

Gedanoborus kerneggeri, gen. et sp. nov. (Diptera: Chaoboridae) from Eocene Baltic amber

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New genus and new species *Gedanoborus kerneggeri* from Eocene Baltic amber is described and illustrated. Its systematic position is discussed. The new genus together with fossil *Taimyborus* Lukashevich, 1999 form sister groups of extant subfamilies Chaoborinae + Eucorethrinae. Tertiary genus *Eochaoborites* Hong, 2002 is excluded from the Chaoboridae and transferred to Psychodidae. A key for the identification of phantom midges from Baltic amber is provided.

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Introduction

Phantom midges (Chaoboridae) are a small family with a worldwide distribution. Their larvae and pupae are aquatic and live exclusively in permanent or temporary lentic habitats (lakes, ponds, pools) (Borkent 1981). Adults do not feed but are capable of drinking water (Sæther 1997). The extant fauna is relatively well known. It includes 50 species placed in six genera and two subfamilies (Borkent 1993).

Three subfamilies are recognized within extant and fossil phantom midges (Sæther 1992, Borkent 1993). They are Eucorethrinae Edwards (including only a single extant species living in North America), Chaoborinae Edwards (worldwide distribution, five extant genera, and including fossil Tertiary species within the extant *Mochlonyx* and *Chaoborus*), and the fossil subfamily Chironomapterinae Kalugina. The latter subfamily including many Mesozoic genera was recognized as paraphyletic by Sæther (1992) and Borkent (1993).

Fossil Chaoboridae are reported from Mesozoic (Jurassic, Cretaceous) and Cenozoic (Tertiary) de-

posits. The Mesozoic records include the following 13 fossil genera: *Astrocorethra* Kalugina, 1986 (Lower Cretaceous), *Baleiomyia* Kalugina, 1993 (Upper Jurassic or Lower Cretaceous), *Chironomaptera* Ping, 1928 (Jurassic-Cretaceous), *Chachotoscha* Lukashevich, 1996 (Upper Jurassic or Lower Cretaceous), *Chaoburmus* Lukashevich, 2000 (Lower Cretaceous), *Dixamima* Rohdendorf, 1964 (Jurassic), *Helokrenia* Kalugina, 1985 (Jurassic), *Hypsocorethra* Kalugina, 1985 (Jurassic), *Mesochaoborus* Zhang et al., 1986 (Jurassic), *Mesocorethra* Kalugina, 1993 (Upper Jurassic or Lower Cretaceous), *Praechaoborus* Kalugina, 1985 (Jurassic), *Rhaetomyia* Rohdendorf, 1962 (Jurassic) and *Taimyborus* Lukashevich, 1999 (Upper Cretaceous), (Borkent 1993, Kalugina 1993, Evenhuis 1994, Lukashevich 1996a, 1999, 2000; Poinar and Szadziewski, 2007). Detailed descriptions of phantom midges from amber have been undertaken only of the genera *Chaoburmus* Lukashevich (Burmese amber, Lukashevich 2000) and *Taimyborus* (Taimyr amber, Lukashevich 1999).

Tertiary records of phantom midges are fossil species from the extant genera *Chaoborus* Lich-

tenstein and *Mochlonyx* Loew (Borkent 1993). *Mochlonyx sepultus* (Meunier, 1902) and *Chaoborus ciliatus* (Meunier, 1904) are known from Eocene Baltic amber. Pupae and larvae of *Chaoborus tertarius* (Heyden, 1862) from Miocene brown paper coal from Rott in Germany were carefully redescribed by Borkent (1978). Pupae of an unnamed *Chaoborus* were also reported from Eocene deposits in the USA (Johnston & Borkent 1998).

