

A NEW CHIRONOMID WITH A LONG PROBOSCIS FROM EOCENE BALTIC AMBER (DIPTERA: CHIRONOMIDAE: TANYPODINAE)

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Abstract.— Both sexes of a new fossil genus and species *Eoprocladius hoffsorsorum* **gen. et sp. n.** from Eocene Baltic amber are described and illustrated. This is the first report of a chironomid with such a long proboscis within the subfamily Tanypodinae and the tribe Procladiini. Within the family the elongated proboscis with narrow labella and suitable to feed on nectar evolved independently among Eocene and extant adult non-biting midges of the subfamilies Orthocladiinae and Tanypodinae. *Djalmabatista maillardi* Doitteau & Nel, 2007 from Eocene amber of France is placed in the extant genus *Procladius* Skuse: *Procladius maillardi* (Doitteau & Nel, 2007), **comb. nov.**



Key words.— Procladiini, *Djalmabatista*, new combination, *Eoprocladius hoffsorsorum*, new genus, new species, fossils

INTRODUCTION

The Chironomidae are a large family of nematoceros flies with immatures common in many freshwater habitats. Some species of the subfamily Orthocladiinae are semiaquatic and live in moist soil close to permanent water bodies; only a few are truly terrestrial. The family includes 5000–7000 extant species (Spies *et al.* 2009, Zakrzewska *et al.* 2016) and over 200 fossil ones (Evenhuis 1994, Zakrzewska *et al.* 2016). Over 100 of the latter species are known from Baltic amber (Evenhuis 1994, Wichard *et al.* 2009, Seredszus & Wichard 2007, 2010, Zakrzewska *et al.* 2016). More than half of them (59), described by Heer, Duisburg and Meunier in the years 1849–1916, have not yet been revised and are treated as nomina dubia (Wichard *et al.* 2009).

The phylogenetic history of Chironomidae goes back to the early-mid Triassic, ca 250–210 Ma, with the oldest fossil reported from Late Triassic deposits in England. All extant subfamilies were probably present in the Late Jurassic 150 Ma (Cranston *et al.* 2012, Ekrem *et al.* 2017).

Adult chironomids have a very short lifespan, from a few days to a maximum of two weeks, and normally do not feed (Lindegård 1997). The adult mouthparts in most Chironomidae are greatly reduced, very short (Fig. 3B). The typical short proboscis consists of a convex clypeus, short labrum, hypopharynx and labium bearing distinct labella (labial palps); mandibles and laciniae are both absent. Such short mouthparts are most probably adapted to lick and drink water as well as carbohydrates from the surfaces of plants (honeydew) or to drink nectar from shallow,

easily accessible, usually umbelliferous, flowers (Downes 1974, Szadziewski 1996, personal observations).

Only few fossil chironomids have an elongated proboscis. One of these, *Cricotopiella rostrata* Meunier, 1916 (Fig. 3E), was described on the basis of a female specimen from the Baltic amber, and four other species are known from the Late Jurassic (Lukashevich & Przhiboro 2011).

Among extant chironomids, *Smittia longirostris* Goetghebuer, 1937 (Orthoclaadiinae) with a long proboscis was described from the Mont Blanc massif (Goetghebuer 1943). An extremely elongated proboscis with a very well developed labium is present in *Pseudorthocladus macrostomus* Sponis, 1980 (Fig. 3D) and in species belonging to *Rhinocladus* Edwards, 1931 (Fig. 3C). In *P. macrostomus* the palps are long, and the proboscis is 3.6 times longer than the eye height (Sponis 1980). *Rhinocladus* species have short palps and a proboscis that may be as long as the whole body. This genus includes two species from South America (Edwards 1931, Saether & Andersen 2003) and one from Australia (Freeman 1961).

Extant mandibulate chironomids are present only in the subfamily Podonominae in two closely related genera – *Archaeochlus* Brundin, 1966 from Africa and *Austrochlus* Cranston, 2002 from Australia. Their females, of unknown feeding habit, have a short proboscis with mandibles armed with 5–7 strong teeth like those of females of insectivorous Ceratopogonidae (Cranston *et al.* 1987, Cranston *et al.* 2002).

