

Reassessment of the taxonomic position of the fossil aphid family Canadaphididae based on two additional specimens of *Canadaphis carpenteri* (Hemiptera: Aphidinea)

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Abstract. Two additional specimens of *Canadaphis carpenteri* Essig are described from amber in a primary site in Alberta, about 78 million years old. The rostrum is longer than previously supposed, and as siphuncular pores apparently are present, the family Canadaphididae is placed tentatively in the superfamily Aphidoidea.

INTRODUCTION

Essig (1938) described the fossil aphid *Canadaphis carpenteri* from amber collected at Cedar Lake, Manitoba, Canada (holotype, No. 30, Royal Ontario Museum of Mineralogy, Toronto) (Fig. 1). It was placed in a new subfamily, Canadaphidinae, by Richards (1966). Heie (1981) raised this taxon to family status, Canadaphididae, in accordance with his classification of the recent aphid fauna (Heie, 1980). Together with Richards' Palaeoaphididae the Canadaphididae were placed in a new superfamily, Canadaphidoidea, which was regarded as the sister group of Aphidoidea, branched out from the common ancestral line before siphuncular pores were developed.

The second author found two additional specimens of this species in Cretaceous amber from Medicine Hat, Alberta, Canada, the same amber as that in which some previously described fossil aphids (Heie & Pike, 1992) were found. They belong to the Royal Tyrrell Museum of Paleontology, Drumheller, Alberta, and are described below. Unlike the holotype, the only specimen known until now, in which important parts of the body were not visible, the new specimens show ventral and dorsal structures, which invalidate the diagnosis of Canadaphidoidea and give a better indication for the systematical position of Canadaphididae in the superfamily Aphidoidea.

STRATIGRAPHY AND PALAEOECOLOGY

The amber in which these specimens are found was collected near the village of Grassy Lake, Alberta, Canada, from sediments of the Foremost Formation. Eberth & Hamblin (1993) indicate that these sediments are part of the Judith River Group. Ogunyomi & Hills (1977) place the Foremost Formation entirely within the Campanian which has been dated at between 82 and 70–71 million years ago. Eberth & Hamblin (1993) also date the upper third of the Judith River Group at 74.8 million years, and indicate that the Foremost Formation is older. Since the amber is associated with coals in the upper third of the Foremost Formation, an age of 78–79 million years is a reasonable estimate.

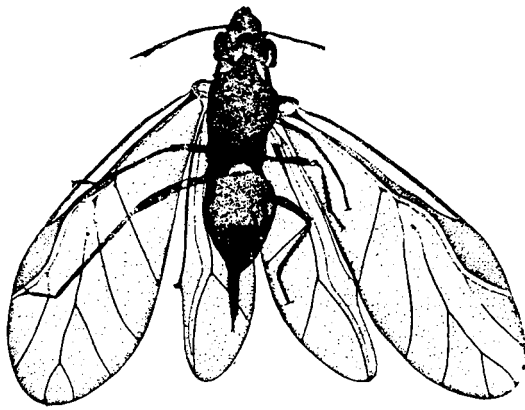


Fig. 1. *Canadaphis carpenteri* Essig. Holotype. (After Essig, 1938, drawn by V. McPheter).

The abundance of nematocerous Diptera with aquatic larval stages also supports this contention. Unopened spore sacs indicate no transport of materials has occurred. Consequently, a deltaic lagoon environment, similar to that of the Mississippi delta, is perhaps the most appropriate palaeoecological interpretation of the current data.

Sediments at the study site are flat-bedded sandstones and shales indicating a quiet, low energy depositional environment. Ogunyomi & Hills (1977) interpret the Foremost Formation as transitional between the underlying marine Pakowi Formation and the younger, non-marine Oldman Formation. It is interpreted as a series of 5 cycles consisting of offshore, barrier island, lagoon/salt marsh and freshwater marsh environments. Coals are interpreted as part of the lagoon phase. Palynological preparations from the shales and coal seam contain no marine Foraminifera, supporting a freshwater deposition.

Canadaphis carpenteri Essig, 1938

DESCRIPTION OF THE MATERIAL (ALL MEASUREMENTS IN MM)

Specimen RTMP#91.148.15 (Figs 2–8)

The amber piece contains 4 aphids. The specimen described below is the only alate specimen in the piece. Some details can only be studied at low magnification (objective 10×) though the amber has been polished into a thin disk.

