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The philopotamid genus *Wormaldia* (Insecta, Trichoptera) embedded in mid-Cretaceous Burmese amber

Wilfried Wichard, Patrick Müller & Bo Wang

Abstract

This paper describes four new species of the genus *Wormaldia* (Philopotamidae): *W. transversa*, *W. cercilonga*, *W. cercifurcata*, and *W. squamosa*, all from Burmese amber. They belong to so-called micro-caddisflies, which, together with many other Philopotamidae, Psychomyiidae, and the Hydroptilidae, rarely exceed a wing length of ca. 3.5 mm. These micro-caddisflies obviously dominate the mid-Cretaceous Trichoptera fauna of Burmese amber.

Key words: Orientalis, amber, fossil caddisflies, micro-caddisflies, wing venation, male genitalia.

1. Introduction

The family Philopotamidae is distributed worldwide with over 800 extant species (Morse 2020). The highest number of species (about 300 species) is found in the Oriental region, where the oldest representatives of the philopotamid genus *Wormaldia* were found in the mid-Cretaceous Burmese amber (with an age of almost 100 Ma): *Wormaldia myanmari* Wichard & Poinar, 2005, *W. cretacea* Wichard & Wang, 2016, *W. resina* Wichard & Wang, 2016. Additional fossil *Wormaldia* species are known from the Late Cretaceous: *W. praecursor* Botosaneanu, 1995 from New Jersey amber (65–95 Ma) and *W. praemissa* Cockerell, 1916 from Tennessee (ca. 70 Ma).

The Eocene Baltic amber (ca. 40–50 Ma) is very rich in extinct caddisflies and the genus *Wormaldia*. Ulmer (1912) studied the Trichoptera of Baltic amber in general and described *W. aequalis* (Hagen, 1856), *W. congenera* Ulmer, 1912, and *W. media* Ulmer, 1912. Later, further fossil *Wormaldia* species were added: *W. advenaria* Mey, 1988, *W. angu*laria Mey, 1986, and *W. contigua* Mey, 1986 from Saxonian amber in Bitterfeld and new descriptions were provided by Ivanov & Melnitsky, 2005: *Wormaldia pheromonia*, *W. vlipla*, and *W. sukatshevae* and from the Rovno amber (Ukraine): *W. nasticentia* and *W. pobeda* (Melnitsky & Ivanov 2010, 2016).

Recently, additional fossil philopotamid caddisflies have been found in mid-Cretaceous Burmese amber, so that we can here describe four more species of the genus *Wormaldia*. Fossil ancestors of the philopotamid species-rich genera *Chimarra*, *Gunungiella*, *Kisaura* and *Dolophilodes* are still missing in Burmese amber.

2. Material and methods

The amber material was collected by local people in several districts of northern Myanmar, but most of the material comes from the amber mine located near Noije Bum Village, Myitkyina District, Kachin State (Kania et al. 2015). The age given by UPb dating of zircons from the volcanoclastic matrix of the amber is early Cenomanian (98.8 ± 0.6 million years) (Shi et al. 2012), but the geological age of Burmese amber should be slightly older than the zircon date.

The fossil specimens are embedded in small amber pieces cut from larger Burmese amber pieces. Many adult insects are nearly completely preserved and often visible in ventral and dorsal view. The male genitalia are flattened and often visible in ventral view only. The hind wings are partly covered by the somewhat distorted forewings. Some parts of insects are missing.

Photographs were taken using a Leica stereomicroscope M 420 Apozoom in combination with a Canon EOS 80D, EOS utility software and the Zerene Stacker software.

The wing venation terminology in general follows: I, II, III, IV, V = apical forks I, II, III, IV, V; DC = discoidal cell, MC = median cell, TC = thyridial cell, inf app = inferior appendage, sup app = superior appendage, harp = harpago (apical segment of an inferior appendage), and coxo = coxopodite (basal segment of an inferior appendage), IX = abdominal segment IX. The new species names refer to genital structures (harpago, cercus = superior appendage).

Institutional abbreviations: ZFMK – Zoological Research Museum Alexander Koenig, Bonn, Germany; NIGP – Nanjing Institute of Geology and Palaeontology, Nanjing, China.

3. Systematic palaeontology

Order Trichoptera Kirby, 1815

Suborder Annulipalpia Martynov, 1924

Family Philopotamidae Stephens, 1829

Genus *Wormaldia* McLachlan, 1865

Type species: *Hydropsyche occipitalis* Pictet, 1834; subsequent designation by Ross (1949).

