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A new species of helicopsychid caddisfly (Insecta, Trichoptera) in Baltic amber, based on a male with remarkable androconial head organs

WILFRIED WICHARD & MADELINE V. PANKOWSKI

Abstract

A new helicopsychid caddisfly, *Palaeohelicopsyche marki* sp. nov., is described from Eocene Baltic amber. The extinct genus *Palaeohelicopsyche* is now represented by three species alongside the genus *Helicopsyche*, with five extinct species in Baltic amber. The male of the new species is notable for its androconial head organs in the form of paired eversible tubes, a feature rarely found in males of fossil helicopsychids and apparently unknown in extant species. The structure and function of these remarkable male organs are discussed.

Key words: Fossil Helicopsychidae, androconia, scent-organ, pheromones, mating, courtship, *Caloca*, *Hydroptila*, Eocene.

1. Introduction

A wide array of male insects have androconial organs that produce chemicals used to attract females in courtship. These organs are located on various parts of the body in different insects. However, it is quite rare to find a male helicopsychid species with androconial organs on the head. Besides the new extinct species, *Palaeohelicopsyche marki* sp. nov., few other fossil helicopsychid species with these extraordinary structures are known from Baltic amber. In recent helicopsychids, similar tubes appear to be unknown, though *Helicopsyche coreana* MEY, 1991 from North Korea was reported to have a “head with small ovoid tubercles and two paired, membranous appendages on the dorsal side,” which were later referred to as “dorsal branch of median postantennal warts” by JOHANSON (1998). No other fossil caddisflies with similar tubular structures are currently documented. In recent caddisflies such tubes are almost unknown; only in *Hydroptila* (Hydroptilidae) and in *Caloca* (Calocidae) are comparable structures present (MOSELY & KIMMINS 1953).

The description of the new extinct species is followed by a discussion of the tubular organs based on our present knowledge.

2. Material and methods

The Baltic amber piece with the embedded trichopteran inclusion was acquired by the second author from MARIUS VETA, an amber dealer in Lithuania, who acquired the specimen from an amber mine in Yantarny (Kalininograd Region, Russia). The age of this amber is now widely believed to be late Eocene. After careful grinding and polishing (with a Struers RotoPol-25 polishing machine)

from the dorsal side, the forewing of the caddisfly and its wing venation became largely visible despite the overlapping hind wing. A Leica M420 macroscope with 1:6 Apo zoom was used in combination with a Canon EOS R camera, EOS 3.0 utility software and Zerene Stacker software. The drawings and measurements were made with a Leica SApo stereomicroscope.

Abbreviations: The wing venation terminology: I = apical fork I, II = apical fork II, III = apical fork III, IV = apical fork IV, V = apical fork V, r-m = crossvein r-m, R = radius, M = media, Cu = Cubitus, Cu1 = cubitus anterior, Cu2 = cubitus posterior, Dc = discoidal cell.

Zoobank: LSID urn:lsid:zoobank.org:pub:C9435799-DD73-48B8-9498-6872152A227B (publication)

3. Systematic palaeontology

Order Trichoptera KIRBY, 1813

Suborder Integripalpia MARTYNOV, 1924

Infraorder Brevitentoria WEAVER, 1984

Superfamily Sericostomatoidea STEPHENS, 1836

Family Helicopsychidae ULMER, 1906

Genus *Palaeohelicopsyche* ULMER, 1912

Type species: *Palaeohelicopsyche serricornis* ULMER, 1912.

Diagnosis: Head without ocelli. Antennae about as long as forewings. Scape about 3–5x longer than the pedicel. Postantennal and cephalic setal warts well developed. Male with or without protruding membranous tubular organs dorsally on the head. Male maxillary palps 2-segmented; 5-segmented in females.