The Jurassic genus *Eucorethrina* Kalugina, 1985 was transferred from the Chaoboridae to Dixidae by Lukasevich (1996a). The genus *Eochaoborites* Hong, 2002, proposed for the male of *E. xui* Hong, 2002 from Eocene Chinese amber (Fushun) is also not a phantom midge. It has separate wing veins R4 and R5 indicating that it should be placed in the Psychodidae. We agree with Borkent (1993) that the genus *Iyaiyai* Evenhuis, 1994 (= *Trichia* Hong, 1981, homonym, = *Fushunotrichia* Hong, 2002) proposed for *Trichia gracilis* Hong, 1981 from Eocene amber of Fushun does not belong to the Chaoboridae. The characters visible in the photographs and drawings of the holotype male of *I. gracilis* (Hong 1981), such as its general habitus with very long legs, flagellum without long hairs, genitalia broad and stout, small head and distinct prothorax evidently show that it is a representative of the Limoniidae, as suggested Lukasevich (2000). The monotypic genus *Baleiomyia* Kalugina, 1993 from the Upper Jurassic or Lower Cretaceous deposits of East Transbaikalia placed in the Chaoboridae (Kalugina 1993) probably is also not a member of that family (Poinar and Szadziewski, 2007).

The purpose of this paper is to describe an unusual phantom midge preserved as inclusion in Eocene Baltic amber and interpret its taxonomic position within the family Chaoboridae.

Systematic paleontology

Family Chaoboridae Edwards, 1912

Genus *Gedanoborus* gen. nov.

Type species: *Gedanoborus kerneggeri*, gen. et sp. nov.

Diagnosis. – The only genus among fossil and extant phantom midges with totally reduced wing vein M2. A combination of following character states of adult is also unique: vertex with sagittal (coronal) suture, postpronotal lobes narrowly connected, first tarsomere longer than second one, tib-

ial spurs absent, clypeus very short, additional vein CuA2a absent, distinct Rsa present.

Gedanoborus kerneggeri sp. nov

Diagnosis. – As for the genus.

Description. – Male. Unknown.

Female. Body length 2.9 mm. Well preserved, only fore tarsus and apex of tibia of right fore leg incomplete; separated elements (part of tibia and first tarsomere ?) visible just below ventral surface of abdomen (Fig. 1A, B). Body uniformly dark brown; wing without pattern (generally not preserved in any Baltic amber fossils).

Head with reniform eyes narrowly separated above antennae (Fig. 2A). Dorsomedian extension of eye gradually narrowing from six at base through five to three facets medially. Vertex with distinct sagittal (coronal) suture. Frons composed of two convex sclerites with distinct sagittal suture.

Flagellum with 13 flagellomeres (Fig. 2C); total length 0.97 mm; apical flagellomere longer than preceding one; pedicel bearing some setae, scape probably bare.

Proboscis, including clypeus, short (Fig. 2A,B). Palpus 5-segmented; third palpal segment relatively stout, 0.140 mm long; fourth and fifth palpal segments slender, 0.155 and 0.163 mm long respectively.

Anterior lateral cervical sclerite well sclerotized, triangular. Postpronotal lobes narrowly connected. Delicate, long setae present on antepronotum (group), proepisternum (group), postpronotum (some at upper margin), katepisternum (some), posteroanepisternum (some) and anepimeron (some). Prealar setae absent (Fig. 2B). Acrostichals and dorsocentrals present. Long setae on scutellum present, their arrangement not well visible. Lanceolate scales on thorax absent.

Legs unmodified, without lanceolate scales. Tibiae without apical spurs, fore tibia 0.97 mm, hind tibia 0.91 mm long. Lengths of first tarsomere as follows: fore leg 0.437 mm, of middle leg 0.274 mm, of hind leg 0.429 mm. First tarsomere 1.5–1.8 times longer than second tarsomere (Fig. 2D). Tarsal ratio (TR) of fore leg TR(I) 1.54, of mid leg TR(II) 1.62, of hind leg TR(III) 1.81. Claws similar on all legs, small, simple, equal (Fig. 2E); pulvilli indistinct.

Wing length measured from arculus 1.97 mm. Veins with slender hairs. Scale like setae present

