



Research article

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A new genus and species of Leptoconopinae (Diptera: Ceratopogonidae) from Lower Cretaceous Baskinta amber outcrop in Lebanon

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Abstract. A new fossil ceratopogonid genus and species from Lower Cretaceous Lebanese amber, *Baskintoconops maaloufi* Pielowska-Ceranowska gen. et sp. nov., is described and illustrated. The studied material originates from a newly discovered amber site in the Lebanese village Baskinta at a locality dubbed Qanat Bakish. The described genus is typified by its wing venation pattern combining characters of genera *Fossileptoconops* and *Jordanoconops* belonging to the subfamily Leptoconopinae.

Keywords. Taxonomy, biting midges, new genus, new species, Lower Cretaceous.

Pielowska-Ceranowska A., Azar D. & Szwedo J. 2023. A new genus and species of Leptoconopinae (Diptera: Ceratopogonidae) from Lower Cretaceous Baskinta amber outcrop in Lebanon. *European Journal of Taxonomy* 908: 27–38. <https://doi.org/10.5852/ejt.2023.908.2335>

Introduction

The nematoceran dipteran Ceratopogonidae Newman, 1834 (biting midges) is a diverse and abundant family, with over 6500 extant and fossil species, which occur from tidal settings to high mountain ranges from the tropics to subpolar areas north and south. The females of these flies have by far the broadest feeding repertoire of any biting insect group, with many taxa requiring a protein meal to develop their eggs – including blood-feeding, haemolymph-feeding, feeding on decaying organic matter, nectar or pollen. Both sexes seek out nectar to fuel flight (Borkent & Dominiak 2020).

The remarkable fossil record of Ceratopogonidae reaches back the mid-Berriasian, Early Cretaceous (ca 142 Ma) of the Purbeck Limestone Group, England (Borkent *et al.* 2013). Currently, there are eight genera representing Ceratopogonidae known from Lower Cretaceous sedimentary deposits and fossil resins, viz. *Atriculicoides* Szadziwski, 1996 (attributed to Atriculicoidinae Szadziwski, 1996), *Archiaustroconops* Szadziwski, 1996, *Fossileptoconops* Szadziwski, 1996, *Jordanoconops* Szadziwski, 2000, *Lebanoculicoides* Szadziwski, 1996, *Minyohelea* Borkent, 1995 (attributed to Leptoconopinae Noè, 1907) and unplaced genera *Archiculicoides* Szadziwski, 1996, and *Gerontodacus* Borkent, 2019 (Borkent & Dominiak 2020; Pielowska-Ceranowska *et al.* 2022a, 2022b). Lower Cretaceous Lebanese and Jordanian amber inclusions comprise 30 species (Borkent & Dominiak 2020; Pielowska-Ceranowska *et al.* 2022a, 2022b) in six genera: *Archiaustroconops*, *Fossileptoconops*, *Jordanoconops*, *Lebanoculicoides*, *Minyohelea*, *Gerontodacus*. Here a species within a new genus is described, placed in Leptoconopinae. This fossil is the first Ceratopogonidae to be described from the Baskinta (Qanat Bakish) amber outcrop (for detail on outcrop see Maksoud *et al.* 2021).

Material and methods

Collection and preservation

Specimens were collected in the locality of Qanat Bakish, in the Baskinta amber outcrop (Maksoud *et al.* 2021), Central Lebanon; lower Barremian (Fig. 1). The examined material comes from the Maalouf collection, deposited in the Natural History Museum of the Lebanese University, Faculty of Sciences II, Fanar, Lebanon.

Morphological characterization

The material was prepared according to the method described by Azar *et al.* (2003). Morphological examination of the specimen was conducted in the Laboratory of Evolutionary Entomology and Museum of Amber Inclusions University of Gdańsk (MAIG) using an Olympus BX51 microscope, equipped with