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D i a g n o s i s (modified after Ross 1956, Muñoz-Quesada & Holzenthal 2008 and Oláh et al. 2019):

Adult: Ocelli present. Maxillary palps 5-segmented; segments 1 and 2 short, segment 2 rounded, with an apical or apicolateral brush of setae; segments 3 and 4 strong and longer, often segment 3 slightly longer than segment 4; segment 5 annulate and as long as segment 3 and 4 together or often significantly longer. Labial palps shorter than maxillary palps, 3-segmented, terminal segment longest and annulate. Mesoscutum never with a pair of warts, sometimes with scattered setae. Tibial spurs 2/4/4. Forewing venation complete; Rl unbranched; five apical forks I–V usually present in most extant species and in the extinct W. *myanmari* Wichard & Poinar, 2008 in Burmese amber, but fork IV absent in some extant species and most extinct species in Burmese amber; intercostal crossvein usually in mid costal region; discoidal cell present, median and thyridial cells often present. Hind wings shorter than forewings with forks I, II, III and V usually present, but fork I sometimes absent; discoidal cell present, median cell absent.

Male genitalia: Sterna VII and VIII with or without processes posteromesally; in the extinct W. *myanmari* in Burmese amber, sternum VII with a subtriangular posteromesal process. Inferior appendages each 2-segmented, usually long, the apical segment (harpago) unbranched, simple, often covered with apicolateral or apical setal patches. In ventral view the pair of inferior appendages spreads in a U- or V-shape. Superior appendages reach in their length approximately the height of the transition from the basal to the apical segments of inferior appendages or are shorter. Tergite X lobate, usually subtriangular or tongue shaped. Phallobase bearing dark sclerites.

In Burmese amber, the four new species of the genus *Wormaldia* show a high morphological similarity in size, shape, and wing venation (Fig. 1). In the fore- and hind wings, the wing venation is with M 3-branched (apical fork IV is missing), forks I, II, III and V present. Discoidal cell is present. In amber the longitudinal veins and especially the crossveins are not always clearly visible. The length of the forewings varies between 2.8 and 3.2 mm. Sternum VII and VIII without posteromesal processes.

Good diagnostic features are offered by the external male genital, although visibility in amber is quite limited. The genitalia are usually not completely visible but only from the ven-

