metathorax and the entire abdomen are missing. If such a female subimago was a member of an extant family, it might be assigned to the nearest genus. Unfortunately, there is no extant genus into which we can place this specimen. We establish a new genus and new species confirming the Cretaceous existence of Leptophlebiinae.

Studies on fossils in amber, with particular reference to the Cretaceous of New Jersey, pp. 127-131
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AUREOPHLEBIA, NEW GENUS
Fig. 1a-f

Description: Female subimago. Eyes separated on meson of head by a distance 3-1/2 X width of an eye. Wings (fig. 1a-b): maximum width of forewings 1/3 to a little more than 1/3 maximum length; vein Rs of forewings forked 1/6 of distance from base to margin; vein MA forked about 2/5 distance from base to margin, fork asymmetrical; stem of MA straight; vein MP_2 attached at base to veins MP_1 and CuA with a crossvein, attachment of vein MP_2 to MP_1 1/5 of distance from base, base of vein MP_2 equidistant between veins MP_1 and CuA; vein ICu_1 attached to vein CuA; remainder of CuA area as in fig. 1a; crossveins numerous. Costal projection of hind wings rounded (fig. 1b), broadest about 1/3 distance from base; apex of wings missing. Visible characters of the mesothorax in fig. 1c-d; scutellum and left posterior portion of mesoscutum missing. Claws of a pair dissimilar, one apically acute, other obtuse (fig. 1c-d).

From exuviae: mesobasisternum broad and flat; lateral arms of mesofurcasternum narrowly separated (exuviae loosely detached from body and visible only from posterior aspect so that mesosternal characters may be distorted) (fig. 1e). Ninth sternum of ♀ deeply cleft apically; no evidence of extended ovipositor or egg guide on sternum 7, but posterior margin with large median opening (fig. 1f). Caudal filaments missing.

Type species: *Aureophlebia sinitshenkovae* new species

Etymology: aureo, L., golden; phlebos, Gr., vein; feminine.

Aureophlebia sinitshenkovae, new species

Description: Female subimago. Length: forewing 4.0 mm, hind wing 0.7 mm; body (estimate based on exuviae) 3.8-4.0 mm. Antennae as in fig. 1c. Lateral ocelli large, median ocellus small (fig. 1c). Legs as in fig. 1c-d; dark (blackish) wash visible on apical third of left fore and middle femora (fig. 1d), also a little darker at base of right fore tibia (fig. 1c). Male and female imagos, male subimago, and nymph unknown.

Type: Holotype: USA: New Jersey: Middlesex Co., Sayreville, White Oaks Pit. 1996. Coll. Derek Yoost. Specimen is deposited in the American Museum of Natural History, AMNH No. NJ-717.

Etymology: Species is named for Dr. N.D. Sinitshenova of the Russian Academy of Sciences, Moscow.

Discussion

Because the fossil is in a corner of the amber, the wing is rolled and there is no single flat view, but all aspects of the wing are visible and fig. 1a is a synthesis of these views. The hind wing is more difficult to see and errors in interpretation are possible.

Most definable characters of *Aureophlebia* are considered plesiomorphic within Leptophlebiidae, such as the deeply cleft ninth sternum, the lack of a costal projection on the hind wing and the deep forks of veins Rs and MP. We agree that the asymmetrical fork of MP where MP_2 attaches to MP_1 by an apparent crossvein is plesiomorphic (Kluge, 1994a). The plesiomorphic condition of the MA fork has been a subject of some discussion (Flowers and Domínguez, 1991; Kluge, 1994a). Rather than considering MA as having a symmetrical or an asymmetrical fork, it is necessary to recognize three basic conditions. The plesiomorphic condition is a slightly asymmetrical fork resulting from a sag in the stem of MA and positioning of crossveins. Thus, for genera where crossveins are rarely fixed in position, the degree of asymmetry

may vary. The plesiomorphic condition occurs in all subfamilies, for example extant *Leptophlebia* and *Paraleptophlebia* in the Leptophlebiinae, *Habrophlebia* in the Habrophlebiinae, *Castanophlebia* in the Atalophlebiinae (Peters, 1997), and in fossil *Leptophlebia* or *Paraleptophlebia* from the Eocene (Demoulin, 1965, 1968; Kluge, 1993). Derived conditions are 1) clearly symmetrical forks, or 2) asymmetrical forks with MA_1 straight, sometimes with fixed crossveins.

In *Aureophlebia* the stem of MA is straight and the connection of MA_2 is strongly asymmetrical; further, this fork is basal to mid wing – about 2/5 of the distance from the base, possibly deeper if what appears to be an incomplete crossvein (fig. 1a) is actually an extension of MA_2. Among extant Leptophlebiinae, a straight MA with strongly asymmetrical MA_2 condition occurs in *Habrophlebiodes* and related genera, and a deep fork is characteristic of some species of *Habrophlebiodes*. Whether the analysis is based on comparisons within Leptophlebiidae, with outgroups, or with fossil Ephemeroptera, the character is apomorphic. Other apomorphies of *Habrophlebiodes* (costal projection of hind wing) are not present.

Aureophlebia is placed in the subfamily Leptophlebiinae because of the wing synapomorphy with *Habrophlebiodes*. Although a similar MA fork is found in some Neotropical members of Atalophlebiinae, it is not in a basal position.