The purpose of this paper is to describe both sexes of a new Eocene species with long mouthparts suitable for feeding on flowers.

MATERIAL AND METHODS

The holotype male (900-5/SDEI=Dip-00434) and paratype female (900-2/SDEI=Dip-00435) from the private collection of Christel and Hans Werner Hoffeins of Hamburg described in this paper will be deposited in the Senckenberg Deutsches Entomologisches Institut (SDEI, Germany). The amber pieces are transparent and embedded in artificial epoxy resin. The dimensions of the plastic cubes with the amber are about 14×9×5 mm (male) and 16×6×4 mm (female). The inclusions are relatively well preserved; in the male all tarsi are incomplete and only tarsomere 1 of the hind leg is preserved. Photographs were taken with a Leica DM6000 microscope in conjunction with the LAS Montage module to create a composite extended-focus montage.

SYSTEMATIC PALAEOLOGY

Family **Chironomidae** Newman, 1834

Subfamily **Tanypodinae** Skuse, 1889

Tribe **Procladiini** Roback, 1971

Adults are characteristic in having tarsomere 4 cylindrical, scutum with or without tubercle, wing fork MCu distal of crossvein m-cu, R2+3 well developed, wing membrane with or without macrotrichia, and relatively short and strongly bent (hooked) gonostyli in the male genitalia. The adults of extant species have a very short proboscis (Fig. 3B).

The tribe contains only three genera: *Procladius* Skuse, 1889, *Djalmabatista* Fittkau, 1968 and *Laurotanypus* Oliveira *et al.*, 1992 (Spies *et al.* 2009). About 70 extant species are known in the nearly worldwide distributed genus *Procladius* with three subgenera *Procladius* s. str., *Psilotanypus* Kieffer and *Holotanypus* Roback. The genus *Djalmabatista* includes 12 named extant species and an unidentified one (Hagenlund *et al.* 2010); they occur in the Neotropical, Nearctic, Oriental, Afrotropical and Australian regions. *Laurotanypus* contains only two South American species (Oliveira *et al.* 1992).

Though very close to *Procladius*, adults of *Djalmabatista* are readily identified by the striking colour patterns of the thorax, legs and abdomen and the iridescent eyes (Hagenlund *et al.* 2010). Unfortunately, the colours of small dipterans in Eocene ambers are not preserved and are unavailable for diagnosis. The gonostyli in the male genitalia of *Djalmabatista* have one or two ventral lobes, usually long lanceolate megaseta, and sometimes ventral expansions to the gonocoxites. In *Procladius* the gonostyli are simple or have one ventral lobe. In our opinion, *Djalmabatista maillardi* Doitteau & Nel, 2007 from Eocene amber of France, should be placed in the genus *Procladius*: *Procladius maillardi* (Doitteau & Nel, 2007), comb. nov. The male of this species has simple, evenly rounded gonostyli without a posterior process (heel) and without a ventral lobe, and the gonocoxites are simple, as in males of the extant species of the subgenus *Procladius* s. str. (Spies *et al.* 2009).

Fossil *Procladius* are reported from Eocene amber of France: *P. (Holotanypus) enigmaticus* Doitteau & Nel, 2007 and *P. maillardi* (Doitteau & Nel, 2007), **comb. nov.**, and from Baltic amber: *P. eocenicus* Seredusz & Wichard, 2010.

Genus ***Eoprocladius*** gen. nov.

Type-species. *Eoprocladius hoffeinsorum* sp. n., by present designation.

Diagnosis. The genus is unique in the Tanypodinae in having a greatly elongated proboscis, about 1.4–1.5 times longer than the eye height. The combination of other characters is as follows: wing membrane with macrotrichia, crossvein m-cu proximal to r-m, distance from crossvein m-cu to fork M3+4 and CuA as long as

0.2–0.4 of CuA, gonostylus simple, with rounded outer surface, i.e. without posterior heel, armed with long lanceolate megaseta, gonocoxite simple.

Etymology. The name is a combination of Eocene and the extant genus *Procladius*.