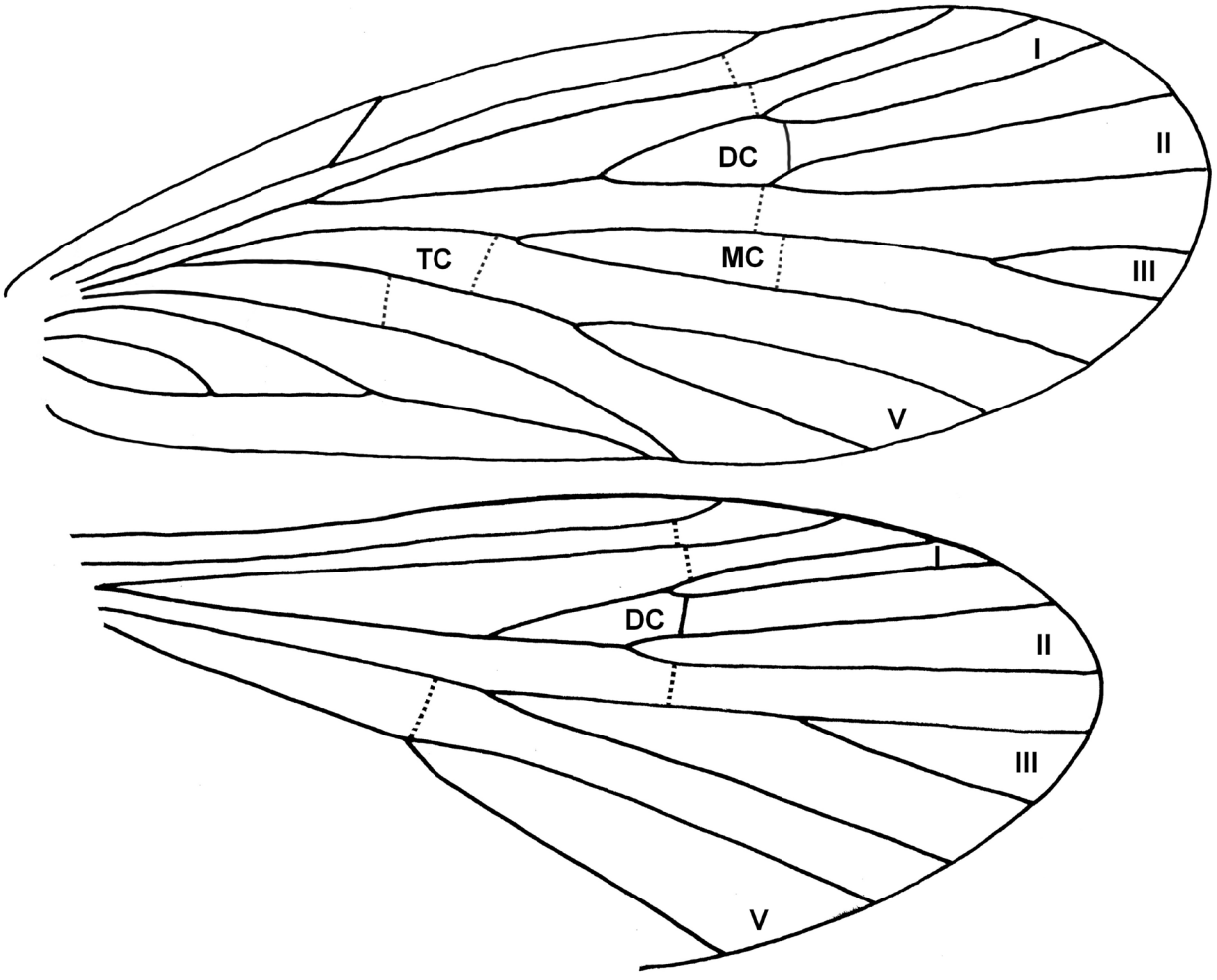

Fig. 1. Fore- and hind wing venations of *Wormaldia* spp. in Burmese amber, I, II, II, V – apical forks I, II, III, V, DC – discoidal cell, MC – median cell, TC – thyridium cell.

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tral side. The overlying wings often obscure lateral and dorsal visibility. In ventral view the inferior and underlying superior appendages provide useful criteria for diagnosis.

Wormaldia transversa n. sp.
Fig. 2

E t y m o l o g y : The new species is named after the crosswise harpagoes: *transversa*.

H o l o t y p e : Male, ZFMK-TRI000817 kept in the amber collection of the Museum Zoological Research Museum Alexander Koenig, Bonn, Germany (ex coll. PATRICK MÜLLER, BUB 1505). The holotype is well embedded in mid-Cretaceous Burmese amber.

D i a g n o s i s : Male genitalia with basal (coxopodite) segments significantly shorter than long apical (harpago) segments; the coxopodite probably cube-shaped, so far as visible, the harpago more than twice as long as coxopodite, narrow at the base, widening distally to a broad spoon, the distal edge rounded and covered with a fringe of short hair. The two basal segments cross in the middle of the genitalia. Superior appendage scale oval, short, partially covered by tergum IX, reaching distal end of the coxopodite.

D e s c r i p t i o n : Male, adult with general characters of the genus. Length of each forewing 2.5 mm, hind wing 2.4 mm. Head with right antenna partially damaged, left antenna with ca. 14 flagellomeres, incomplete. In forewings apical forks without fork IV. Sterna VII and VIII without processes posteromesally.

Wormaldia cercilonga n. sp.
Fig. 3

E t y m o l o g y : The new species is named after the long superior appendages: *cercilonga*.

H o l o t y p e : Male, NIGP172211, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Well preserved in mid Cretaceous Burmese amber.

D i a g n o s i s : Superior appendages needle-shaped in ventral view and narrow, oval, scaly in ventrolateral view, reaching the full length the basal segment of the inferior appendages. Basal segment basally broad and gradually tapering distally, apical segment uniformly narrow, its cap covered with a fine hair brush. Basal and apical segments of the inferior appendages elongate, both segments of about the same length.

D e s c r i p t i o n : Male, adult with general characters of the genus. Length of each forewing 3.3 mm, hind wing 3 mm in length. Filiform antennae each with 27 flagellomeres plus a little stronger scapus and a small pedicellus. In forewings apical forks without fork IV. Sterna VII and VIII without processes posteromesally.

Wormaldia cercifurcata n. sp.
Fig. 4

E t y m o l o g y : The new species is named after the apically forked cerci: *cercifurcata*.

H o l o t y p e : Male, NIGP172212, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Well preserved in mid Cretaceous Burmese amber.

D i a g n o s i s : Male genitalia with long and strong inferior appendages, the basal segment longer than the apical segment. The basal segment slightly convex outwards and forming a narrow, flat, light-coloured shell on its inside. The apical segment kept short, widening towards the apex and closing with a wide edge. The superior appendage dark, slightly curved inwards, with a small membranous (?) fringe along its length, pointed at the end, completed with an additional apicolateral dark tooth.