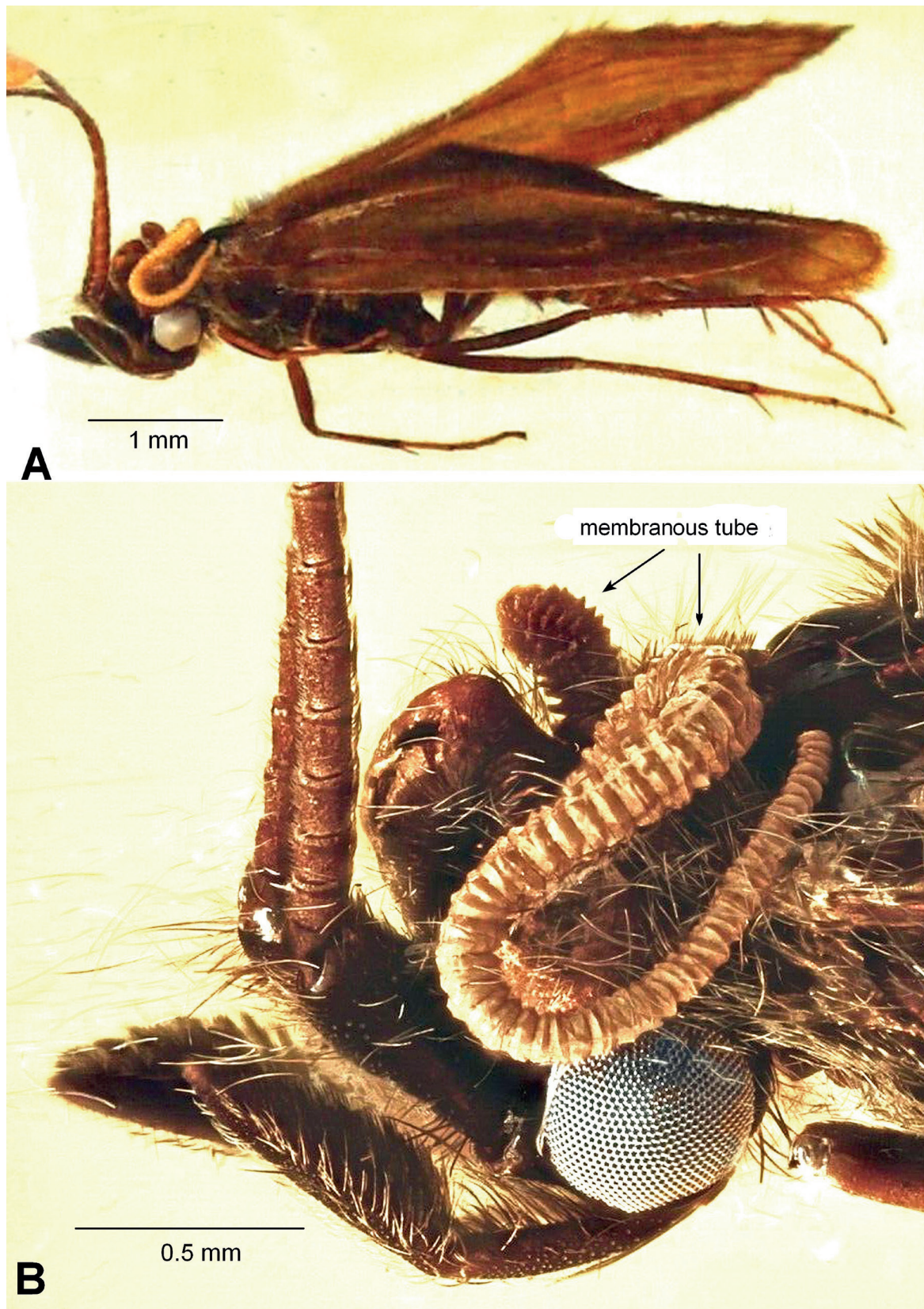


Fig. 1. *Palaeohelicopsyche marki* sp. nov., holotype ZFMK-TRI000840. **A** – Male in lateral view, **B** – Head with membranous tube.