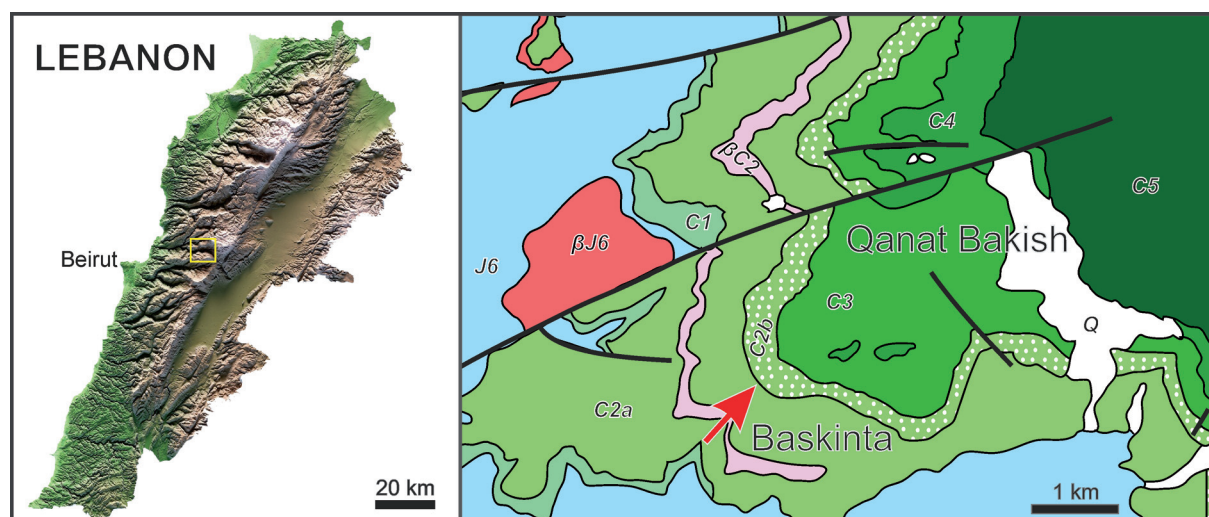


Fig. 1. Geological map: Baskinta (Qanat Bakish) (red arrow) (modified from Dubertret 1945, and Dubertret & Wetzel 1945). Abbreviations: J6 = uppermost Jurassic; C1 = Salima Formation (lower Valanginian); C2a = lower Barremian “Grès du Liban” sandstone; C2b = Barremian clay and oolitic deposition of the upper part of the “Grès du Liban” and oolitic deposition of the lower part of the Jezzian; C3 = micritic part of the Jezzian (uppermost Barremian-lowermost Aptian); C4 = Albian; C5 = Cenomanian; Q = Quaternary scree; β J6 = Kimmeridgian volcanic deposition; β C2 = lower Barremian volcanic deposition. Thick lines represent faults.

camera lucida for drawings and Canon EOS 90D digital camera and an Olympus DSX 1000 digital microscope. Drawings were readjusted using GIMP ver. 2.10, CorelDrawX7 and Inkscape ver. 1.1.2 packages, photographs were composed using Helicon Focus ver. 7.6.4 stacking software (method B) and readjusted using CorelPhotoPaintX7 graphic package. Measurements: LR – the leg ratio, is obtained by dividing the length of the tibia into the length of the basitarsus (ta_1/ti). TR – tarsal ratio, is the division of the second tarsomere length into that of the basitarsus (ta_1/ta_2). CR – costal ratio, is the length of the costa from the arculus divided by the wing length. Comparative palaeontological material used for preparation of this study comes from the collection of the Museum of Amber Inclusions University of Gdańsk (MAIG).

Results

Systematic palaeontology

Class Insecta Linnaeus, 1758
Order Diptera Linnaeus, 1758
Suborder Nematocera Latreille, 1825
Infraorder Culicomorpha Hennig, 1948
Superfamily Culicoidea Meigen, 1818
Family Ceratopogonidae Newman, 1834
Subfamily Leptoconopinae Noè, 1907

Genus *Baskintoconops* Pielowska-Ceranowska gen. nov.
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Type species

Baskintoconops maaloufi Pielowska-Ceranowska gen. et sp. nov.; by present designation and monotypy.

Diagnosis

Costa significantly extended beyond the tip of R_{2+3} vein (as in *Jordanoconops* and *Fossileptoconops*), and prolonged to 0.8 of wing length (reaching about 0.75 of wing length in *Jordanoconops* and *Fossileptoconops*). Vein R_{2+3} ends at about the middle of the wing, while maintaining a relatively long first radial cell as a result of reduction of the R_2 vein (similarly to *Jordanoconops* and *Fossileptoconops*); vein M forked in basal half of wing length, *r-m* absent (*r-m* present in *Jordanoconops*; uncertain in *Fossileptoconops*), basal section of M about twice as long as M_1 section from fork to fusion with R_{2+3} , basal section of R_{2+3} thickened (stem M forked in distal half of wing length in *Jordanoconops* and *Fossileptoconops*).

Etymology

The new genus is named after its collecting location, the Lebanese village Baskinta.