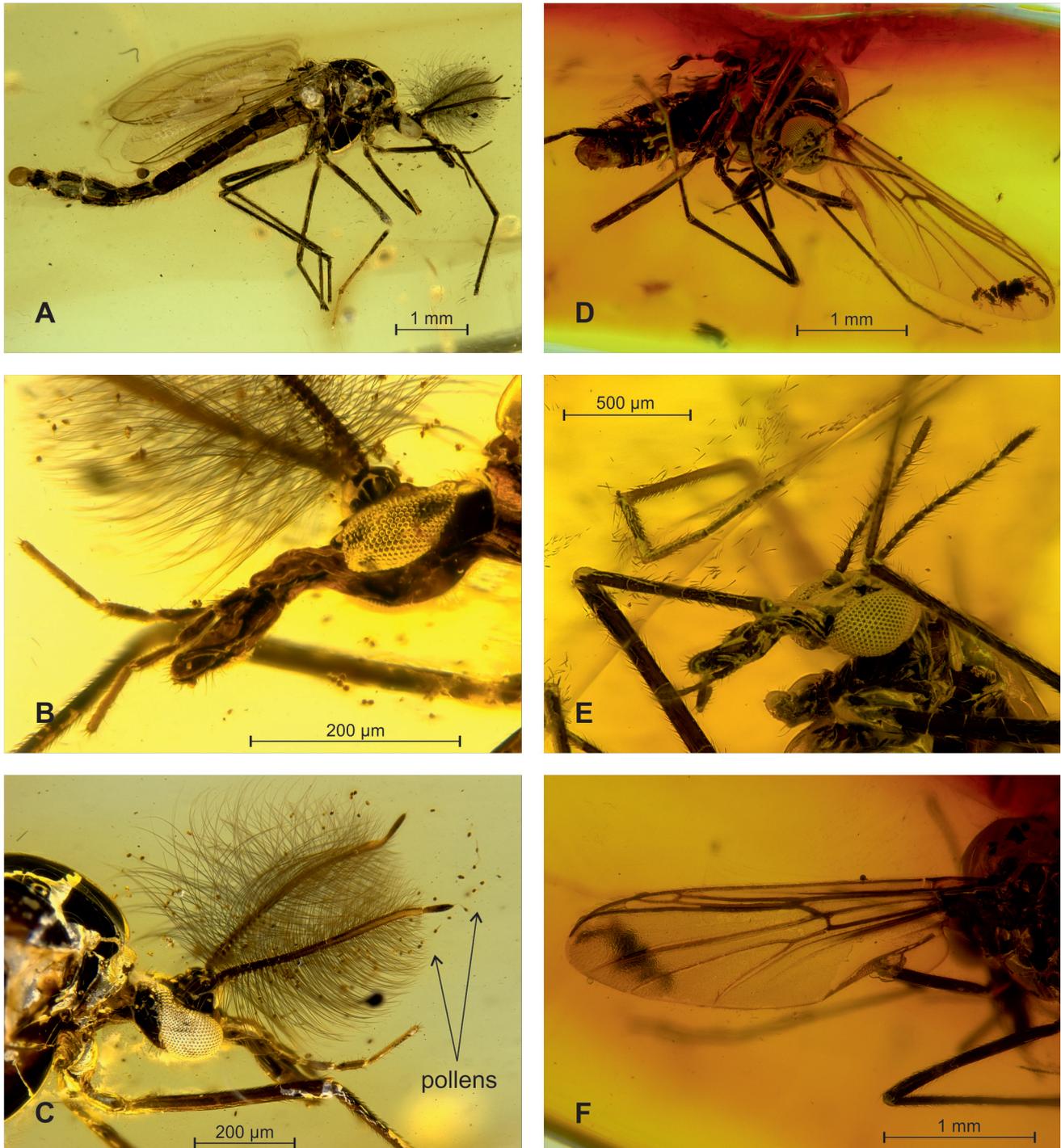


Figure 1. *Eoprocladius hoffeinsorum* gen. et sp. nov.: (A) lateral view of holotype male; (B) lateral aspect of male proboscis; (C) head of male and pollen grains; (D) ventral view of paratype female; (E) lateroventral view of female head; (F) wing of female.

Eoprocladius hoffeinsorum sp. nov.

Diagnosis. As for the genus.