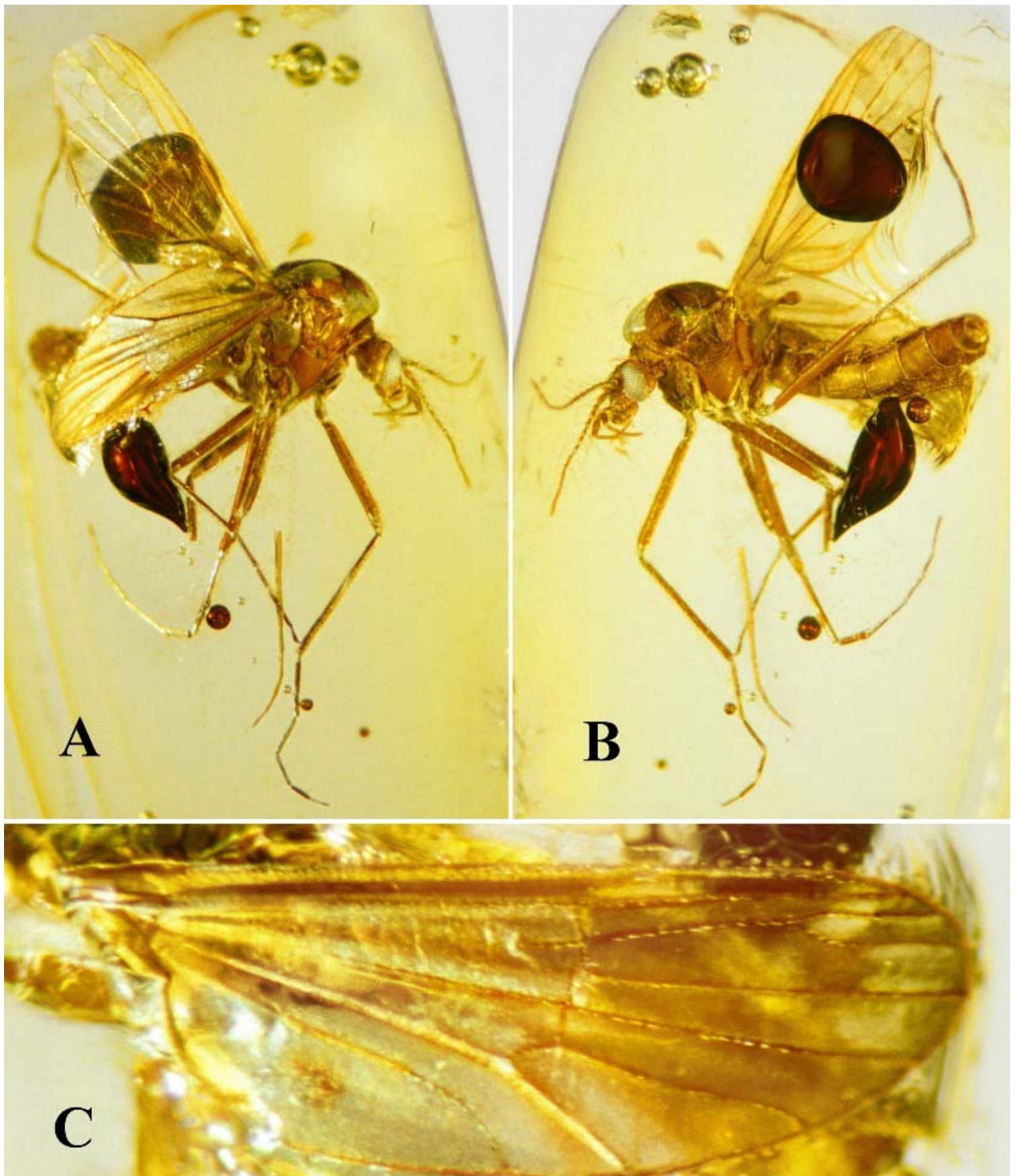


Fig. 1 A-C. *Gedanoborus kerneggeri* gen. nov. et sp. nov., female holotype. A – total habitus, right side, B – total habitus, left side, C – wing.

on anterior wing margin (only one preserved). Nine veins reaching wing margin; vein M2 absent. Cross veins cu-m, r-m and Rs in one transverse

row. Vein Rs spurred. Vein CuA2 simple, i.e. without additional vein CuA2a (Fig. 1C, 2F). Halter without distinct setae.