D e s c r i p t i o n : Male, adult with general characters of the genus. Length of each forewing 2.5 mm, hind wing 2.4 mm in length. Filiform antennae each with 25 flagellomeres plus a little stronger scapus and a small pedicellus. In forewings apical forks without fork IV. Sternites VII and VIII without processes posteromesally.

Wormaldia squamosa n. sp.
Fig. 5

E t y m o l o g y : The new species is named after the scaly harpago: *squamosa*.

H o l o t y p e : Male, ZFMK-TRI000818 kept in the amber collection of the Museum Zoological Research Museum Alexander Koenig, Bonn, Germany (ex coll. PATRICK MÜLLER, BUB 2854). The holotype is well embedded in mid-Cretaceous Burmese amber.

P a r a t y p e : Male, ZFMK-TRI000819 kept in the amber collection of the Museum Zoological Research Museum Alexander Koenig, Bonn, Germany (ex coll. PATRICK MÜLLER, BUB 530). The type is embedded in mid-Cretaceous Burmese amber, incomplete.

D i a g n o s i s : Male genitalia with basal and apical segments of the inferior appendages about the same length. Basal segment rombic in ventral view, broader than the apical segment, shaped like a flat scale, long oval. Superior appendages scaly, long, about as long as the scaly apical segments of the inferior appendages, in ventral view acicular and curved, narrow, oval, scaly.

D e s c r i p t i o n : Male, adult with general characters of the genus. Length of each forewing 3.5 mm, hind wing 3.2 mm in length. Antennae about half as long as the forewings, each consisting of 23 flagellomeres plus stronger scapus and smaller pedicellus. In forewings apical forks without fork IV. Sterna VII and VIII without processes posteromesally.

4. Key to the seven known extinct species of *Wormaldia* embedded in mid-Cretaceous Burmese amber

1 Sternum VII with a subtriangular posteromesal process, in forewings M vein 4-branched (apical forks III and IV present), in hind wings fork I absent
W. myanmari

Sternum VII without a subtriangular posteromesal process, in forewings M vein 3-branched (apical forks

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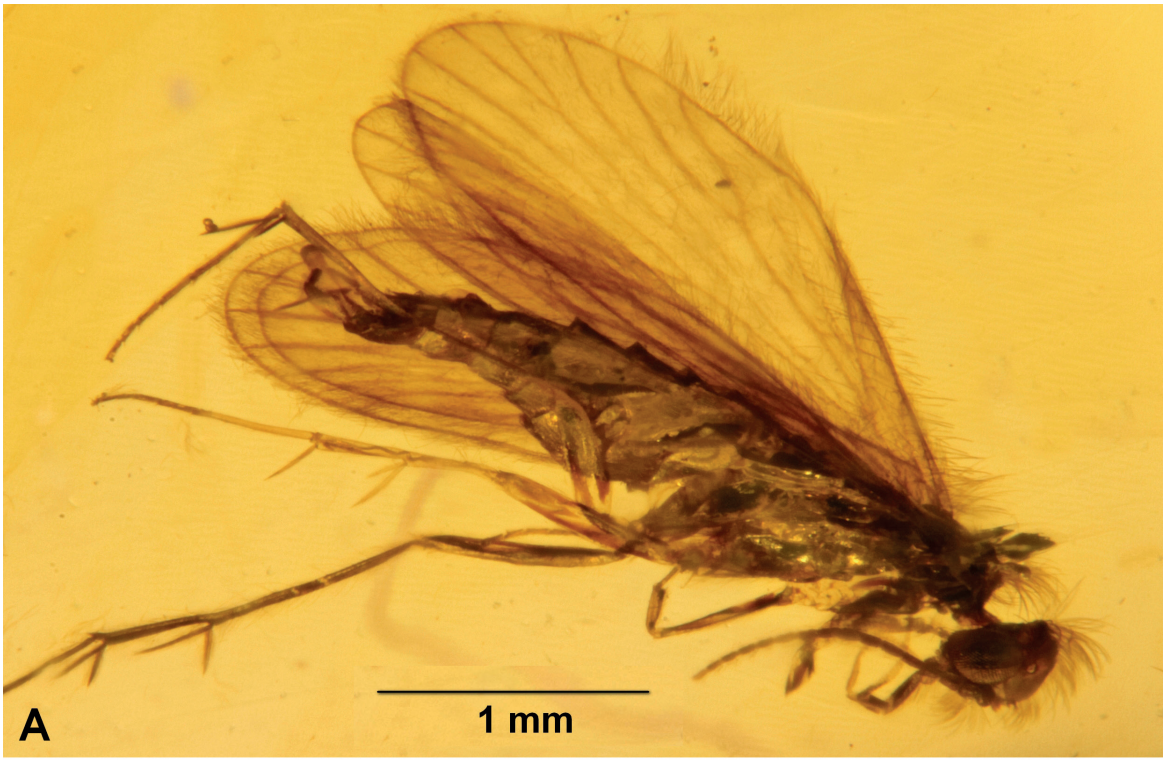