Remarks

The identification features in the venation of the wing are a fusion of those previously observed in representative of Lower Cretaceous Ceratopogonidae genera. The venation combines the features of, and is most congruous to, that of *Jordanoconops*, and *Fossileptoconops*. The general scheme of wing venation of the new genus is similar to that of *Jordanoconops* due to the presence of an elongated single radial cell, absence of the R_2 vein, and basal section of R_{2+3} perpendicular to R_1 . In *Baskintoconops* gen. nov. and in *Fossileptoconops* vein R_{2+3} ends at the costal margin at about half of wing length, while in *Jordanoconops* R_{2+3} vein ends distinctly apicad of half of wing length. However, *r-m* vein is clearly

present in *Jordanoconops*, and absent in *Baskintoconops*; this feature is not clear in *Fossileptoconops*, it could be absent (Szadziwski 1996; Borkent 2019).

Baskintoconops maaloufi Pielowska-Ceranowska gen. et sp. nov.
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Figs 2–4

Diagnosis

As for genus as it is only included species so far. In addition: fore leg LR 1.83, TR 2.4; hind leg LR 1.71, TR 1.18.

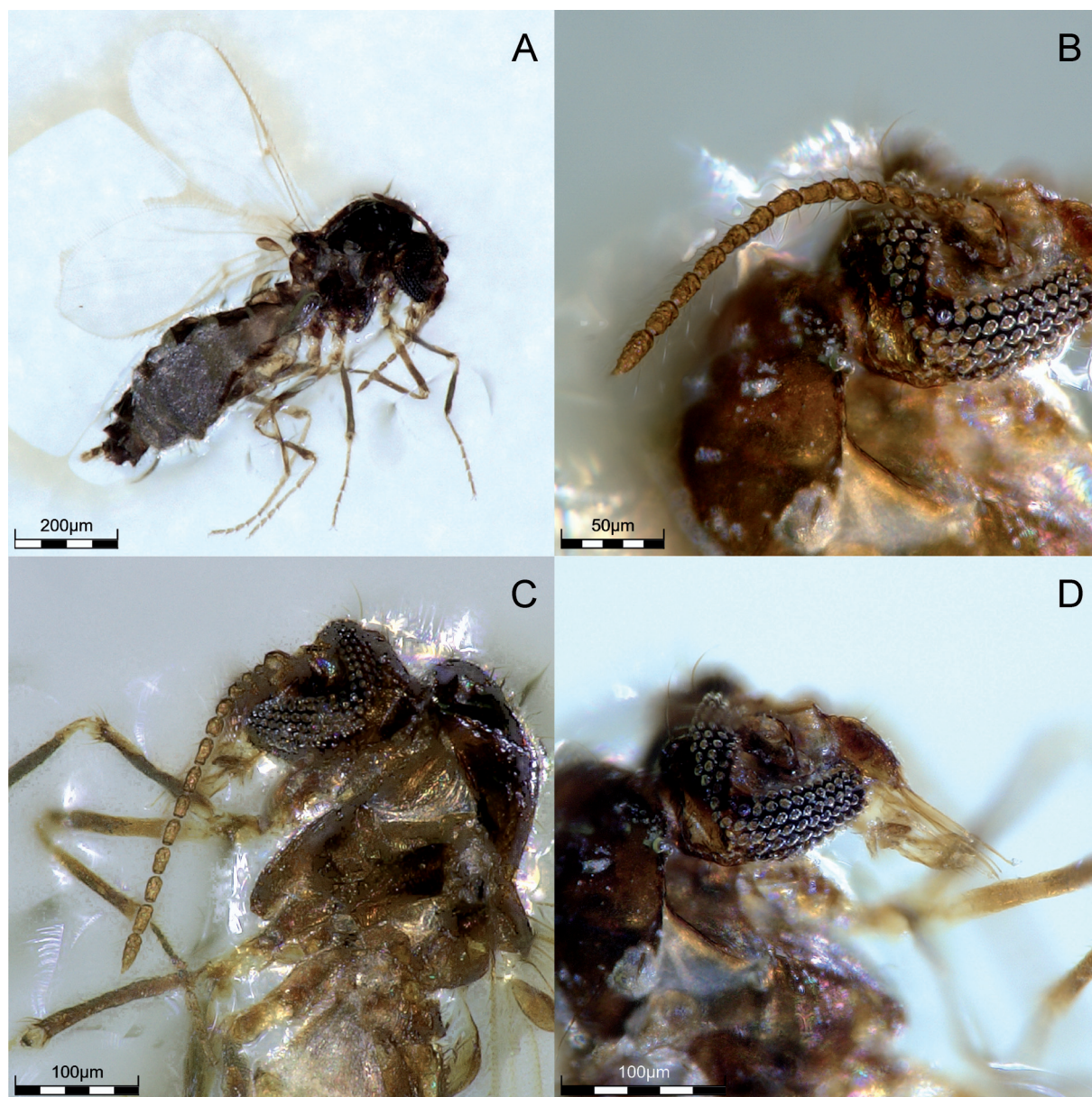


Fig. 2. *Baskintoconops maaloufi* Pielowska-Ceranowska gen. et sp. nov., holotype (QBC-13D). A. General view. B. Compound eye and right antenna. C. Anterior portion of body, left lateral view. D. Head and mouthparts, right lateral view.

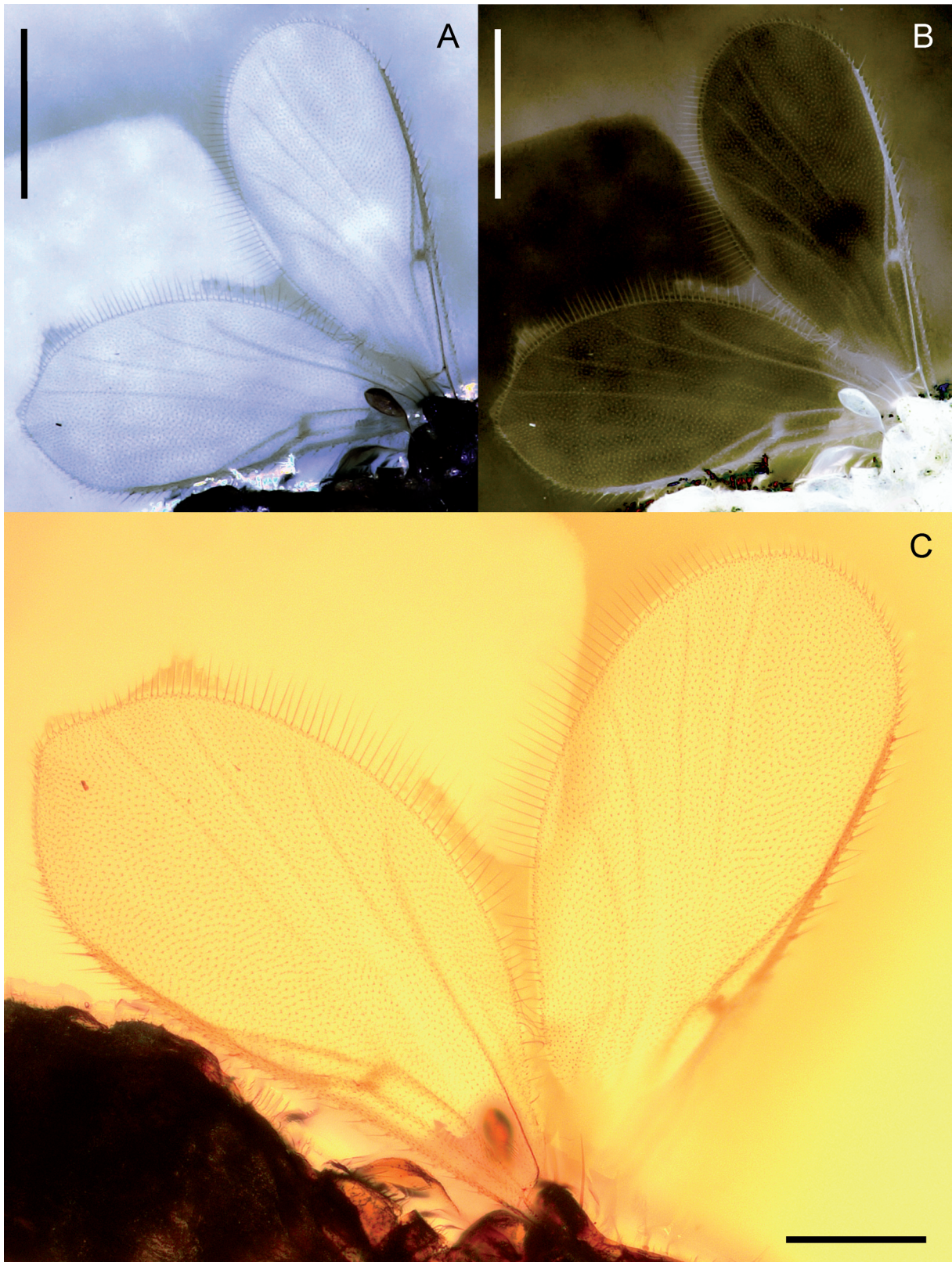


Fig. 3. *Baskintoconops maaloufi* Pielowska-Ceranowska gen. et sp. nov., holotype (QBC-13D). **A.** Wings venation and halter in mixed blue light. **B.** Negative image of wings venation and halter in mixed blue light. **C.** Wings in white translucent illumination. Scale bars: A–B = 0.2 mm; C = 0.1 mm.

