

**Additional biting midges (Diptera: Ceratopogonidae)
from Burmese amber**

RYSZARD SZADZIEWSKI* & GEORGE O. POINAR JR.**

*Department of Invertebrate Zoology, University of Gdańsk,
Piłsudskiego 46, 81-378 Gdynia, Poland
e-mail: szadz@sat.ocean.univ.gda.pl

**Department of Zoology, Oregon State University,
3029 Cordley Hall, Corvallis, Oregon 97331-2914, USA
e-mail: poinarg@science.oregonstate.edu

ABSTRACT. An examination of 22 inclusions of biting midges from Lower Cretaceous Burmese amber in the G.O. Poinar Jr. collection revealed six species in the extant genus *Leptoconops* SKUSE (11 specimens, 2 species) and representatives in the extinct genera *Archiaustroconops* SZADZIEWSKI (8 specimens, 2 species), *Protoculicoides* BOESEL (2 specimens, 1 species) and *Atriculicoides* REMM (1 specimen, 1 species). Four new species are described and illustrated and keys are provided for the determination of *Leptoconops subrossicus* sp. n., *Archiaustroconops gracilis* sp. n., *A. kotejai* sp. n., and *Protoculicoides burmiticus* sp. n. With this study, the biting midges in Lower Cretaceous amber of Myanmar are represented by nine described species assigned to two extant genera; *Austroconops* WIRTH & LEE (1 species, Lower Cretaceous-Recent) and *Leptoconops* (4 species, Lower Cretaceous-Recent), and three fossil genera; *Archiaustroconops* (2 species, Lower Cretaceous), *Protoculicoides* (1 species, Lower-Upper Cretaceous) and *Atriculicoides* (1 species, Lower-Upper Cretaceous). The Lower Cretaceous genus *Archiculicoides* SZADZIEWSKI is removed from the synonymy with *Protoculicoides*.

KEY WORDS: Diptera, Ceratopogonidae, Biting midges, *Archiaustroconops*, *Protoculicoides*, *Leptoconops*, *Atriculicoides*, Burmese amber, Lower Cretaceous.

INTRODUCTION

The fossil record of the Ceratopogonidae is one of the most complete of all Diptera. There are presently 5748 described species in the family, with fossils representing almost 4.4 % of

these (Borkent pers. comm.). The family is well documented from the Lower Cretaceous through the Tertiary. From the Lower Cretaceous, representatives occur in Lebanese amber (SZADZIEWSKI 1996; BORKENT 2000, 2001), Jordanian amber (SZADZIEWSKI 2000), Spanish amber (SZADZIEWSKI & ARILLO 1998, 2003), and Burmese amber (SZADZIEWSKI 2004).

Burmese amber or Burmite from Myanmar (Burma) is considered to be Lower Cretaceous (Upper Albian) in age as determined by CRUICKSHANK & KO (2003) for one amber locality.

COCKERELL (1919) briefly described the well-preserved male of *Johannsenomyia swinhoei* from Burmese amber and this holotype was photographed by ROSS & YORK (2000). Subsequently *J. swinhoei* COCKERELL was redescribed and assigned to the extinct genus *Atriculicoides* REMM (SZADZIEWSKI 2004).

RASNITSYN & ROSS (2000) reported 12 biting midges (Ceratopogonidae) preserved among 1198 arthropods in 117 Burmese amber pieces at The Natural History Museum, London. These biting midges (14) were studied by the senior author who described four new species in two extant genera, *Austroconops* WIRTH & LEE and *Leptoconops* SKUSE (SZADZIEWSKI 2004).

A collection of Burmese amber inclusions recently purchased by the American Museum of Natural History, New York, included 204 biting midges among 3012 arthropods (GRIMALDI et al. 2002) and these specimens will be studied by Dr. Art Borkent from Canada.

A collection of Burmese amber biting midges obtained by George O. Poinar Jr. and deposited at Oregon State University contained 22 specimens and are the subject of the present study.

Acknowledgements

We are much indebted to Dr. W.L. Grogan, Jr. of University Salisbury, Maryland, USA, for his critical review of the manuscript and helpful suggestions.

MATERIALS AND METHODS

The 19 amber pieces containing 22 biting midges (2 *Protoculicoides*, 1 *Atriculicoides*, 8 *Archiaustroconops* and 11 *Leptoconops*) were re-polished by the junior author in order to better view the body characters. Terminology and abbreviations used in this article follow those explained earlier by SZADZIEWSKI (1988, 1996).

SYSTEMATIC DESCRIPTIONS

Family: **Ceratopogonidae** NEWMAN, 1834

Basal lineage

Genus *Protoculicoides* BOESEL, 1937

Type species: *Protoculicoides depressus* BOESEL, 1937, by original designation.