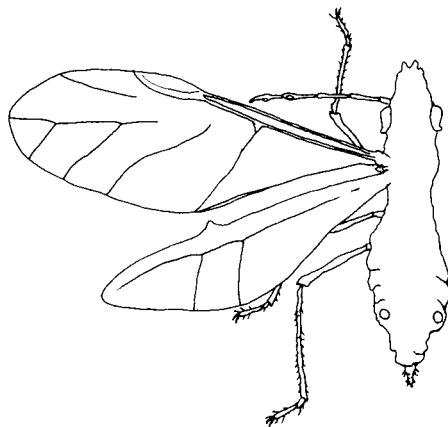


Fig. 2. Reconstruction of *Canadaphis carpenteri*, dorsal view.

Body 0.90 long (Figs 2 and 3); lengths: head 0.20 (Fig. 5), thorax 0.31, abdomen 0.39; length of abdomen 0.43 × body, narrow part alone 0.16. Width of head across eyes 0.17; width of thorax about 0.18; maximum width of abdomen about 0.18, of posterior narrow part about 0.04. Thoracic segments oblique, fore legs situated on level with fore wings, middle legs on level with hind wings. The basal 0.09 of the narrow part of abdomen covered by part of the broad part on dorsum.

Frons prolonged, with 2 prominent, short processes, their length 0.01, more laterally frons with 2 lower and broader processes. Eyes large, with numerous ommatidia, partly

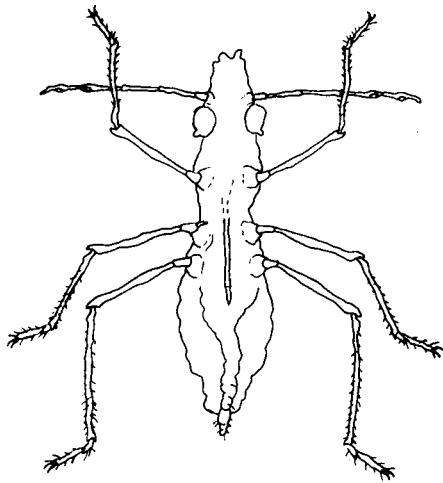


Fig. 3. Reconstruction of *Canadaphis carpenteri*, ventral view.

turned downwards; longitudinal diameter 0.10; not on sockets; large ocular tubercle placed behind the eye, longitudinal diameter about 0.02. Distance from fore edge of eye to fore edge of frons 0.10. Distance from fore edge of eye to antennal base 0.01. Distance between antennal bases about 0.08. Antenna 0.33, 0.36 times as long as body, 6-segmented (segment I not visible), placed on underside of head; surface imbricate; lengths of segments: I?, II at least 0.02, III 0.08, IV 0.05, V between 0.06 and 0.07, VI 0.09. Processus terminalis 0.04, basal part of ultimate segment 0.05, processus terminalis $0.7 \times$ basal part of ultimate segment. Widths of segments III and IV between 0.01 and 0.02, V and basal part of VI narrower than 0.01 at base, VI broader distally, width of processus terminalis nearly 0.01. Primary rhinaria very large, rounded, diameters between 0.01 and 0.02, not ciliate; accessory rhinaria on ultimate segment and secondary rhinaria not visible. Rostrum thin, perhaps shrunk, reaching to the middle part of abdomen; apparently arising from the underside of the head far behind the vertex, almost from the middle part of the body; apex bent (so that details are invisible) (Fig. 7); with hairs shorter than 0.01. Legs rather long and thin; lengths: fore femur 0.21, hind femur 0.27, fore tibia 0.24, middle tibia 0.23, hind tibia 0.33, middle tarsus 0.06, hind tarsus 0.12, segment II of hind tarsus 0.10; widths in the middle: fore femur about 0.01, middle femur 0.02, hind femur

0.02, fore tibia 0.01, middle tibia 0.01, hind tibia 0.01. Tibial hairs shorter than diameter of tibia; tarsi thin, especially the proximal parts (Fig. 6). Tibiae with 0.01 long "heels". Dorso-apical hairs on segment II of hind tarsus between 0.01 and 0.02. Claws pointed, 0.03 long. Fore wing 1.06 long, maximum width 0.43; radial sector nearly straight, leaving the middle of pterostigma, its basal part invisible; media with two forks; cubitus-branches leaving at two points on the main vein, 0.07–0.10 apart (Figs 2 and 4). Hind wing 0.78 long, maximum width 0.23, with two almost parallel oblique veins. Fore wing $1.18 \times$ body length, $1.36 \times$ hind wing. Abdomen apparently shrunk, with tuberculate surface and pigmented irregularly. Siphuncular pores apparently present; two pale spots visible on margins of the posterior segment of