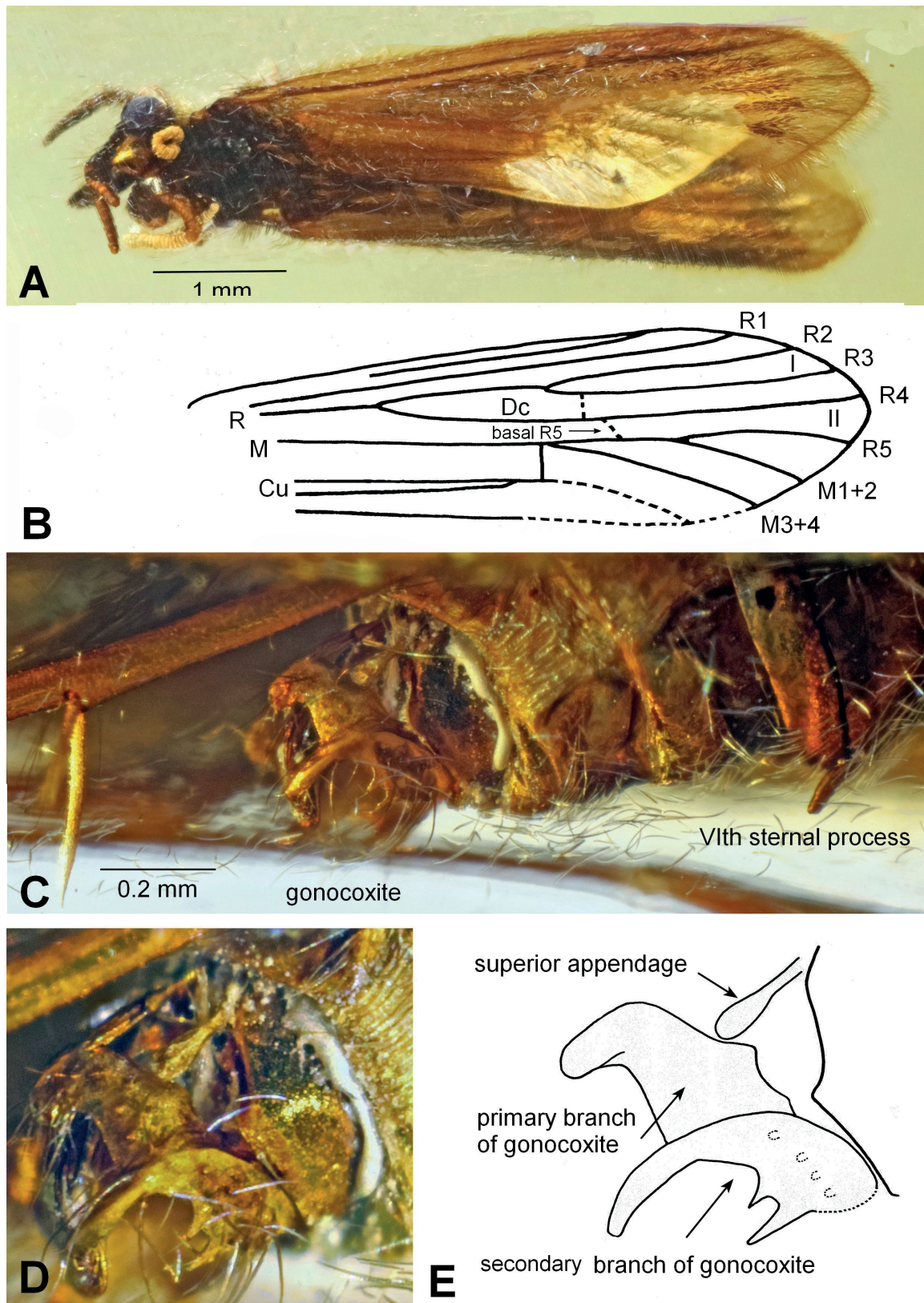


Fig. 2. *Palaeohelicopsyche marki* sp. nov., holotype ZFMK-TRI000840. **A** – Male in dorsal view, **B** – drawing of forewing venation, **C** – abdomen with gonocoxite and VI sternal process, **D** – genitalia with gonocoxite in ventrolateral view, **E** – drawing of gonocoxite.

Forewing with Dc about as long as 1/2 to 1/3 of the wing length. R2 and R3 form fork I. R4 and R5 form fork II, where R4 running straight to the wing margin and the base of R5 makes an abrupt turn to M and running – partially on M1+2 – straight ahead to the wing margin. Crossvein r-m absent. M branched consisting of M1+2 and M3+4, fork III and IV absent. Cul simple, runs very close to and parallel with Cu2. Fork V absent. Hind wings with forks I and V; Dc absent. In fore and hind wings nigma and thyridial cell absent.

Spurs 2, 2, 4. VIth sternal process truncate. Male gonocoxite with a large dorsal primary branch and a small ventral secondary branch.