Type material. Holotype male, Ch. & H.W. Hoffeins collection, No 900-5/SDEI=Dip-00434. Paratype female, Ch. & H. W. Hoffeins collection, No 900-2/SDEI=Dip-00435. The holotype and paratype will be deposited at the Senckenberg Deutsches Entomologisches Institut (SDEI, Germany). Syninclusions: together with the holotype a group of about 100 ovoid pollen grains are well visible around the long antennal plume and in front of the male head; some stellate hairs are present together with the paratype female.

Description. Male (Fig. 1A). Total length 6.9 mm. Wing length 2.73 mm (measured from basal arculus).

Total length/wing length 2.55. Wing length/length of profemur 2.60.

Colouration. Uniformly black.

Head (Fig. 1B, C). Eyes narrowly separated, 0.09 mm apart; eye-elongation composed of 5 rows of facets. Flagellum 1.28 mm long with 14 flagellomeres; plume well developed; terminal flagellomere 0.15 mm long, with evenly pointed apex. Palpus 5-segmented, 3rd palpomere 0.16 mm, 4th 0.17 mm, 5th 0.31 mm. Proboscis 1.4 times longer than eye height. Clypeus flat, rectangular, almost twice as long as broad. Hypopharynx not visible. Labrum long, reaching apex of labium; labellum slender. Mandible and lacinia absent.

Thorax. Scutum evenly rounded without tubercle. Scutellum bearing single row of delicate long marginal

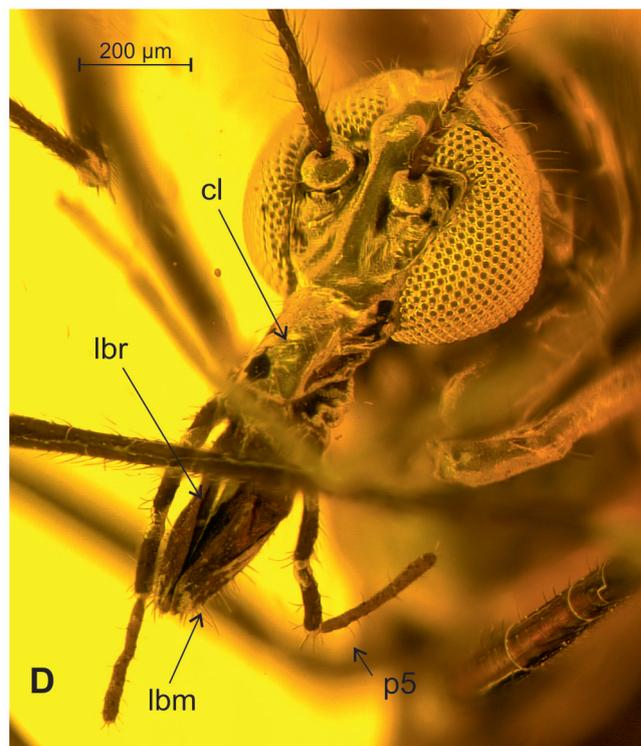
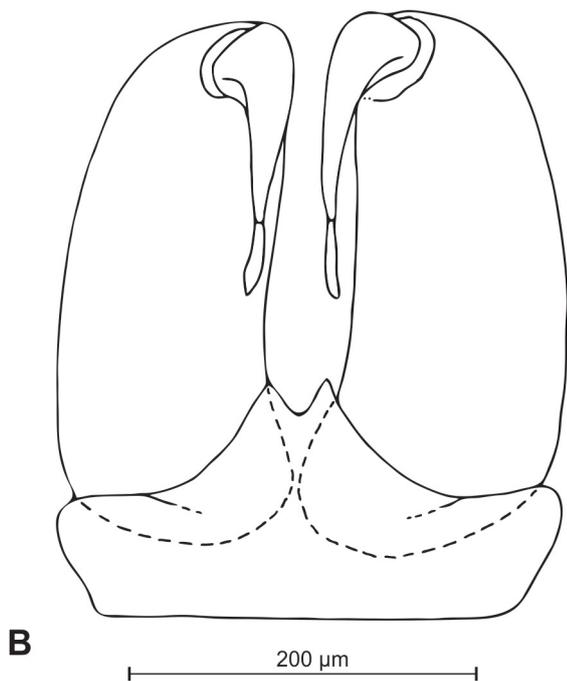
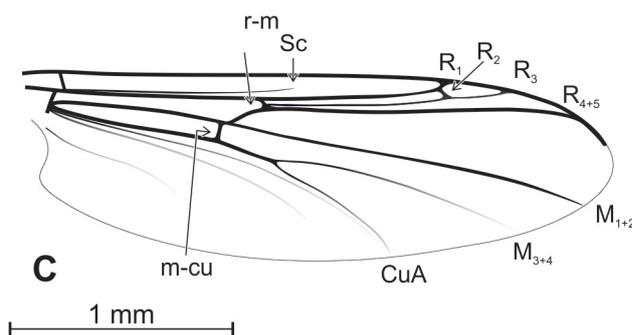
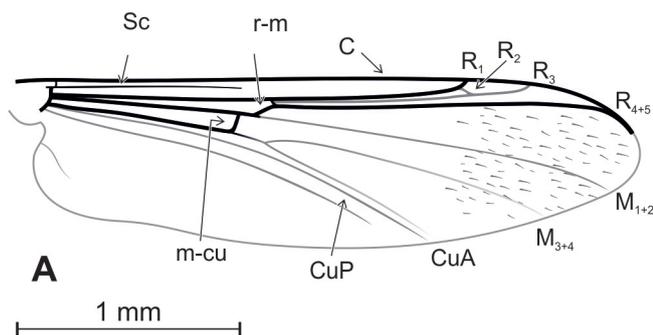