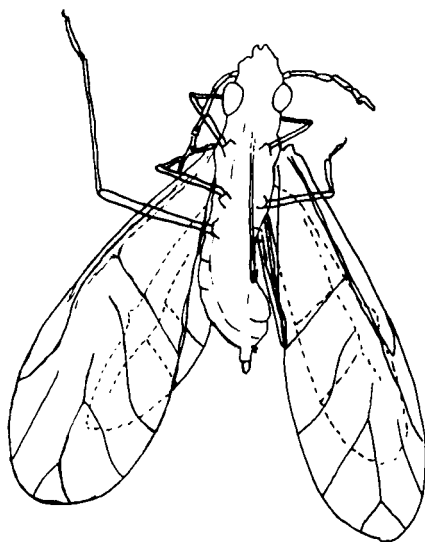
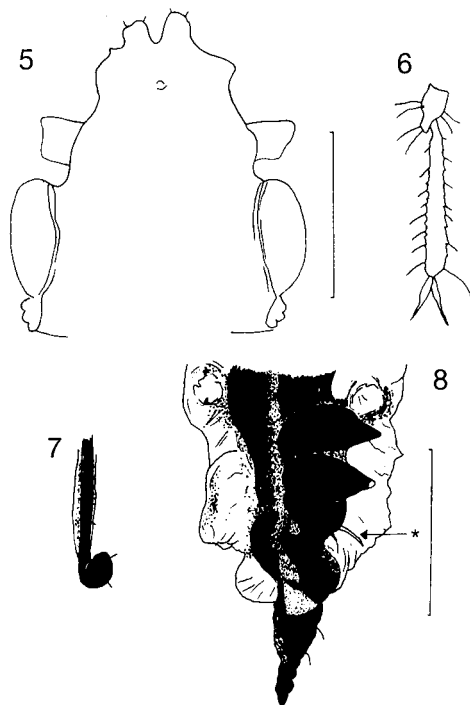


Fig. 4. Specimen RTMP#91.148.15, ventral view.



Figs 5–8. Specimen RTMP#91.148.15. 5 – head; 6 – tarsus; 7 – apex of apical segment of rostrum; 8 – posterior part of abdomen in ventral view (* – thorn-like structure, with some doubt interpreted as the apex of an ovipositor), with siphuncular pores, irregular pigmentation and tubercular structures, supposed to be caused by shrinking of body segments. (Scales 0.1 mm.)

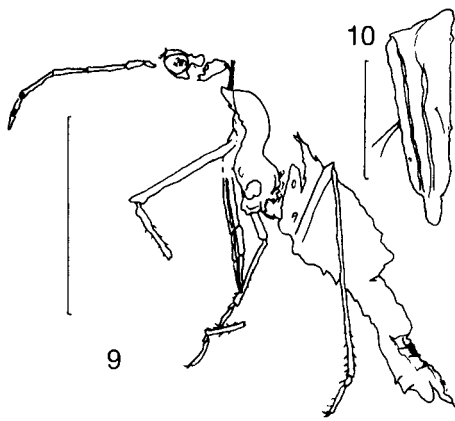
ommatidia; longitudinal diameter 0.07; not on sockets; ocular tubercle large. Antenna 0.51, 0.46 times as long as body, 6-segmented; lengths of segments: I ?, II 0.07, III 0.10, IV a little shorter, V and VI a little longer; processus terminalis between 0.04 and 0.05, 0.7 × basal part of ultimate segment, about 0.5 × segment III. Widths of segments: distal part of II a little longer than 0.02, basal part of II 0.01, III between 0.01 and 0.02, IV 0.01, V as wide as III 0.015, basal part of VI 0.02, processus terminalis at base just as thick as basal part of VI, elongated triangular, pointed. Primary rhinaria apparently rather small; accessory rhinaria on ultimate segment not visible. Two or three rounded secondary rhinaria apparently present on apical half of segment III (but they may be impurities in the amber). Processus terminalis with at least 2 apical and 3 subapical (probably more) fine hairs, the longest apical one 0.02 long. Hairs on segment II–V not visible. Rostrum reaching to middle part of abdomen. Length of segment III 0.08, apical segment (IV + V) 0.10 (IV 3 × V), 0.9 times as long as segment II of hind tarsus (Fig. 10). Basal width of segment III 0.04, of apical segment of rostrum between 0.03 and 0.04. Hair on III 0.01 long; apical segment with at least two accessory hairs, probably a few more. Legs rather thin; lengths: fore

the broad basal part of abdomen, diameter about 0.02. Posterior end of abdomen more slender than that anterior, pointed, with up to about 0.02 long hairs. A pointed, thorn-like structure, perhaps an ovipositor, visible under the narrow part of the abdomen, 0.12 from apex of abdomen, 0.016 long (Fig. 8).