Species included: *Palaeohelicopsyche serricornis* ULMER, 1912; *Palaeohelicopsyche grotae* JOHANSON & WICHARD, 1997 [*P. grotae* JOHANSON & WICHARD, 1997 was mistakenly synonymized with *Palaeohelicopsyche serricornis* ULMER, 1912 by WICHARD (2013). *P. grotae* is clearly distinguished in the forewing venation and the male inferior appendages.]

Palaeohelicopsyche marki sp. nov.

Figs. 1, 2

Zoobank: LSID urn:lsid:zoobank.org:act:486082E4-75BD-466F-93A5-2ED315EB9B17 (species)

Etymology: The new species is named after MARK A. PANKOWSKI, oldest brother of the second author, for inspiring her love of discovery in the natural world.

Holotype: Male, ZFMK-TRI000840, deposited in the amber collection of the Zoological Research Museum Alexander Koenig, Bonn, Germany. The male is well preserved, laterally clearly visible from both sides. The antennae are incomplete, maxillary palps and legs are present. The forewing venation is difficult to recognize from the dorsal side, as the hind wing partially overlaps the forewing and shines through. Inferior appendage (gonocoxites) of the male genitalia is visible in ventrolateral view. The female of the species is unknown.

Type locality: A Baltic amber mine in the Yantarny settlement, Kaliningrad Region, Russia.

Male diagnosis: Head with a pair of large cephalic tubercles, from each of which a contractile membranous tubular organ arises (Fig. 1B). Forewing length of 5 mm. The forewing venation (Fig. 2B) the discoidal cell closed, about as long as 1/3 of the wing length. The apical forks I and II of the forewings present. Fork I about as long as the bifurcation of M into the two branches M1+2 and M3+4. Fork II consisting of R4 and R5; the basal part of R5 abruptly turns to M and runs afterwards – fused partially with M1+2 – to the wing margin. M branched in M1+2 and M3+4; forks III and IV absent. Cul and Cu2 fused approximately in the middle of the forewing and running parallel to M to the wing margin, fork V absent.

In the male genitalia, the inferior appendages (gonocoxites) consist of the primary branch and the secondary branch (Fig. 2D, E). The primary branch of the gonocoxite is broad and flat basally, directed dorsally and bent posteriorly into a short, finger-shaped, rounded apex. The secondary branch is curved in ventrolateral view and tapers to a rounded apex; the inner margin of the secondary branch with two spines of unequal lengths. Abdomen with genitalia and VIth sternal process truncate (Fig. 2C).

Comparisons: *Palaeohelicopsyche marki* sp. nov. is distinguished from *P. serricornis* ULMER, 1912 and *P. grotae* JOHANSON & WICHARD, 1997 by the forewing venation and the different gonocoxites.

Description: *Head* with missing ocelli. Antennae filiform, scapus long and strong, pedicellus smaller than the following flagellomeres. Antennae approximately equal to the length of the forewings of ca. 5 mm. Head with a pair of large cephalic tubercles, from each of which a contractile membranous tubular organ arises. The two erect tubes are rolled up and reach a length of about 2 mm (Fig. 1B).

Forewing venation (Fig. 2B) with a discoidal cell (Dc) probably closed, about as 1/3 as long as the forewing and about as long as fork I consisting of R2 and R3. Fork II formed by R4 and R5, whereby the basal part of R5 turns to M – barely visible, partly fused with M1+2 and running straight to the wing margin. M branched in M1+2 and M3+4; forks III and IV absent. Cul and Cu2 fused, running parallel with M to the wing margin; fork V absent. Hind wing venation not visible.

Tibial spurs: 2/2/4.

Male genitalia (Fig. 2D, E) show in ventrolateral view the gonocoxite and the superior appendage somewhat club-shaped. The primary branch of the gonocoxite forms a broad, convex plate, dorsal margin rounded, little undulated with some long hairs. The secondary branch curved in ventrolateral view and tapering to a smaller rounded apex. Two spines of unequal lengths on the inner margins. The basomedian branch of the gonocoxite probably present, but not visible in ventrolateral view.