Etymology

The specific name is after Mounir and Ramy Maalouf, collectors of this fossil.

Material examined

Holotype

LEBANON • ♀ (placed between cover slips with medium (Canada balsam), well preserved); lower Barremian; QBC-13D, Museum of Natural History of the Lebanese University, Faculty of Sciences II, Fanar, Lebanon.

Locality and horizon

Qanat Bakish, Baskinta (33°57'3" N, 35°47'24" E), Caza (= District) El-Maten, Mouhafazet (= Governorate) Mount Lebanon, Central Lebanon; lower Barremian (Maksoud & Azar 2020; Maksoud *et al.* 2021, 2022).

Description

Female (holotype, QBC-13D)

TOTAL HABITUS. As in Fig. 3A.

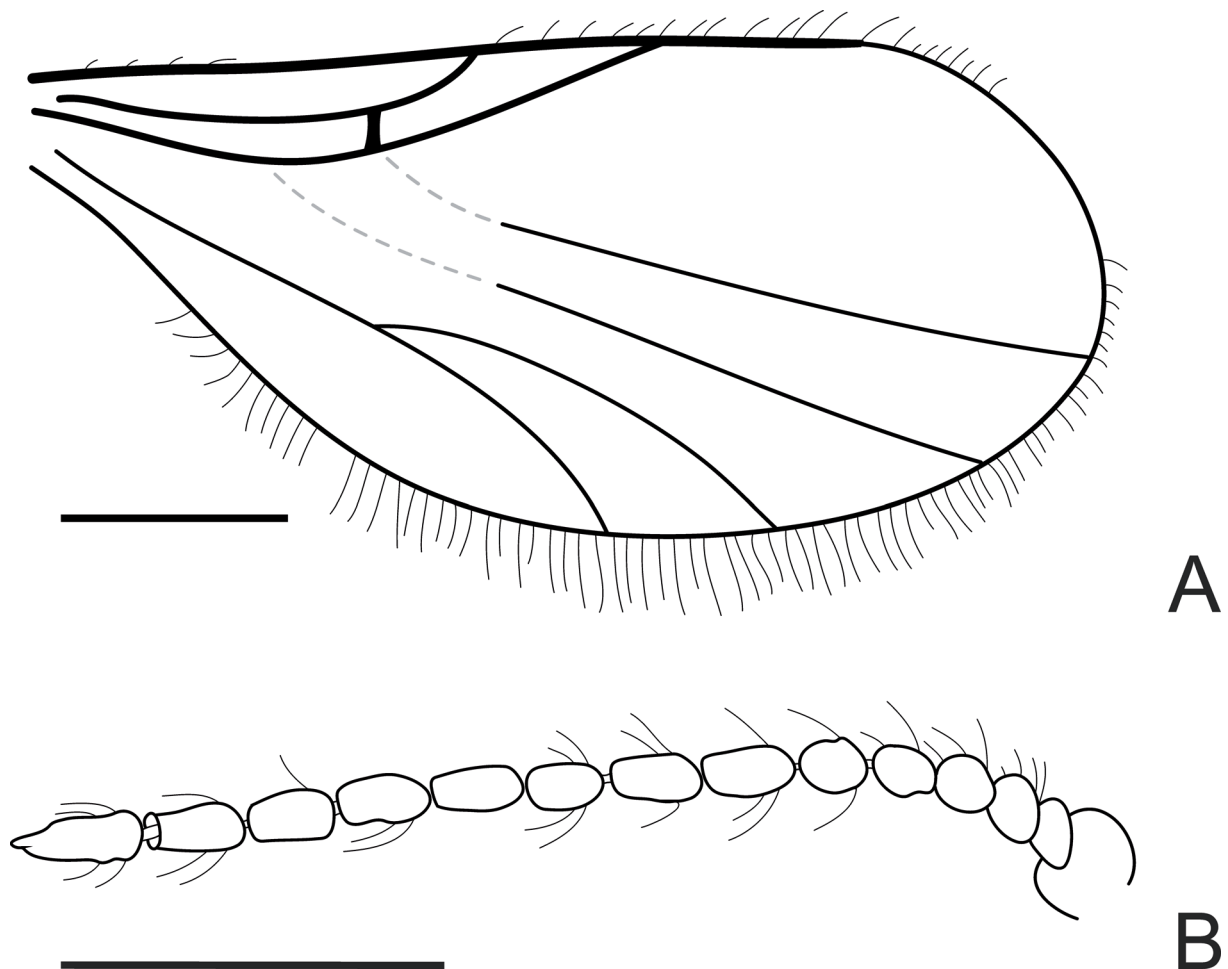


Fig. 4. *Baskintoconops maaloufi* Pielowska-Ceranowska gen. et sp. nov., holotype (QBC-13D). **A.** Venation pattern of wing. **B.** Antenna. Scale bars = 0.1 mm.

HEAD. Eyes reniform, deep antieriad concavity, surrounding base of antennae, bare, fused above antennae, with distinct ommatidia; mouthparts elongated, needle-like, shorter than height of head capsule, hypophygium spatulate, palpi 4-segmented, third palpomere slightly thicker with round sensory pit and single elongate seta, apical palpomere slightly slender with 4 apical setae. Antennae with 15 antennomeres, flagellum composed of 13 separate flagellomeres, 6th–12th nearly equal in length, terminal flagellomere with slightly pointed apex; proboscis quite long.

MEASUREMENTS. Body length 0.86 mm. Thorax 0.29 mm long, 0.14 mm high. Legs: moderately slender, fore femur as long as fore tibia, 0.13 mm, fore tarsus 0.17 mm, tarsomeres: I – 0.06 mm, II – 0.025 mm, III – 0.02 mm, IV – 0.02 mm, V – 0.025 mm; hind femur as long as hind tibia, 0.13 mm; hind tarsus 0.21 mm, tarsomeres: I – 0.065, II – 0.055 mm; III – 0.02 mm, IV – 0.015 mm; V – 0.03 mm. Claws simple, near equal in length.

WING. Length 0.5 mm, costal vein length 0.41 mm, costal ratio 0.82, wing membrane without macrotrichia. Haltere with thin pedicellum and droplet-shaped, elongately spatulate capitulum. Base of M_1 and M_2 veins weakly expressed (marked with dashed lines in the Figures 4A and 5C).

ABDOMEN. Abdomen 0.48 mm, cerci rather long and slender, ca 0.05 mm.

Male

Unknown.

Discussion