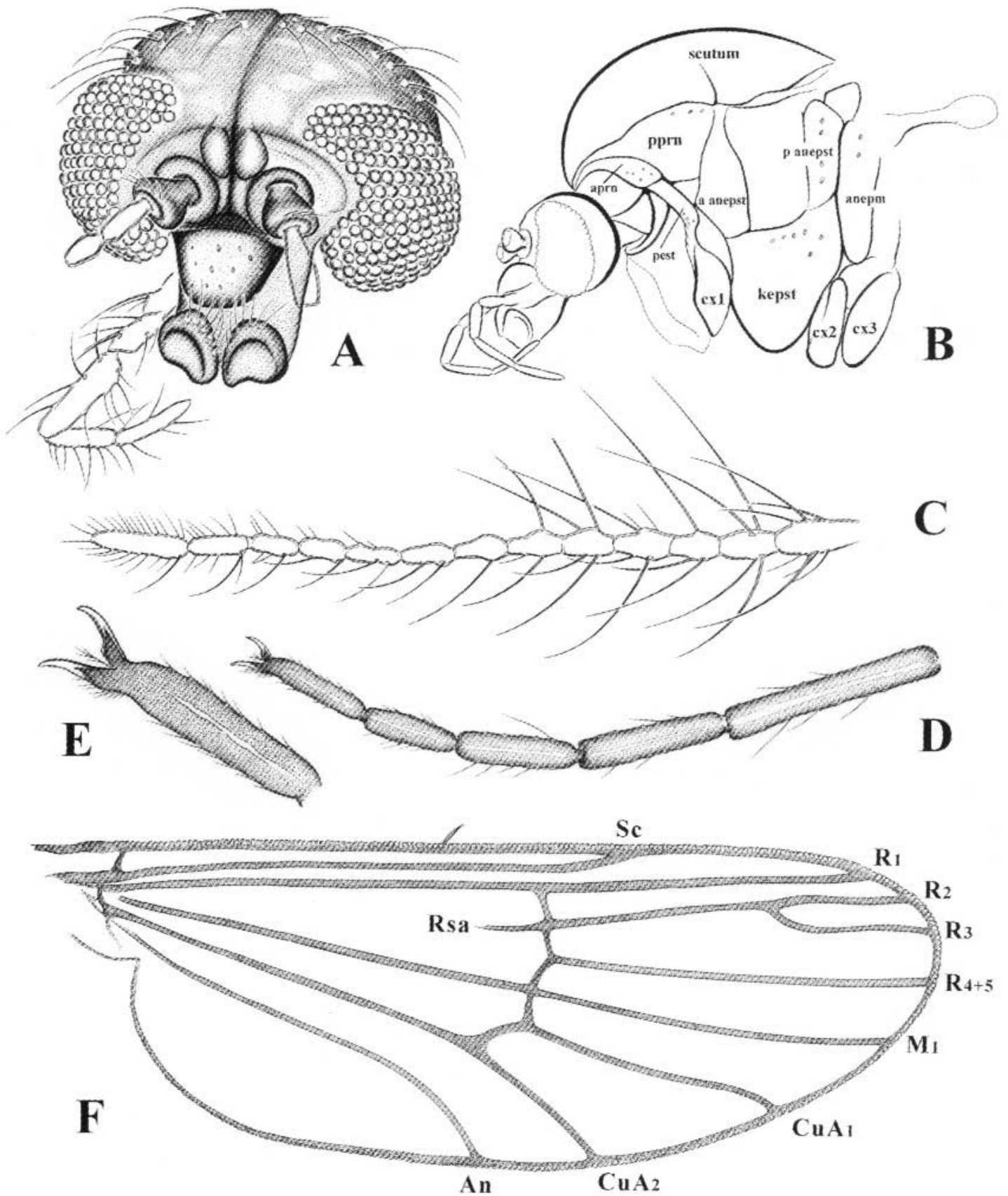


Fig. 2 A-F. *Gedanoborus kerneggeri* gen. nov. et sp. nov., female holotype. A – frontal aspect of head, B – lateral aspect of head and thorax, C – flagellum, D – tarsus of midleg, E – fifth tarsomere of midleg, F – wing venation. Abbreviations: aprn – antepronotum, pest – proepisternum, pprn – postpronotum, a anepst – anteroanepisternum, p anepst – posteroanepisternum, kepst – katepisternum, anepm – anepimeron, cx 1,2,3 – coxa of fore, mid and hind leg.

Abdomen stout without lanceolate scales. Cercus short.

Type material. – Holotype female in a small piece of Baltic amber embedded in artificial resin from collection of Friedrich Kernegger of Hamburg (Saselheider str. 39, 22159 Hamburg, Germany), no. 14/2006. The holotype will be deposited in the Museum of Amber Inclusions, University of Gdańsk, No. MBI 4995.