Figure 2. *Eoprocladius hoffeinsorum* gen. et sp. nov.: (A) wing of male; (B) dorsal view of male genitalia; (C) female wing venation; (D) latero-dorsal view of female proboscis. cl – clypeus, lbr – labrum, lbm – labium, p5 – fifth palpomere.

hairs (about 20). Anepisternum and katepisternum bare. Anteprepronotum with group of about 10 setae.

Wing (Fig. 2A). Wing length 2.73 mm (measured from basal arculus). Costal vein extending beyond

R4+5 and almost reaching wing apex, costal extension longer than r-m, 0.17 mm long. Subcostal vein not reaching costal vein. Crossvein r-m distal of crossvein m-cu. Crossvein m-cu perpendicular (90°) and r-m

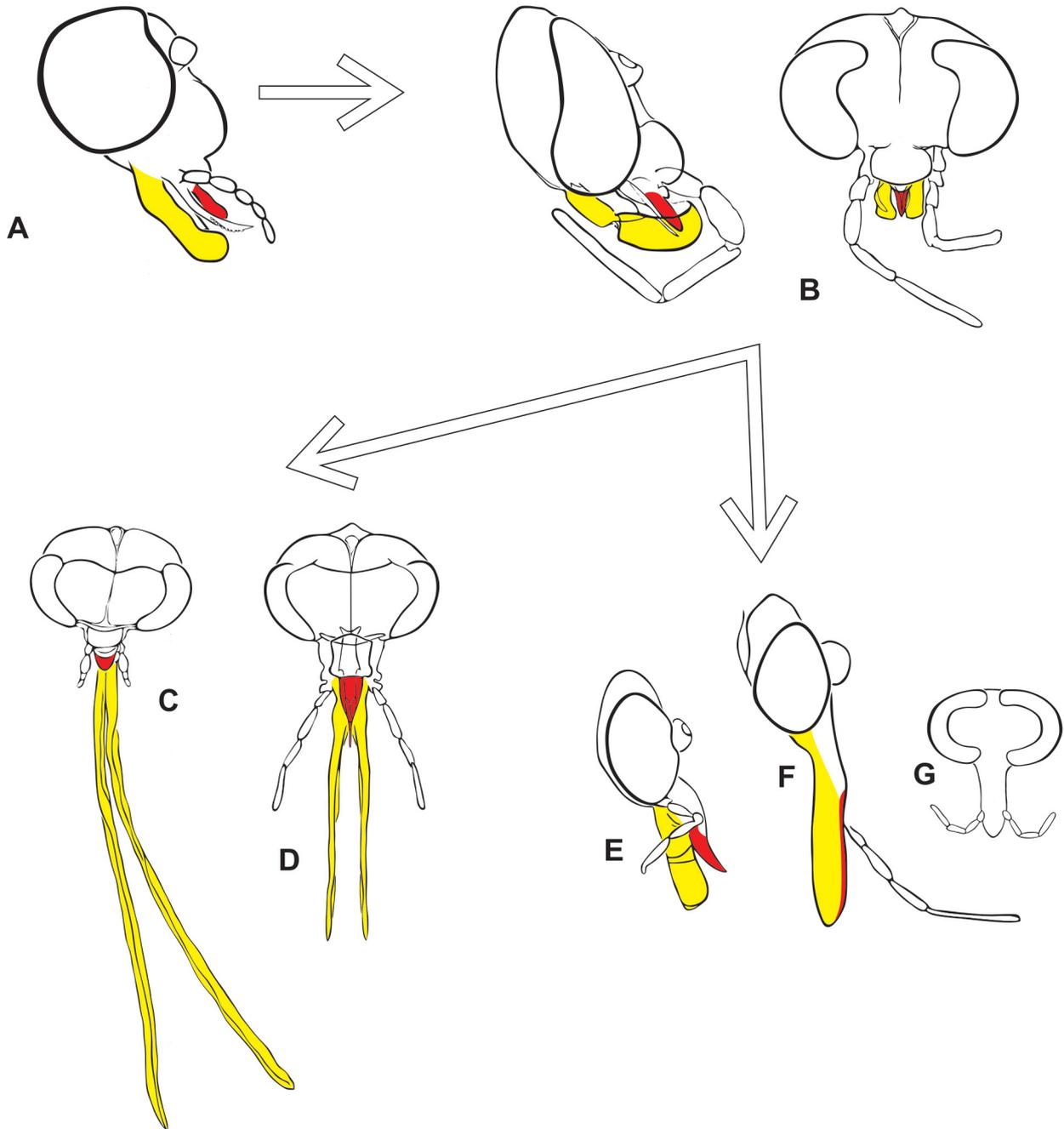


Figure 3. Evolution of a non-mandibulate proboscis among Chironomidae. (A) plesiomorphic mandibulate female of *Haematotanyppus libanicus* Azar *et al.* 2008 from Lower Cretaceous Lebanese amber (from Azar & Nel 2012, modified); (B) lateral and frontal view of non-mandibulate female mouthparts of extant *Procladius* sp. collected in Poland; (C) male proboscis of *Rhinocladius longirostris* Edwards, 1931 (after Saether & Andersen 2003, modified); (D) male proboscis with greatly elongated labella of *Pseudorthocladius macrostomus* Sponis, 1980 (from Sponis 1980, modified); (E) lateral