Specimen RTMP#91.184.16 (Foremost Formation, Campanian, Grassy Lake, Alberta; Figs 9 and 10)

The body is lying in the amber with one side towards the surface. Parts of body and appendages have been lost.

Alate, but wings missing. Body distorted (Fig. 9), probably about 1.1 long; dorsal length of head about 0.16, thorax about 0.39, abdomen about 0.54, slender; length of abdomen 0.5 × length of body. Segmentation of body rather distinctly visible. Head and thoracic segments with oblique borders in lateral view, reaching far to the rear on underside of body. Abdominal dorsum apparently with dark, narrow cross bands. Ventral cuticle granulate. Dorsal hairs very short. Hind edges of abdominal segments partly covering the anterior margins of the following segments, both on dorsum and venter. Head rather flat, frontal part missing. Eyes large, partly turned downwards, with many



Figs 9–10. Specimen RTMP#91.184.16. 9 – body in lateral view; 10 – apical segment of rostrum. (Scales 0.5 mm for 9, 0.005 mm for 10.)

femur 0.28, hind tarsus (without claws) 0.12, segment II of hind tarsus 0.11. Tibiae with prolonged “heels”. Length of tibial hairs up to about 0.03. Number of ventral hairs on segment I of middle tarsus and hind tarsus about 5. Dorso-apical hairs on segment II of tarsi fine, on middle tarsus and hind tarsus 0.02 long. Claws long, nearly straight. Siphuncular pores indistinctly visible. Posterior end of abdomen slender as in the holotype. Abdomen consisting of three parts: (1) a broad and high basal part of 3–4 segments, 0.19 long, 0.20 high, (2) a middle part of 3–4 segments, ending at the fore edge of the genital plate, 0.23 long, only 0.12 high, (3) a slender posterior part, probably consisting of 2–3 segments, about 0.12 long, 0.05 high in the middle. Below the thin posterior part a broad and rounded process present, probably the genital plate, with up to about 0.04 long hairs. Ovipositor not visible.

CONCLUSIONS

Specimen #91.148.15 is similar to the holotype of *C. carpenteri*. Some morphological details not visible in the previously known specimen of *C. carpenteri* change our opinion with regard to the diagnostic characters of the family, particularly the presence of a long rostrum and the apparent presence of siphuncular pores.

Wegierek (1993) described *C. kovalevi* from rock impressions found in Magadanski Krai, north-eastern Russia [holotype 3901/709(790) in the Institute of Palaeontology of the Russian Academy of Sciences, Moscow]. A long rostrum was also visible in this specimen.

The only differences between the two new specimens of *C. carpenteri* and the holotype are the shorter antennal segment III and the shorter processus terminalis, and the main difference between the two new specimens is the width of the rostrum. These differences may be due to intraspecific variation, or perhaps taphonomic changes after the death of the insects. The presence of a long rostrum in both specimens and in the holotype of *C. kovalevi* described by Wegierek (1993) and the apparent presence of siphuncular pores in specimen #91.148.15, perhaps also in specimen #91.148.16, show that *Canadaphis*, and consequently also the family Canadaphididae, is better placed within the Aphidoidea, the only systematic aphid group with siphunculi or siphuncular pores. Therefore, the Canadaphidoidea is here synonymised with Aphidoidea. Richards (1966) and Wegierek (1993) interpreted the posterior slender prolongation of the abdomen as a cauda, and it is probable that they were correct. Wegierek gives as an argument that the ovipositor of *C. kovalevi* lies at the basis of the strongly narrowed prolongation, while Heie (1981) interpreted a terminal structure as an ovipositor. Specimen #91.148.15 possesses a thorn-like structure, which, perhaps, is an ovipositor, at the basis of the prolongation, but the interpretation is

very uncertain. A similar process is not visible in specimen #91.148.16, though its body may be studied in a lateral view.

The classification of aphids given by Heie (1981) should be changed in such a way that the superfamily Aphidoidea, characterised by presence of siphuncular pores, consists of the recent families without an ovipositor and at least two Cretaceous and now extinct families with an ovipositor, viz. Oviparosiphidae and Canadaphididae.

The diagnosis of the latter family is: head at least occasionally extremely flat (as in *Salтусaphidini*); eyes partly turned downwards; antennae inserted on underside of head; thoracic sterna directed towards posterior part of body, fore legs situated on level with fore wings; fore wing with radial sector nearly straight, leaving middle of pterostigma; media normally with two forks; cubitus branches – at least normally – widely separated at their bases; hind wings relatively large; all generations probably oviparous.

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