Range. Lower to Upper Cretaceous.

Diagnosis

Wing membrane without macrotrichia, two radial cells present, sensilla coeloconica absent, legs unmodified, 4th tarsomeres cylindrical, claws simple, tarsal ratios (TR) of all legs similar. Male antenna with 3 elongate terminal flagellomeres, tergite IX of male genitalia with distinct apicolateral processes, parameres double, gonostylus with apical tooth.

Discussion

The proposal by BORKENT (2000) to expand the generic limits of *Protoculicoides* by including *Archiculicoides* SZADZIEWSKI, 1996 (type species *Archiculicoides schleei* SZADZIEWSKI, 1996) is not accepted here, as is indicated in the above diagnosis and the following key. The latter genus was described from Lebanese amber for a female of *A. schleei* having sensilla coeloconica on the first flagellomere, two radial cells, the costal vein prolonged almost to the wing apex, terminal flagellomere with a pointed apical prolongation, the wing membrane lacking macrotrichia and the tarsal ratios of all legs similar. When BORKENT (2000) reexamined *A. schleei*, he noted the single radial cell and interpreted the sensilla coeloconica on the first flagellomere as a group of sensilla trichodea. Subsequently, based on females with a single radial cell, he described two species in the genus *Protoculicoides*: *P. acraorum* BORKENT, 2000 and *P. unus* BORKENT, 2000. He observed possible sensilla coeloconica on the first flagellomere of a female of *P. acraorum*, a condition which had previously been observed in *A. schleei* by SZADZIEWSKI (1996).

The single radial cell character state is clearly visible in fossils and justifies the separation of *Archiculicoides* from *Protoculicoides*, which has two radial cells. This character state is very important in the classification and identification of recent genera of biting midges. Only occasionally are both character states (1 or 2 radial cells) noted in a few extant genera of the tribes Ceratopogonini and Sphaeromiini.

The modified diagnosis of the genus *Archiculicoides* (only females known) is as follows: wing membrane without macrotrichia, radial cell single, costa almost reaching wing apex, palpus 4-5 segmented, legs unmodified, claws simple, first flagellomere with sensilla coeloconica or a group of sensilla trichodea. Included species (all from Lower Cretaceous Lebanese amber): *A. schleei*, *A. acraorum*, **comb. n.** and *A. unus*, **comb. n.**

The genus *Protoculicoides* belongs to the basal lineage of the family (SZADZIEWSKI 1996). In Burmese amber it is represented by two specimens, a male which is described below as a new species and an undescribed female.

Key to *Protoculicoides*

1. Large species. Female wing length 1.7 mm.....
 *P. depressus* BOESEL (female, Upper Cretaceous Canadian amber)

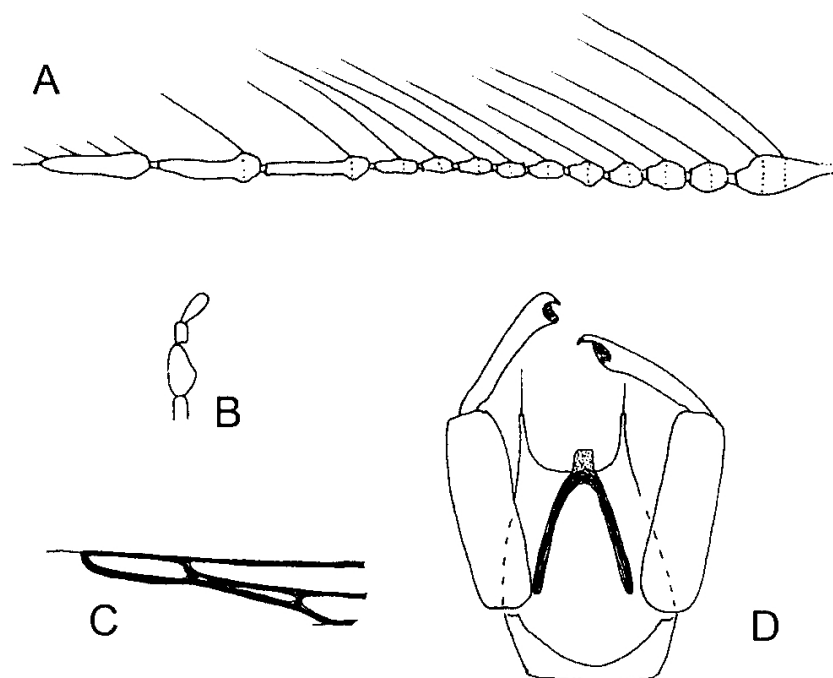
- Small species. Wing length less than 0.9 mm.....2
- 2. Palpal segments 4 and 5 almost equal in length3
- Palpal segment 4 much shorter than segment 5.....4
- 3. Female CR= 0.73, first and second radial cells similar in length.....
 *P. skalskii* SZADZIEWSKI & ARILLO (female, Lower Cretaceous Spanish amber)
- Female CR= 0.82, second radial cell longer than first radial cell
 *P. punctus* BORKENT (male, female, Lower Cretaceous Lebanese amber)
- 4. Male gonostylus slightly tapering to rounded apex, subapical ventral surface smooth.....
 *P. succineus* SZADZIEWSKI (male, female, Lower Cretaceous Lebanese amber)
- Male gonostylus slightly widening to claw-like apex, subapical ventral surface with
 distinct excavation *P. burmiticus* sp. n. (male, Lower Cretaceous Burmese amber)