Newly described *Baskintoconops* gen. nov. belongs to Leptoconopinae because of a combination of characters present in other fossil and extant genera of this subfamily – eyes separated medially without a suture, antennae with flagellum composed of 13 flagellomeres, with apical flagellomere elongated, palpus 4-segmented, wing lacking microtrichia, with veins R strengthened but bare, without setae, 1st metatarsomere without a palisade of setae and elongate cercus (Borkent 1995, 2000, 2017, 2019; Szadziewski 1996; Szadziewski *et al.* 2015). The subfamily Leptoconopinae comprises currently the extant genera *Leptoconops* Skuse, 1889 (with six extant subgenera and extinct subgenus *Palaeoconops* Borkent, 2001), *Austroconops* Wirth & Lee, 1958, and extinct genera *Archiaustroconops*, *Fossileptoconops*, *Jordanoconops*, and *Minyohelea* (Borkent & Dominiak 2020) and here we add another genus to this group – *Baskintoconops*.

Baskintoconops gen. nov. is well separated from other taxa of Ceratopogonidae by a unique set of features. In *Baskintoconops* the upper ommatidia appear to be placed close together, as in *Jordanoconops*, in contrast to females of *Fossileptoconops*, where the ommatidia are widely separated. The anterior margin of the compound eyes of *Baskintoconops* is deeply incised, constricting the median part of the compound eyes. *Baskintoconops* shares with *Fossileptoconops* the feature of an elongate female cercus, but the cercus is longer than in *Fossileptoconops*. The cercus is short in *Jordanoconops*. Regarding the fore wing venation, *Baskintoconops* is distinguished by the complete reduction of veinlet *r-m*. This veinlet is also reduced or shifted to the very base of the wing in subgenus *Palaeoconops* of *Leptoconops* (Borkent 2001, 2019), also from Lebanese amber. The interesting separation of stem R and fate of veinlet *r-m* is crucial in understanding the morphological disparity within the Ceratopogonidae. In *Baskintoconops* the basal portion of R_{2+3} is short and perpendicular to main stem and its prolongation R_1 (Fig. 5). Veinlet *r-m* and its variability needs to be reinvestigated, as it is evidently very labile, changing from a distinct, short veinlet, a long section in prolongation of M stem, to obsolete or completely reduced. The variability in conformation of stems R and M leads to different patterns of forking (Fig. 5), with the common section of M, apicad of *r-m*, branches M_1 and M_2 clearly bifurcated, or with basal section(s) of terminal more or less weakened, to the pattern observed in *Baskintoconops* with a weak base of M_2 shifted distinctly