Peters (1988) discussed the present vicariant distribution of *Habrophlebiodes* which he suggested was associated with a distribution through Beringia via the Arcto-Tertiary forest that occurred during the Early Tertiary into the Pleistocene. Based on the discovery of *Aureophlebia*, certainly a *Habrophlebiodes*-like ancestor was available for such a northern distribution. The existence of *Aureophlebia* would indicate that the separation of the *Habrophlebiodes*-group from other Leptophlebiinae began before the end of the Cretaceous.

In Florida, extant *Habrophlebiodes* (*H. brunneipennis* Berner) live in marginal habitats (leaf litter, tree roots, and vegetation) – usually in slightly acidic, sand-bottomed streams draining forested areas (Berner and Pescador, 1988). It is possible that *Aureophlebia* occupied a similar habitat, but because the nymph is unknown, any comments on its biology are speculative.

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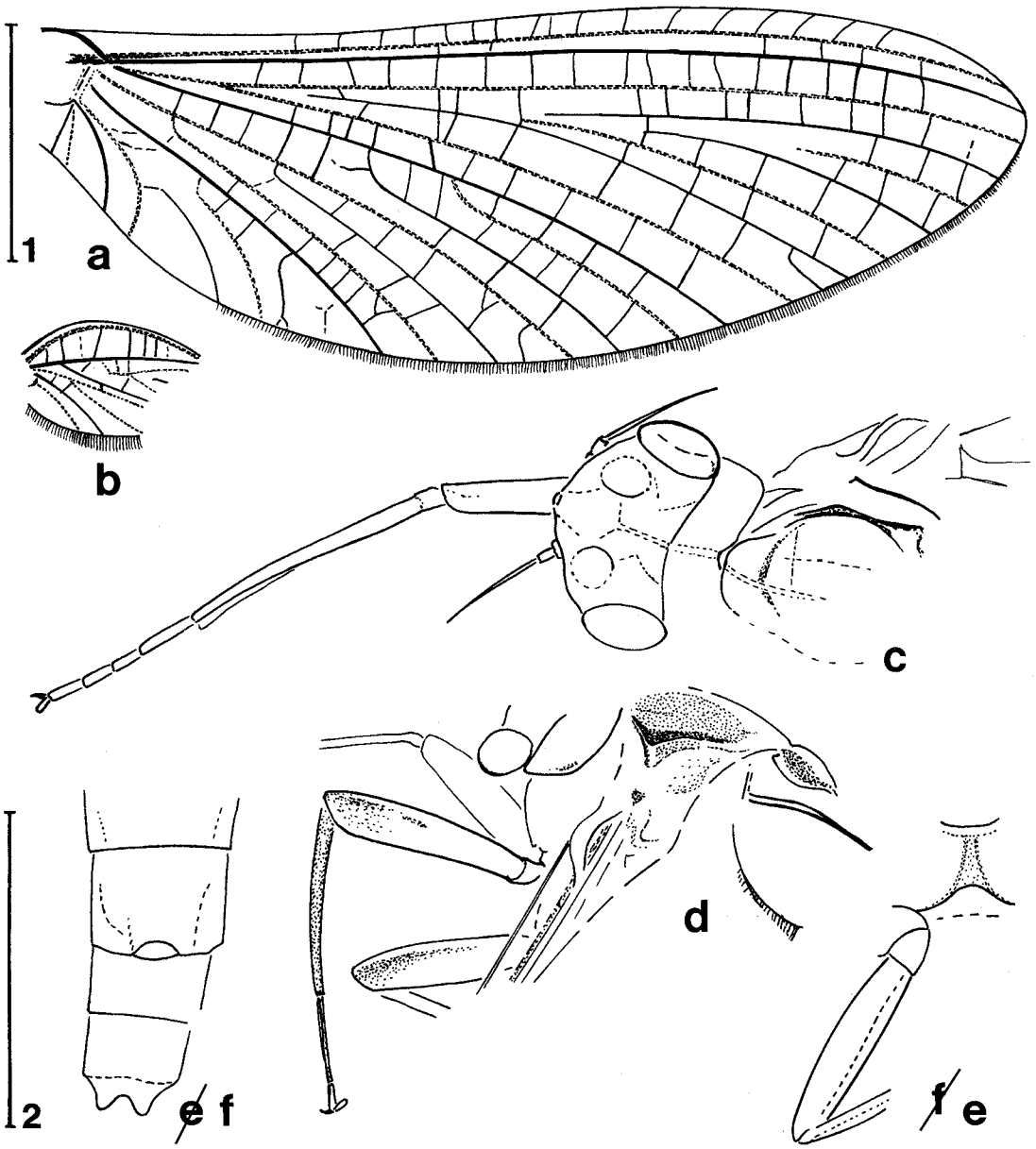

Fig. 1. Aureophlebia sinitshenkovae, n.gen., n.sp., holotype (AMNH NJ-717). **a-b.** Fore- and hind wing, dorsal surface (convex veins are solid, concave veins are stippled). **c.** Head, right portion of thorax and foreleg. **d.** Left aspect of thorax with legs. **e.** Portion of mesofurcasternum and hind leg. **f.** Abdominal sterna 7-9 drawn from exuviae. Scales = 1 mm: 1 = **a-b**, 2 = **c-f**.