***Protoculicoides burmiticus*, sp. n.**

(Figs 1A-D)

Diagnosis

The only species with males having slightly widened gonostyli distally with subapical ventral excavation and short claw-like apex armed with apical tooth.



Figs 1A-D. *Protoculicoides burmiticus* sp. n., male, holotype. A - flagellum, lateral aspect, B - palpus, C - radial cells of wing, D - genitalia, ventral aspect, parameres not visible.

Description

Male. Body length about 1 mm. Flagellum composed of 13 flagellomeres; length 0.34 mm; distal 3 flagellomeres elongate (Fig. 1A). Proboscis short. Palpus 5-segmented (Fig. 1B). Antepnotum distinct, collar-like. Wing length 0.466 mm, CR 0.57. First and second

radial cells small (Fig. 1C). Wing membrane with distinct microtrichia; macrotrichia absent. Scutellum with 7 marginal setae. Legs slender, claws simple. First tarsomere of hind leg slightly swollen like in extant *Culicoides* LATREILLE. TR(I) 2.1, TR(II) 2.6, TR(III) 2.2. Tibial spur of fore leg long, of hind leg short and stout. Tibia of mid leg without spur.

Genitalia as in Fig. 1D. Sternite IX with deep caudomedian excavation. Tergite IX with long, cylindrical apicolateral processes armed with apical seta. Gonocoxite rather slender, not modified. Gonostylus long and straight, with deep ventral excavation at apex; apex claw-like, probably armed with apical tooth. Aedeagus high, Y-shaped. Parameres not visible.

Female. Unknown.

Holotype. Male, In. C-1. Poinar collection at Oregon State University.

Etymology

The specific epithet refers to Burma (Myanmar), the country of origin of the amber.

Discussion

Within the genus, males are known only for *P. punctus* and *P. succineus* from Lebanese amber (BORKENT 2000) and *P. burmiticus* described here. In the latter species, the terminal 3 flagellomeres (11-13) are greatly elongated as in *P. punctus* whereas in *P. succineus* flagellomeres 10-13 are only slightly more elongated than proximal ones as in the males of *Atriculicoides* REMM (SZADZIEWSKI 1996). Tergite IX in all species has a distinct apicolateral processes armed with apical setae. Parameres (paired, symmetrical) were observed only in *P. succineus* from Lebanese amber (BORKENT l.c.). The aedeagus is also Y-shaped in *P. burmiticus* and *P. succineus*.

***Protoculicoides* sp. indet.**

Description

Female. Body length 1.1 mm. Proboscis long and straight. Palpus 5-segmented. Flagellomeres gradually increasing in length. Eyes separated above antennae. Humeral pits large, well visible. Wing length 0.57 mm, CR 0.81. Two long radial cells present. Wing membrane with distinct microtrichia, macrotrichia lacking. TR(III) 2.1. Cerci short.

Material examined

In. C-2, 1 female, Poinar collection at Oregon State University. Associated fauna: 2 Coccinea (Hemiptera).

Discussion

This female cannot be assigned to *P. burmiticus* since it has a distinctly higher CR and longer and more slender palpi.

Subfamily: **Leptoconopinae** NOÉ, 1907

(=**Austroconopinae** BORKENT et al., 1987; BORKENT & CRAIG 2004)

***Archiaustroconops* SZADZIEWSKI, 1996**

Archiaustroconops SZADZIEWSKI, 1996: 34. Type-species: *Archiaustroconops ceratoformis* SZADZIEWSKI, by original designation.

Range. Lower Cretaceous.

Diagnosis

Macrotrichia absent on wing membrane. First and second radial cells well developed. Transverse vein r-m oblique. Tarsal ratio of hind leg distinctly lower than on fore and mid legs. In male two terminal flagellomeres (12-13) elongate.