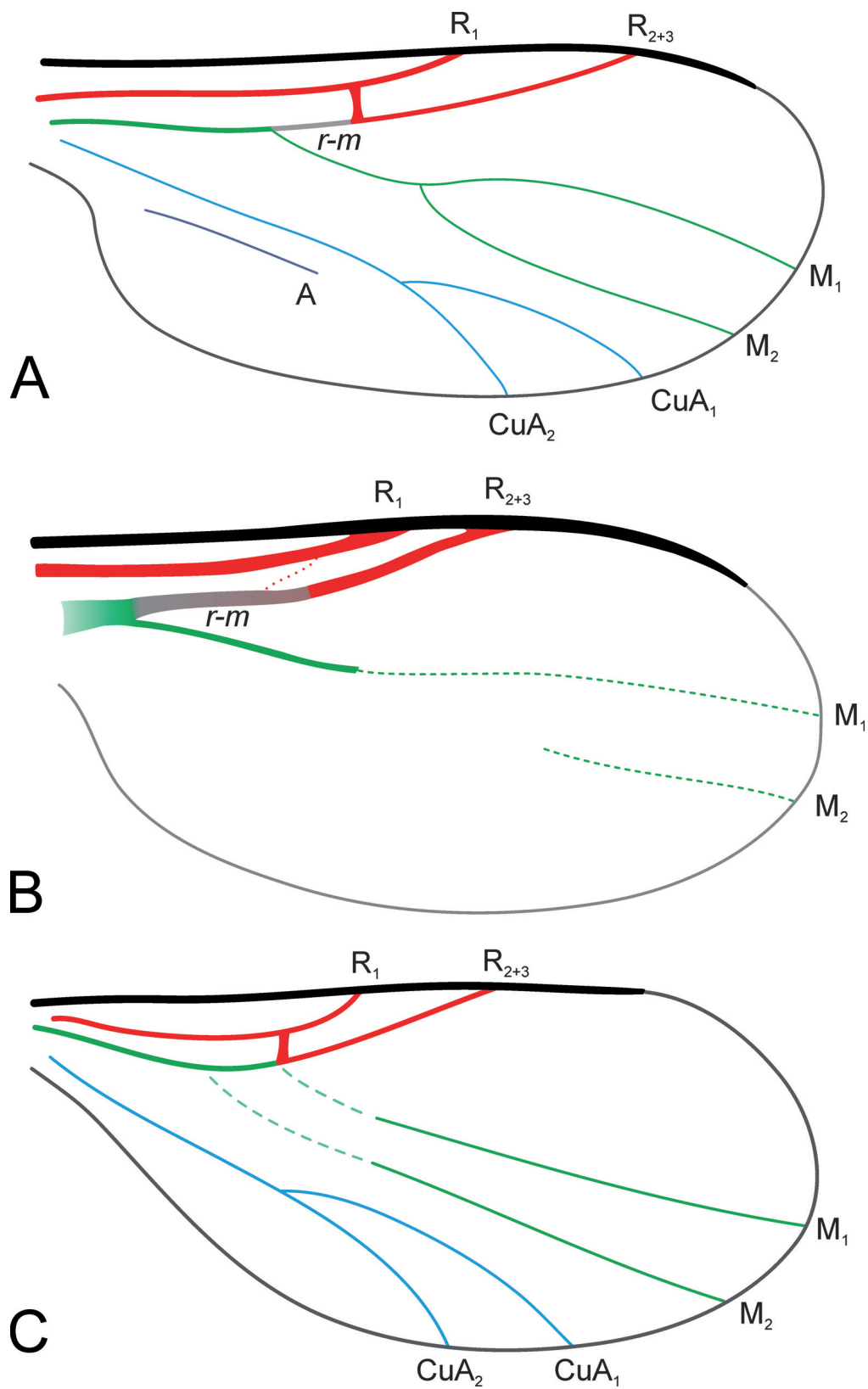


Fig. 5. Venation patterns of Lower Cretaceous Leptoconopinae Noè, 1907. **A.** *Jordanoconops* Szadziwski, 2000. **B.** *Fossileptoconops* Szadziwski, 1996. **C.** *Baskintoconops* Pielowska-Ceranowska gen. nov. A and B modified after Szadziwski (2000) and Borkent (2000, 2019).