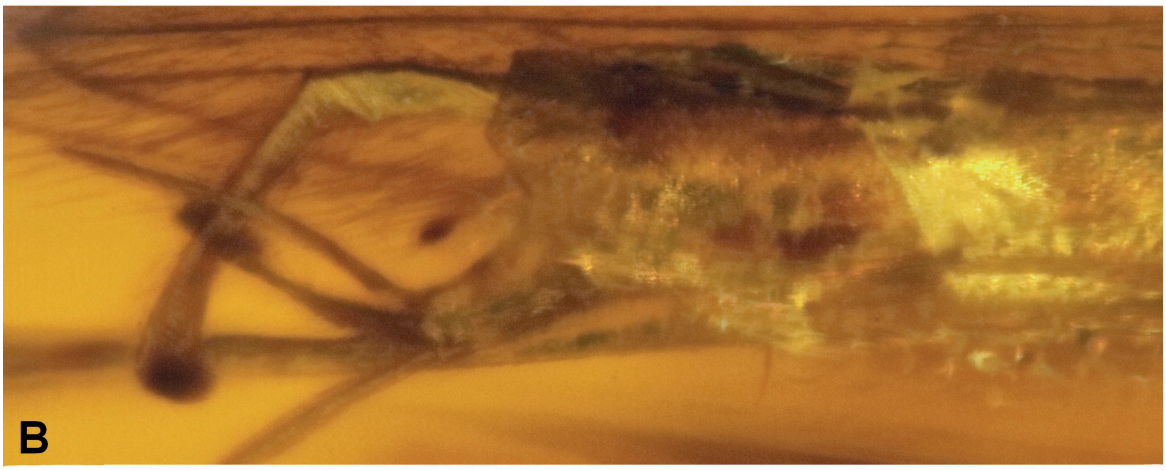

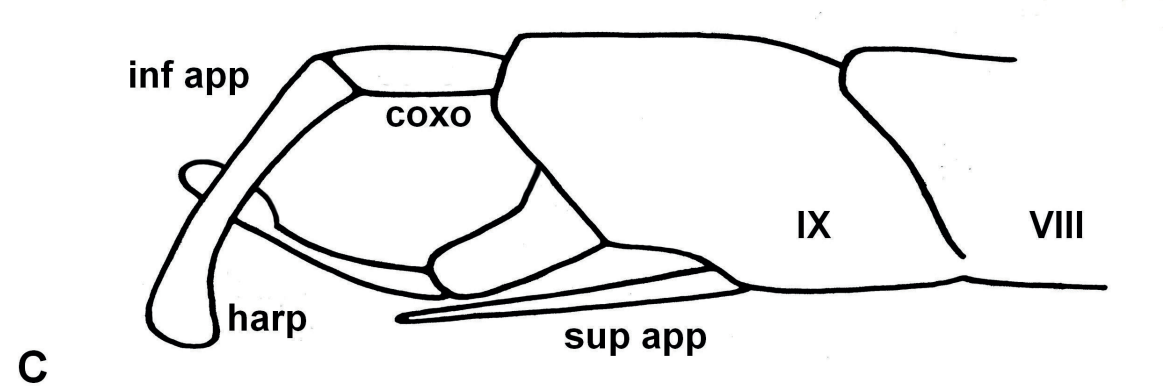

Fig. 2. *Wormaldia transversa* n. sp. **A** – Male holotype (ZFMK-TRI000817) in lateral view. **B** – Male genitalia in lateral view. **C** – Drawing of male genitalia.