Etymology. – The generic name *Gedanoborus* is a combination of Gedanum (Latin name of Gdańsk, the world centre of amber jewellery) and *Chaoborus*. The species is dedicated to Friedrich Kernegger of Hamburg in recognition of his outstanding work at collecting the amber inclusions who decided to deposit the holotype in the public institution.

Discussion

The phylogenetic history of the Chaoboridae goes back to the Jurassic or earlier. The oldest fossils, regarded as phantom midges, are *Rhaetomyia* and *Praechaoborus* reported from the Lower Jurassic (Rohdendorf 1962, Kalugina & Kovalov 1985). Other barely preserved compression fossils from the Middle and Upper Jurassic or Lower Cretaceous deposits include further genera: *Astrocorethra*, *Baleiomyia*, *Chironomaptera*, *Dixamima*, *Helokrenia*, *Hypsocorethra*, *Mesochaoborus* and *Mesocorethra*. They are usually placed in the fossil subfamily Chironomapterinae Kalugina, 1974 (Kalugina 1980, 1993; Kalugina & Kovalov 1985) recognized as a paraphyletic group (Sæther 1992, Borkent 1993). We include here the barely preserved genus *Chachotosha* (Lukashevich 1996b), as well as *Chaobormus* (Lukashevich 2000), both of unknown subfamilial position.

The taxonomic position of *Gedanoborus* within the Chaoboridae is rather clear. *Gedanoborus*, with its distinct sagittal suture and short proboscis, cannot be placed in *Chaoborus* as the vertex of the genus lacks sagittal suture, while the proboscis is relatively long and includes elongated clypeus (Sæther 1997). As shown in Fig. 3 below, the genus *Chaoborus* probably evolved during Tertiary and is not synonymous with the extinct Mesozoic genus *Chironomaptera* as suggested by Sæther (1992). *Gedanoborus* cannot be placed in the extant subfamily Chaoborinae because it has a short proboscis and a single vein CuA2, and the median part of the postpronotum is not totally reduced.

The new genus cannot be placed within the extant subfamily Eucorethrinae Edwards, either. This subfamily includes the single extant Nearctic

species *Eucorethra underwoodi* Underwood, 1903 with a greatly elongated clypeus and proboscis (see below). *Gedanoborus* with the Rsa appendix vein cannot be placed within the paraphyletic Chironomapterinae, as this fossil subfamily lacks this character state.

The phylogenetic analyses within the Chaoboridae involve mostly characters of the immatures because the number of adult characters are limited (Sæther 1992, 2000; Borkent 1993).

We are focusing on the following adult characters observed in *Gedanoborus*:

Appendix wing vein Rsa present. The dipteran Rs vein usually joins the R1 evenly, at a sharp angle. On rare occasions, Rs is connected with R1 almost at right angle, in which case Rs is more or less prolonged or spurred to the wing base as Rsa (Fig. 2F). The spurred vein Rs is rare but widely distributed among lower dipterans; for example it is recorded in the Tanyderidae, Ptychopteridae, mosquitoes of the genus *Anopheles* (Culicidae), and possibly in some other groups. In the fossil record of the Chaoboridae, the character state was first found in the Upper Cretaceous *Taimyborus aequiarticulatus* (Lukashevich 1999). We believe that the Rsa vein evolved within the Chaoboridae during that time because the vein is absent in the known genera of phantom midges from the older Jurassic and Lower Cretaceous. Similar suggestion was put forward by Lukashevich (1999). Rsa is observed in all the Tertiary species (*Gedanoborus*, *Chaoborus* and *Mochlonyx*; present observations) found in the Eocene Baltic amber, while it is absent or present in the extant phantom midges. We recognize Rsa as synapomorphy for the Eucorethrinae+Chaoborinae+*Gedanoborus*+*Taimyborus*. If our suggestion is true, then it is possible that the family Culicidae evolved from this lineage with a spurred Rs, as Rsa is present in all the extant *Anopheles* and was reported from a Tertiary member of the genus by Zavortink & Poinar (2000). However, the oldest true mosquito reported from the Upper Cretaceous (*Palaeoculicites minutus*) (Poinar et al. 2000) has no recognizable spurred Rs (the wing venation was not clearly illustrated and interpreted). Spurred Rs is also absent in the female of *Burmaculex antiquus* Borkent & Grimaldi, 2004 preserved in Lower Cretaceous Burmese amber and recognised as the oldest mosquito (Borkent & Grimaldi 2004). However, we doubt that this fossil, devoid of long proboscis and