basad. A synapomorphy for fossil genera of Leptoconopinae was proposed by Szadziwski (1996) and discussed by Borkent (2000) and Borkent & Craig (2004) – the foreleg tarsal ratio/hind-leg tarsal ratio being ≥ 1.4 . *Baskintoconops* also presents this state.

The new genus described above is the 7th genus and 31st species of Ceratopogonidae from Lower Cretaceous Lebanese amber. This family is (and it seems was) a diverse and abundant component of various terrestrial habitats, with their larvae developing in a wide range of aquatic and semi-aquatic habitats (Borkent 2017; Mullen & Murphree 2019). Among the modern representatives of Ceratopogonidae, females subsist on a wide variety of food. Recent Ceratopogonidae can develop in estuarine marshes, intertidal pools and mangrove habitats, and similar lifestyles and habitats have been postulated for the fossil forms (Szadziwski 2018). The known biological requirements of Ceratopogonidae were met in habitats where Lebanese amber was formed (Maksoud & Azar 2020; El Hajj *et al.* 2021; Maksoud *et al.* 2022, and references herein). The evolution of haematophagy in insects has already been widely discussed, but many questions remain unanswered (Lukashevich & Mostovski 2003; Lehane 2005; Boulton 2022). The hypothesis about haematophagy on homoiothermic vertebrates, including non-avian dinosaurs in the Cretaceous, was presented, but so far with limited evidence. Teeth and tracks of a variety of dinosaurs have been recorded in Barremian deposits in Lebanon, indicating that they were part of the local palaeoenvironment (Buffetaut *et al.* 2006; Gèze *et al.* 2016). Younger Cenomanian (early Upper Cretaceous) deposits contain fossils of pterosaurs and early birds (Dalla Vecchia *et al.* 2001; Dalla Vecchia & Chiappe 2003; Cay & Arduini 2008; Elgin & Frey 2011; Kellner *et al.* 2019). These vertebrates and their young, but also possible mammals, living near the water or at least occasionally visiting water borders could have been reliable hosts of biting midges. The taxonomic diversity and morphological disparity of the Cretaceous Ceratopogonidae from Lebanon suggest that these flies diversified and adapted to their host quite rapidly.

Acknowledgements

We are grateful to anonymous reviewers for their comments that greatly improved the final version of the manuscript. We wish to thank Dr Tomasz Kasikowski (Evident Europe GmbH Sp. z o. o. Polish Branch) for the opportunity to test and use Olympus DSX 1000 digital microscope. This paper is a contribution of the activity of the Laboratory of Evolutionary Entomology and Museum of Amber Inclusions “Evolutionary trends and relationships in Ceratopogonidae (Diptera)” conducted by APC at Gdańsk University. This paper is a contribution of the activity of the laboratory “Advanced Micropalaeontology, Biodiversity and Evolution Researches” (AMBER) led by DA at the Lebanese University.

Conflict of interest statement

Authors declare no conflict of interest.

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Manuscript received: 29 March 2023

Manuscript accepted: 9 June 2023

Published on: 16 November 2023

Topic editor: Marie-Béatrice Forel

Desk editor: Pepe Fernández

Printed versions of all papers are also deposited in the libraries of the institutes that are members of the *EJT* consortium: Muséum national d’histoire naturelle, Paris, France; Meise Botanic Garden, Belgium; Royal Museum for Central Africa, Tervuren, Belgium; Royal Belgian Institute of Natural Sciences, Brussels, Belgium; Natural History Museum of Denmark, Copenhagen, Denmark; Naturalis Biodiversity Center, Leiden, the Netherlands; Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; Leibniz Institute for the Analysis of Biodiversity Change, Bonn – Hamburg, Germany; National Museum of the Czech Republic, Prague, Czech Republic.

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Jahr/Year: 2023

Band/Volume: [0908](#)

Autor(en)/Author(s): Pielowska-Ceranowska Agata, Azar Dany, Szwedo Jacek

Artikel/Article: [A new genus and species of Leptoconopinae \(Diptera: Ceratopogonidae\) from Lower Cretaceous Baskinta amber outcrop in Lebanon 27-38](#)