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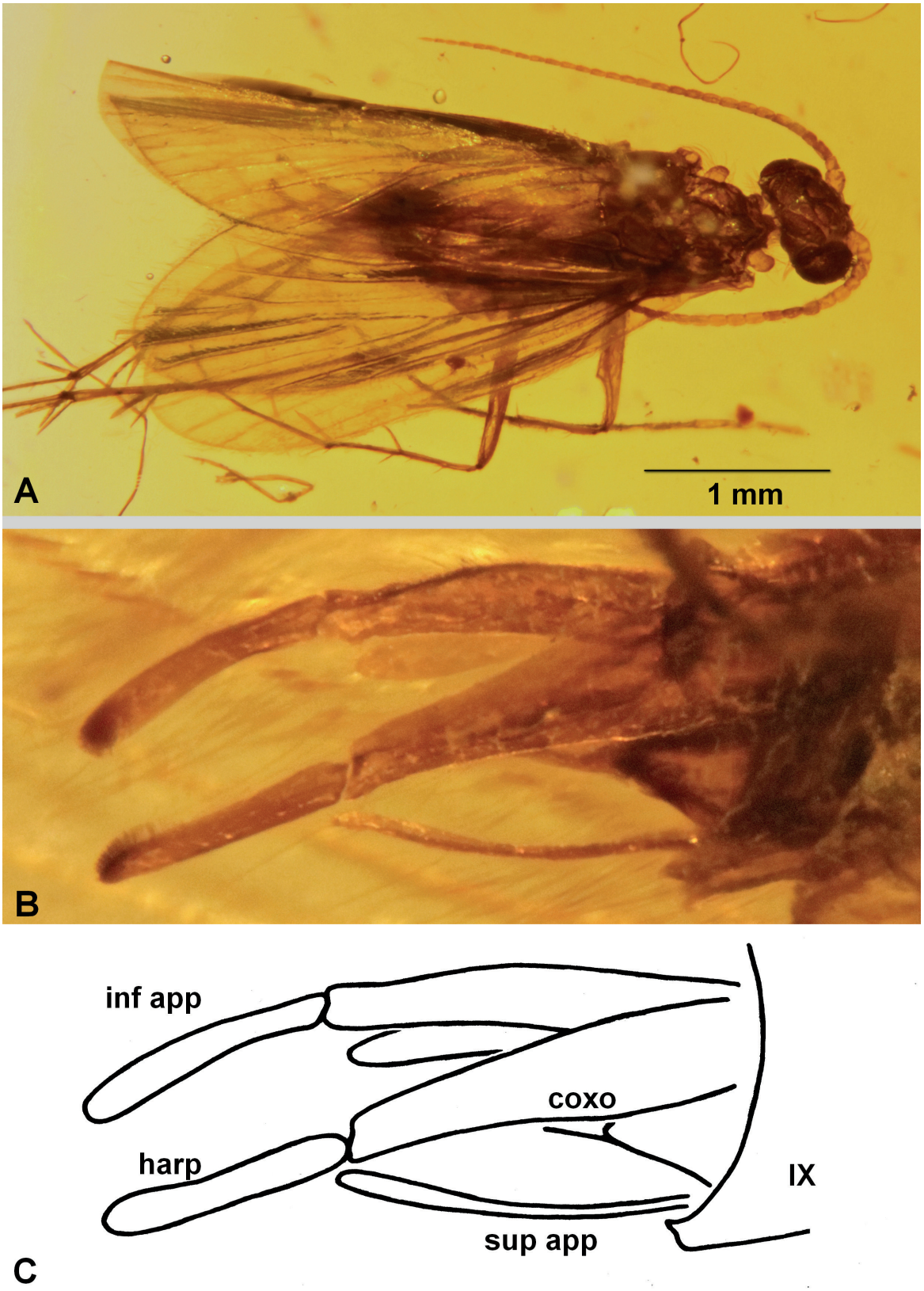

Fig. 3. *Wormaldia cercilonga* n. sp. **A** – Male holotype (NIGP172211) in dorsal view. **B** – Male genitalia in dorsolateral view. **C** – Drawing of male genitalia.