4. Discussion

Androconial organs are common in some male insects that use chemical communication and sex pheromones to help females more readily locate them or as male display in courtship. These organs are located on various parts of the body in different insects, including the wings, abdomen, antennae and other appendages, and occur in a variety of shapes, such as scales, scale fields, hairbrushes, hairfringes, hairpencils, and coremata. Females do not have androconia.

These structures, which are conspicuously associated in courtship, were first called “androconia” by SCUDDER (1877). At the same time, MÜLLER (1877) also discussed that such structures served to spread scents or pheromones to influence the behavior of females. It was obvious that a large number of variations of androconial organs characterize the courtship biology of Lepidoptera in particular. To this day, interest in the functioning of androconial organs in butterflies has not waned, with numerous papers documenting these structures (e.g., BOPPRÉ 1984; HALL & HARVEY 2002; BOPPRÉ et al. 2019; GNATZI et al. 2020; PAN et al. 2022).

In the Amphiesmenoptera, androconial organs occur not only in the order Lepidoptera, but also in the orders Tarachoptera and Trichoptera, albeit with a limited range of variation. Species of the extinct Tarachoptera have so

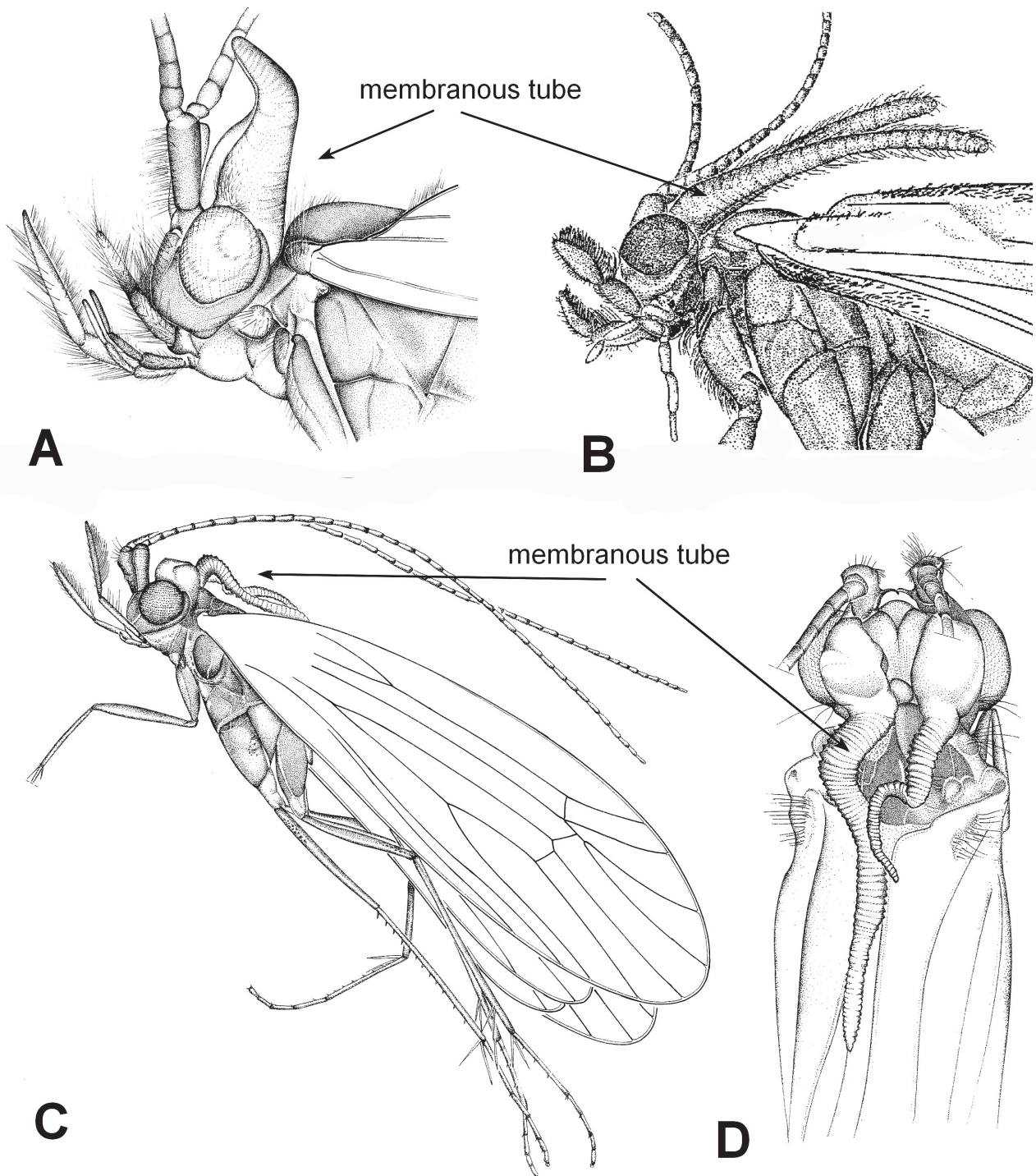


Fig. 3. Male extinct helicopsychid species with androconial head organs. **A** – *Helicopsyche cona*, **B** – *Helicopsyche damseni*, **C** – *Palaeohelicopsyche serricornis*, lateral, **D** – *Palaeohelicopsyche serricornis*, head dorsal.