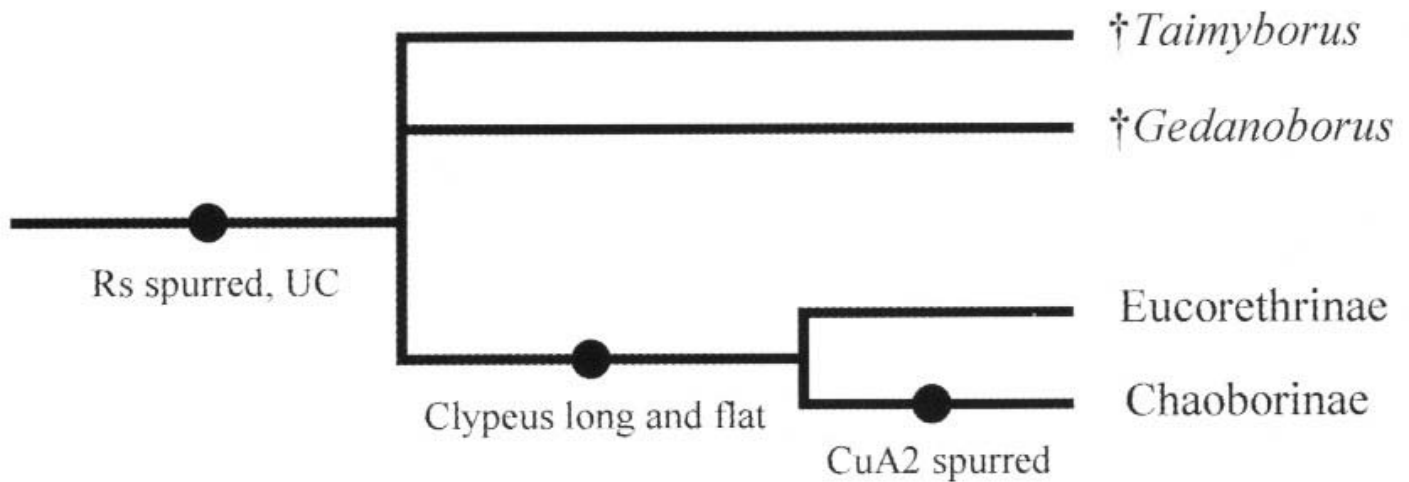


Fig. 3. Cladogram showing position of *Gedanoborus* within the family Chaoboridae. Lower Cretaceous and Jurassic genera from the paraphyletic subfamily Chironomapterinae not included (UC – Upper Cretaceous). Synapomorphies marked with black dots.

striated scales on all wing veins, is a true mosquito but rather a member of the family Chaoboridae. Further studies are necessary.

Short and convex clypeus. Within the Culicoidea, the clypeus in adults is short and convex in the Culicidae, most of the Dixidae (Borkent, pers. comm.), and in the Corethrellidae, while it is long, slender and flat in the extant Chaoboridae. In the subfamily Chaoborinae, its length is usually at least twice its width. We propose to treat the elongated and flat clypeus as synapomorphy for the Eucoethrinae+Chaoborinae (Fig. 3). All the Mesozoic phantom midge fossil genera, including *Gedanoborus*, have a short clypeus. Only *Chachotoscha* from the Upper Jurassic/Lower Cretaceous has a long proboscis and a long clypeus (Lukashevich 1996b). However, its description is based on an impression fossil, therefore the information should be treated with caution.