view of female head of *Cricotopiella rostrata* Meunier, 1916 from Eocene Baltic amber (from Meunier 1916); (F) lateral view of male head of *Eoprocladius hoffeinsorum* gen. et sp. nov.; (G) frontal view of male head of *Smittia longirostris* Goetghebuer, 1937 (from Goetghebuer 1943, modified). Labrum – red or black, labium – yellow or grey.

oblique (45°) to medial vein M1+2. Wing membrane, at least in distal portion, with macrotrichia. Anal lobe well developed. Distance between cubital fork and medial-cubital m-cu crossvein about 2.2 times the length of m-cu vein. Distance from crossvein m-cu to fork of veins M3+4 and CuA (MCu petiole) as long as 0.20 of CuA.

Legs. Tarsi incomplete, only first tarsomere of hind leg measuring 0.75 mm preserved. Legs slender; femur of fore leg 1.13 mm, of mid leg 1.37 mm, of hind leg 1.33 mm. Tibia of fore leg with 1 spur, of mid leg with 2 spurs, of hind leg with 2 spurs, 1.75 mm long. Tibial spurs slender, with some (4–5?) lateral inner teeth on basal half.

Genitalia (Fig. 2B). Tergite IX short, with caudo-median M-shaped expansion. Gonocoxite stout, simple, cylindrical. Gonostylus strongly bent at base, with rounded outer corner; distal portion slender and armed with long apical, probably lanceolate megaseta.