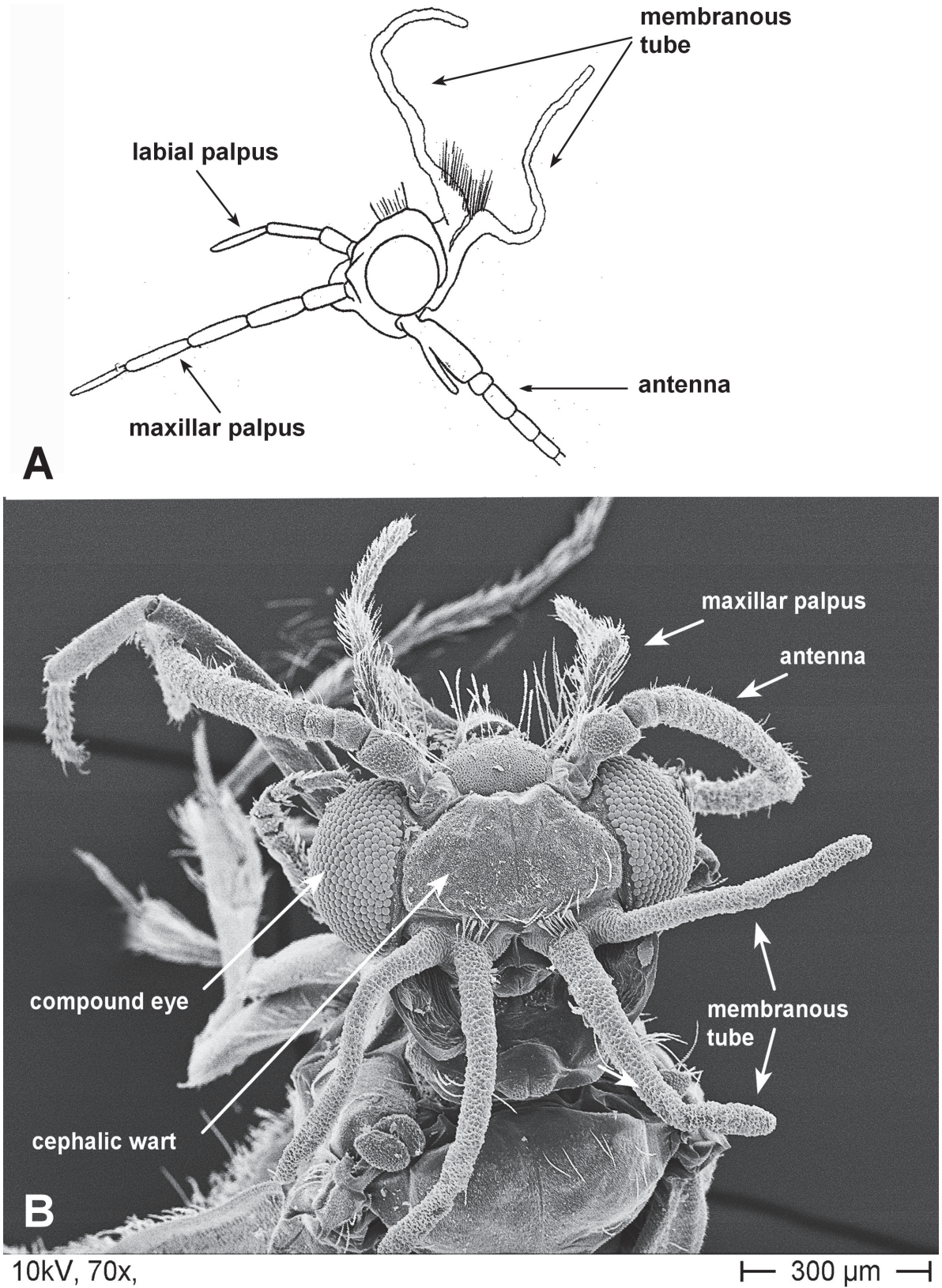


Fig. 4. **A** – *Caloca straminea*, head with androconial head organs (after MOSELY & KIMMINS 1953). **B** – *Hydroptila sparsa*, head with androconial head organs (after WICHARD 2013a).

far only been recorded in Burmese amber from the mid-Cretaceous (MEY & WICHARD 2023), with males of various species possessing androconial organs. In *Tarachocelis microlepidoptera*, for example, long and erect androconial scales are lined up on radial and medial veins of the fore and hind wings. In males of the genus *Retortocelis*, there are small pockets or folds containing specialised scales or androconial hair tufts on the costa of the forewings (WICHARD & MEY 2021).

In extant Trichoptera, the male androconial organs – if present – are also attached to different parts of the body. Many androconia are distributed species-specifically on the fore and/or hind wings or are located in pouches and folds, often on the wing margin at the costa. Androconial organs are also present on the head, antennae, maxillary palps, legs, abdomen and genitalia (e.g., MORETTI & BICCHIERAI 1979, 1981; MORETTI et al. 1979; BOTOSANEANU 1991; BOTOSANEANU & FLINT 1991; WARD & MCKENZIE 1998; ROBERTSON & HOLZENTHAL 2008).

Among the extinct Trichoptera found in Baltic amber from the Eocene, there are only a few species of Helicopsychidae whose males have two androconial organs on their heads. The androconia are tubular and arise dorsally from the paired, large and curved cephalic warts. The tubes are membranous, contractile and expandable, closed at the end. Previously (WICHARD 2013b), three extinct species were known to have exhibited these tubular, androconial head organs (Fig. 3): *Helicopsyche cona*, with a pair of cone-shaped androconia; *H. damseni*, with a pair of full everted filaments about 1.5 mm long; and *Palaeohelicopsyche serricornis*, with a pair of extendable head androconia reaching a length of up to about 2 mm, straight or furled. The new species *Palaeohelicopsyche marki* sp. nov. from Baltic amber described here represents another extinct helicopsychid species with tubular androconial head organs, which are curled (Fig. 1B) and also almost 2 mm long.

A search among extant Trichoptera, which also have androconial filaments on the head, leads to references by MOSELY & KIMMINS (1953). The male of *Caloca straminea* MOSELY, 1953 shows a pair of long tubular androconia (“scent-organs”) closed with silky hairs at their bases (Fig. 4A). Genus *Caloca*, distributed in Australia, belongs to the family Calocidae ROSS, 1967, which is narrowly related to the worldwide distributed family Helicopsychidae within the superfamily Sericostomatoidea (JOHANSON et al. 2017). MOSELY (1923) and MOSELY & KIMMINS (1953) reported that *Hydroptila* males also possess eversible filaments, numbering either two or four. SEREDSZUS & WICHARD (2006) collected caddisflies and some *Hydroptila sparsa* CURTIS, 1834 on the Rhine River near Cologne using light traps, which were dropped directly into water with a shot of dishwashing detergent. At 22 ♂♂, about half of all *H. sparsa* males had an unusually large number of

protruding head tubes, possibly caused by the tensides (WICHARD 2013a). Scanning electron micrographs of the tubes of *Hydroptila sparsa* males show a rough, enlarged surface (as also observed in helicopsychid androconia), which probably increases the evaporation of pheromones (Fig. 4B).

The filaments of *Caloca straminea* are probably extruded, whereas in *Hydroptila sparsa* males and in extinct Helicopsychidae males, they appear to be eversible, as demonstrated in WICHARD (2013a, 2013b).

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