Spurred vein CuA2 not developed. Additional vein CuA2a or spur of CuA2 is observed only within the Tertiary *Chaoborus* and *Mochlonyx*, and also in many extant species of these genera (Edwards 1930, Verbeke 1958, Sæther 1997). We propose the character state be treated as synapomorphy for the subfamily Chaoborinae. This is a unique apomorphy, unknown among other dipterans. That character state was disregarded in Sæther's (1992) phylogenetic analysis. We suggest that the additional vein CuA2a evolved during the early Tertiary and propose that the character state be treated as synapomorphy for the subfamily

Chaoborinae. Obviously, the synapomorphy is not complete, i.e., it is secondarily reduced in some species. All the phantom midges found in the Eocene Baltic amber and determined as *Mochlonyx* and *Chaoborus* (present observations) have distinct CuA2a. It is worth noting that the character is sometimes difficult to observe in amber-embedded specimens, as Hennig (1966) did not mention it when reporting on *Mochlonyx sepultus*.

Non-divided postpronotum. It is curious that the postpronotum is clearly visible in the fossil specimen examined. The postpronotum lateral lobes of *Gedanoborus* are connected by a narrow band located between the antepronotum and the scutum (Fig. 2B). A similar character state has been observed only in North American *Eucoethra* (subfamily Eucoethrinae) forming a sister group of the extant Chaoborinae (Fig. 3). Adults of the subfamily Chaoborinae have a reduced median band, and their postpronotum lateral lobes are separated (Cook 1981). The lobes are fused with the anterolateral margins of the scutum. We observed a similarly reduced postpronotum in members of other Culicomorpha in our collection (Culicidae, Dixidae, Corethrellidae, Simuliidae, Ceratopogonidae, Chironomidae and Thaumaleidae) that we cursorily examined. Although the out-group comparison suggests that the character state may be treated as synapomorphy, we believe that the more complete (undivided) postpronotum is a plesiomorphy within the family.

Wing vein M2 absent. The totally reduced wing

vein M2 (Fig. 2 F), observed in *Gedanoborus*, is unknown in other fossil and extant phantom midges. The new species is not related to *Chaoborus anomalus* Edwards, 1930 from Africa placed in the new subgenus *Neochaoborus* Edwards, 1930 (Edwards 1930, Verbeke 1958). This extant species has an atrophied M2 base, reduced palps, and female flagellum. Other characters are typical of *Chaoborus* as suggested by Edwards (1930) and Borkent (1979, personal comm.). The forked M1 and M2 are always present in all the extant and fossil chaoborids.

First tarsomere longer than second. In the new genus, the first tarsomere is 1.5–1.8 times longer than the second. The tarsal ratio (TR) higher than 1.0 is a plesiotypic feature within the family. The tarsal ratio lower than 0.5 is found only in *Mochlonyx*, *Promochlonyx* Edwards, 1930, *Australomochlonyx* Freeman, 1962 and *Cryophila* Edwards, 1930 which form a monophyletic sister group of *Chaoborus* as proposed by Sæther (1992). The character state (a short first tarsomere) is widely distributed among the lower Diptera. It is known among the Trichoceridae, Ceratopogonidae, Cecidomyiidae, and possibly in some other groups. Within the phantom midges, a low TR evolved probably during Tertiary. All the known Mesozoic chaoborids have the first tarsomere equal or longer than the second.

In the cladogram presented (Fig. 3) the Tertiary *Gedanoborus* and the Upper Cretaceous *Taimyborus* are in a position of sister groups of the extant Chaoborinae+Eucoethrinae. The genus *Taimyborus* is known from a single female which showed the following set of characters: proboscis, including clypeus, short; Rsa spurred; tibia without apical spurs; spur of CuA2 absent; first and second tarsomeres almost equal in length; M2 present. The first four characters indicate some similarity to *Gedanoborus*. The postpronotum in *Taimyborus* is not examinable. *Gedanoborus* and *Taimyborus* will probably need a new paraphyletic subfamily as they have no synapomorphy.

Key to adult phantom midges from Baltic amber

1. Wing vein M2 absent; additional vein CuA2a absent *Gedanoborus kerneggeri* gen. et sp. nov.
- Wing vein M2 present; additional vein CuA2a present 2
2. First tarsomere longer than second one. Tarsal claws short, simple. Female wing length 3.0–

- 3.5 mm..... *Chaoborus ciliatus* (Meunier, 1904)
- First tarsomere much shorter than second one. Tarsal claws long; in male with large median tooth and basal talon. Male wing length 2.4–2.5 mm *Mochlonyx sepultus* (Meunier, 1902)

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