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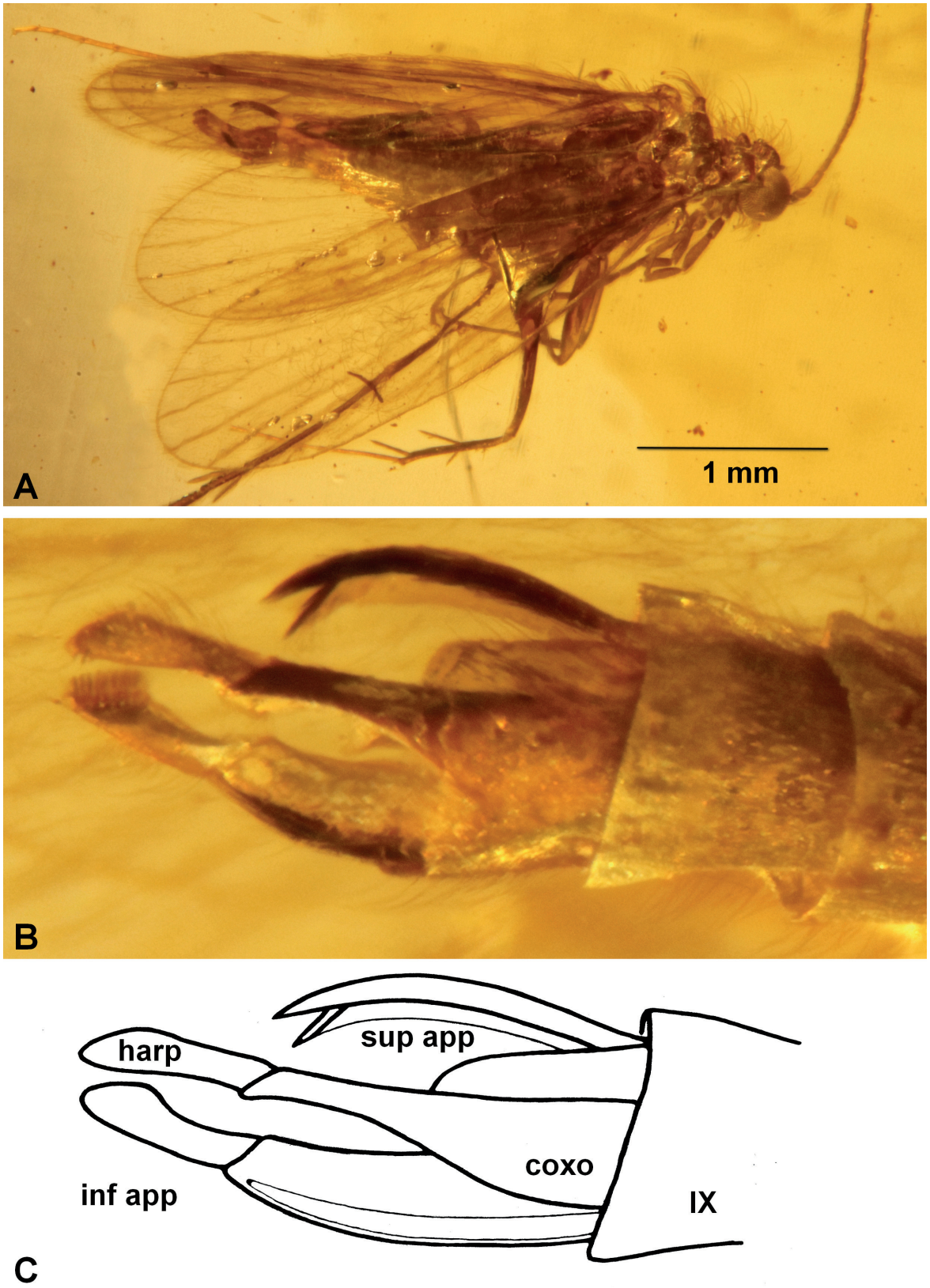

Fig. 4. *Wormaldia cercifurcata* n. sp. **A** – Male holotype (NIGP172212) in dorsal view. **B** – Male genitalia in ventrolateral view. **C** – Drawing of male genitalia.