Female (Fig. 1D). Similar to male with usual sexual differences. Total length about 2.8 mm. Wing length 2.53 mm (measured from basal arculus). Total length/wing length about 1.12. Wing length/length of profemur 2.61.

Head (Fig. 1E, 2D). Eyes broadly separated. Eye prolongation 5 facets wide. Flagellum 0.91 mm long, with 14 flagellomeres; terminal flagellomere 0.19 mm long, cylindrical, with apical nipple-like prolongation armed with subapical seta; proportions of flagellomeres 1–14 as follows in μm : 70-45-50-50-50-50-55-55-55-55-60-60-60-180. Palpus 5-segmented, 3rd palpomere 0.15 mm, 4th 0.14 mm, 5th 0.24 mm. Proboscis 1.5 times longer than eye height.

Wing (Fig. 1F, 2C). Length 2.53 mm (measured from basal arculus). Wing membrane at apex with macrotrichia. Costal extension 0.17 mm long. Distance from crossvein m-cu to fork of veins M3+4 and CuA (MCu petiole) as long as 0.43 of CuA.

Legs. Tibia of fore leg with 1 spur, of mid leg with 2 spurs, of hind leg with 2 spurs; each spur with several (4–5?) lateral inner denticles on basal half. Tarsomere 4 cylindrical, claws simple, equal. Fore leg proportions as follows: femur – 0.97 mm, tibia – 1.20 mm, first tarsomere – 0.86 mm. Femur of mid leg – 1.25 mm. Hind leg with proportions as follows: femur – 1.15 mm, tibia – 1.53 mm, tarsomere 1 – 1.20 mm, tarsomere 2 – 0.68 mm, tarsomere 3 – 0.45 mm, tarsomere 4 – 0.25 mm, tarsomere 5 – 0.13 mm.

Abdomen. Stout with blunt apex. Genitalia barely visible. Cerci short.

Etymology. This species is named for the private collectors Christel and Hans Werner Hoffeins of Hamburg, the owners of many fascinating inclusions of dipterans in Baltic amber.

DISCUSSION

Species of the tribes Tanypodini and Procladiini are very close. They are usually separated by the length of the MCu petiole, i.e. the distance from the m-cu crossvein to the fork of veins M3+4 and CuA. In Tanypodini, including the single genus *Tanypus* Meigen, 1803, the petiole is short, at most as long as 0.33 of CuA, and the scutal tubercle is present. In the tribe Procladiini the petiole is long, at least as long as 0.50 of CuA, and the scutal tubercle is absent (*Procladius* and *Djalmabatista*) or present (*Laurotanypus*) (Spies *et al.* 2009).

In fossil species placed in the genus *Procladius* of the tribe Procladiini, the petiole is shorter than in extant members of the genus. In the male of *Procladius eocenicus* Seredusz & Wichard, 2010 from Baltic amber, the petiole is 0.48 times as long as CuA, while in *P. maillardi* (Doitteau & Nel, 2007) from French amber it is 0.62 times as long as CuA.

In the new genus the wing petiole is relatively short (0.20–0.43 of CuA), as in adults of the tribe Tanypodini (less than 0.33), but we include it in the tribe Procladiini because of the evenly rounded scutum with no tubercle.

CONCLUDING REMARKS

Adult mouthparts in most Chironomidae are greatly reduced – they are very short, usually less than 0.8 times the eye height (Fig. 3B). An elongate proboscis, equal to or longer than the eye height, is present in a very few extant and fossil chironomids of three groups: 1) with complete biting mouthparts armed with mandibles and laciniae, 2) with reduced mandibles and laciniae; labrum, hypopharynx and labium of similar length, 3) with reduced mandibles and laciniae; labrum and hypopharynx short, labium greatly elongated.