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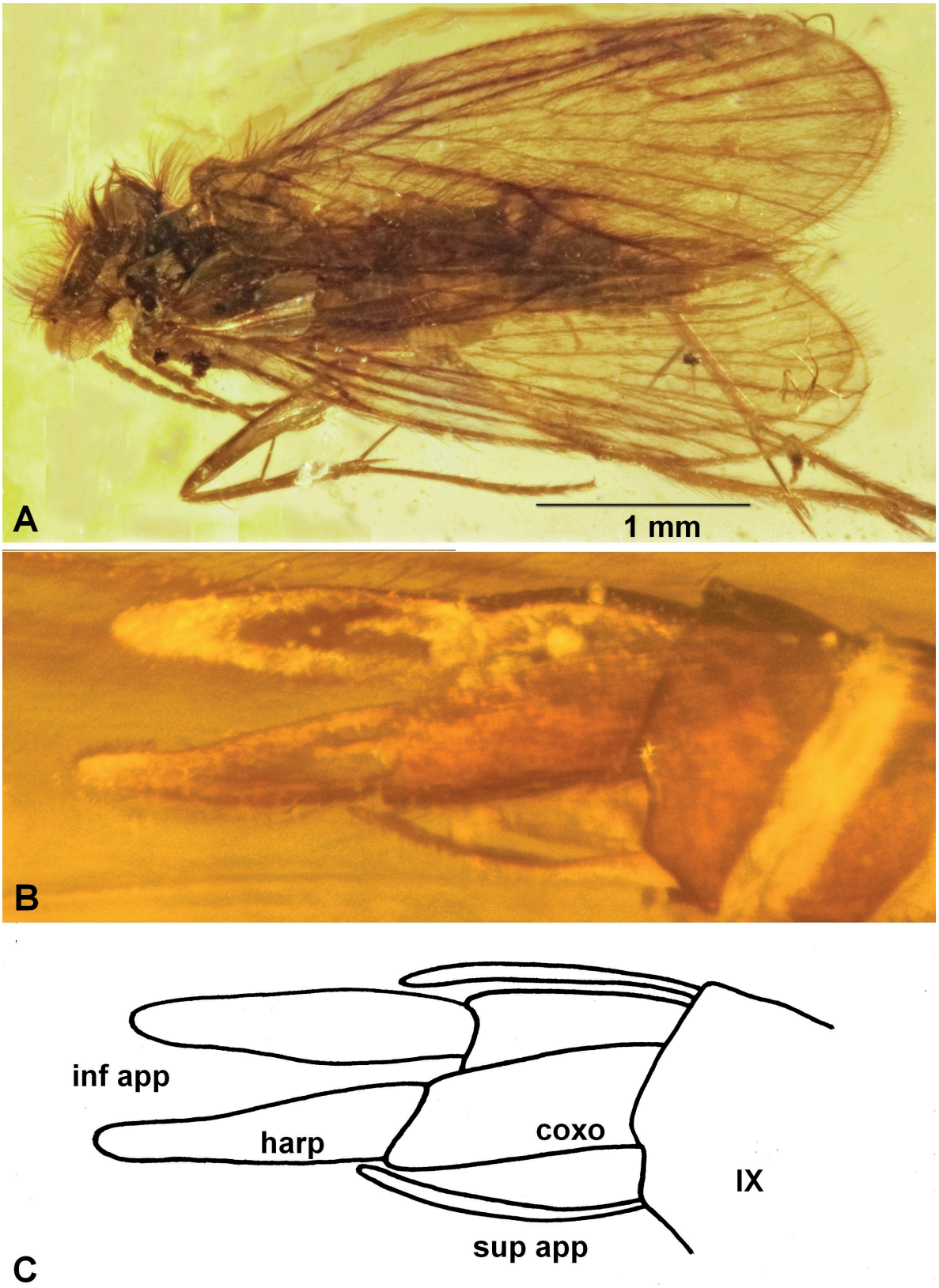

Fig. 5. *Wormaldia squamosa* n. sp. **A** – Male holotype (ZFMK-TRI000817) in dorsal view. **B** – Male genitalia in dorsolateral view. **C** – Drawing of male genitalia.

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III present and IV absent), in hind wings fork I present 2
2 Basal (coxopodite) segment shorter than apical (harpago) segment 3
– Basal segment significantly longer than apical segment 4
– Basal and apical segments of the inferior appendages about the same length 5
3 Superior appendages elongate, pointed, about as long as the inferior appendages *W. resina*
– Superior appendage short, about as long as the coxopodite *W. transversa* n. sp.
4 Superior appendages elongate, scaly, simple *W. cercilonga* n. sp.
– Superior appendages elongate, dark, at apex forked *W. cercifurcata* n. sp.
5 Apical segment of each inferior appendage scaly, long oval *W. squamosa* n. sp.
– Apical segment slender, elongate, slightly curved, apex slightly widened *W. cretacea*

5. Conclusions

Considering the caddisflies of Burmese amber in general, a small size of the adults is often noticeable. Up to now, among the recent caddisflies, the Hydroptilidae, have often been called "micro-caddisflies" (e.g., Marshall 1979; Wells 1993; Wells & Malicky 1997), because their forewings are usually only 2.5–3.5 mm long. In Burmese amber the Psychomyiidae are certainly among the smallest caddisflies, at least in the genus *Palerasnitsynus*, whose adult wings are only 1.8–2.6 mm long (Wichard et al. 2011, 2018). Philoptamidae of genus *Wormaldia* described so far also have forewing lengths of about 2.5–3.5 mm and may also be considered "micro-caddisflies," whereas, e.g., in Europe the extant adults of *Wormaldia* have forewing lengths of 4–7 mm (Oláh et al. 2019). The tiny specimens of the *Palerasnitsynus* obviously tend to swarm, because in some amber up to 100 embedded specimens have been counted. Compared with *Palerasnitsynus* the *Wormaldia* specimens occur sporadically in amber and do not seem to swarm.

Questions about the biology of the micro-caddisflies in the Cretaceous Burmese amber are becoming increasingly important. But the time distance of about 100 Ma can hinder the interpretation based on the "principle of actualism".

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