1. Most plesiomorphic mandibulate chironomids with mouthparts armed with toothed mandibles, adapted to feed on protein-rich meals taken from insects or vertebrates (blood), have a short proboscis (Fig. 3A) (Azar *et al.* 2008, Azar & Nel 2012). Lukashovich & Przhiboro (2011) described four species with an elongated proboscis from the Late Jurassic of Mongolia in the fossil genus *Cretaenne* Azar *et al.*, 2008 of unclear subfamilial position (similar to extinct Aenninae or extant Tanypodinae), and three others in the fossil genus *Podonomius* Kalugina (extant subfamily Podonominae). Two species, *Podonomius robustus* Lukashovich & Przhiboro, 2011 and *Cretaenne rasnicyni* Lukashovich & Przhiboro, 2011 have a long proboscis, 1.2–1.3 times as long as the eye height (measured from illustrations). Mandibles and laciniae were identified in *C. rasnicyni* while in *Podonomius*

macromastix Lukashovich & Przhiboro, 2011 a pair of sclerotized blades is present (Lukashovich & Przhiboro 2011). According to descriptions, two other species have shorter mouthparts (0.9–0.7 times as long as the eye height), and in *P. blepharis* Lukashovich & Przhiboro, 2011 (Fig. 1, l) the proboscis has evidently reduced mandibles and laciniae as in most extant species (Fig. 3B). Males and females of *Wadelius libanicus* Velts *et al.*, 2007 (Tanypodinae) with mouthparts armed with mandibles (Azar *et al.* 2008), from Lower Cretaceous Lebanese amber, also have an elongated proboscis that is 1.2 times as long as the eye height (measured from Fig. 10, Azar & Nel 2012). Extant mandibulate chironomids are present only in the subfamily Podonominae in two closely related genera – *Archaeochlus* Brundin, 1966 from Africa and *Austrochilus* Cranston, 2002 from Australia. Their females, of unknown feeding habit, have a short proboscis with mandibles armed with 5–7 strong teeth like those of females of insectivorous Ceratopogonidae (Cranston *et al.* 1987, Cranston *et al.* 2002).

2. The new species with elongated mouthparts (1.4–1.5 times longer than eye height) belongs to the group of chironomids with reduced mandibles and laciniae, and having the labrum, hypopharynx and labium of the same length (Fig. 3E–G). Among all fossil chironomids, the proboscis of *Eoprocladius hoffeinsorum* gen. et sp. n. (Tanypodinae) described here is the longest. This group of chironomids, though with a shorter proboscis (as long as the eye height), should include the fossil *Cricotopiella rostrata* Meunier, 1916 (Orthoclaadiinae) described from Baltic amber (Fig. 3E) and also the extant *Smittia longirostris* Goetghebuer, 1937 (Orthoclaadiinae) from Europe (Fig. 3G). Both sexes of the latter species with a proboscis about 1.0 times as long as the eye height were described from an altitude of 3050 m in the Mont Blanc massif. They were collected from flowers of montane (oreal) *Saxifraga bryoides* (Goetghebuer 1943 p. 95).

Adults of *Eoprocladius hoffeinsorum* gen. n. sp. n. have slender, elongated mouthparts that must have been used to feed on nectar from deep flowers. This hypothesis is supported by the syninclusions of about 100 smooth, ovoid pollen grains that are perfectly visible around the long antennal plume and in front of the male head (Fig. 1C). This suggests that this chironomid had been visiting flowers shortly before becoming trapped in the sticky resin.

3. The chironomids of this group, with reduced mandibles and laciniae and a greatly elongated labium, include four extant species of the subfamily Orthoclaadiinae. Such mouthparts are present in all species of the genus *Rhinocladius* Edwards, with two species living in South America (Edwards 1931, Saether & Andersen 2003) and one in Australia (Freeman 1961), and also in *Pseudorthocladius macrostomus*

Soponis, 1980 from Florida in North America (Soponis 1980). In their proboscis the labrum and hypopharynx are short whereas the labella (=palpi labialis) of the labium are greatly elongated (Fig. 3C, D). In *Rhinocladius* (Fig. 3C) the palps are short and the proboscis is extremely long, sometimes as long as the whole body, whereas in *P. macrostomus* (Fig. 3D) the palps are long and the proboscis about 3.6 times longer than the eye height (Soponis 1980).

In conclusion, the elongated mouthparts evolved independently several times among mandibulate and non-mandibulate adult chironomids. Among the non-biting adults of the subfamilies Tanypodinae and Orthoclaadiinae, the elongated proboscis evolved during the Cenozoic as an adaptation to feed on nectar from deep flowers. This implies that adaptation to feed on nectar within the family has a short geological history and has also evolved several times.

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