Remarks

The genus was described from Lower Cretaceous Lebanese amber based on *A. ceratiformis* (SZADZIEWSKI 1996). A second species, *A. alavensis*, is known from Lower Cretaceous Spanish amber (SZADZIEWSKI & ARILLO 1998). Subsequently BORKENT (2000) described 3 additional species from Lebanese amber: *A. hamus*, *A. bocoparvus* and *A. szadziewskii* and transferred *A. cretaceous* SZADZIEWSKI, 1996 which was originally placed in the genus *Austroconops*, to *Archiaustroconops*.

Among the 8 biting midges of this genus examined in the present study, 5 females and 1 male remain undetermined. They are barely visible or do not have adequate characters which could be used to describe them. In. **C-6**, 1 female, palpus 4 segmented, proboscis slightly bent forward, tarsal claws rather simple, TR(III) 1.1, wing 0.64 mm. In. **C-7**, 1 male, body complete, length 1.5 mm, proboscis bent forward, terminal flagellomere 1.6 times longer than preceding one, palpus 5-segmented, wing length 0.77 mm, r-m transverse, TR(I) about 2.0, TR(III) 1.5, genitalia broad, barely visible, Gonostylus with distinct apical spine. In. **C-8**, 2 females, evidently represent one species, palpus 4 segmented, proboscis bent forward, tarsal claws probably with internal tooth. In. **C-9**, 1 female [+ 1 male *Leptoconops* indet.], palpus 5-segmented, proboscis straight, relatively long, wing 0.44 mm long, TR(I) 2.1, TR(II) 2.5, TR(III) 1.1, claws probably simple. In. **C-10**, 1 female, body length 0.7 mm, proboscis long and straight, palpus 4 segmented, wing 0.47 mm, tarsal claws probably with basal internal tooth, TR(II) 2.0, TR(III) 1.1.

A key to the described species of fossil *Archiaustroconops* is presented below.

Key to fossil *Archiaustroconops*

1. Palpus with 4 segments.....2
- Palpus with 5 segments.....3
2. Male tergite IX longer than gonocoxite.....
- *A. ceratiformis* SZADZIEWSKI (male, female, Lower Cretaceous Lebanese amber)
- Male tergite IX shorter than gonocoxite.....
- *A. cretaceous* (SZADZIEWSKI) (male, Lower Cretaceous Lebanese amber)
3. Tarsal claws with inner tooth.....4
- Tarsal claws simple..... 6
4. Male gonostylus large, armed with very long apical blunt spine.....
- *A. kotejai* sp. n. (male, Lower Cretaceous Burmese amber)
- Male gonostylus short and slender, apical spine not visible..... 4

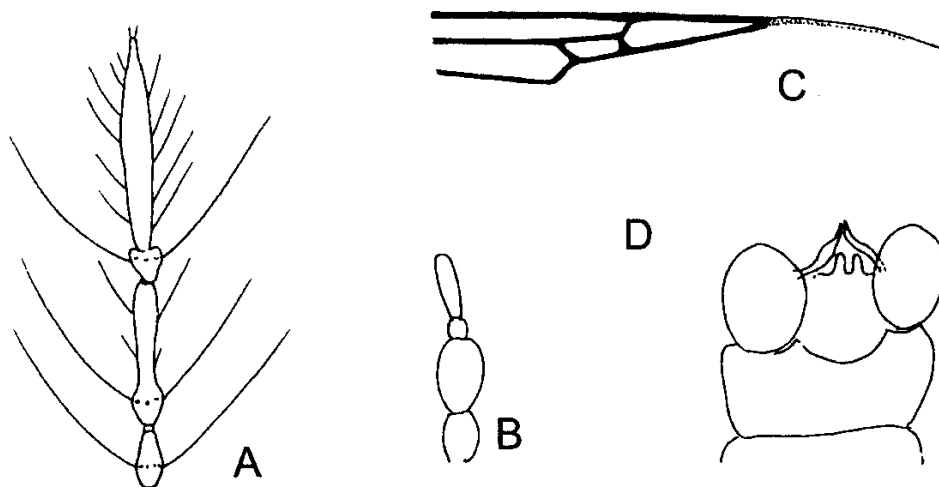
5. Male gonocoxite cylindrical, gonostylus straight.....
 *A. hamus* BORKENT (male, Lower Cretaceous Lebanese amber)
 -. Male gonocoxite almost spherical, gonostylus sinuous.....
 *A. gracilis* sp. n. (male, Lower Cretaceous Burmese amber)
6. Proboscis very short.....
 *A. bocoparvus* BORKENT (female, Lower Cretaceous Lebanese amber)
 -. Proboscis moderately long.....7
7. Female third palpal segment greatly swollen. Eyes separated above antennae.....
 *A. alavensis* SZADZIEWSKI & ARILLO (female, Spanish amber)
 -. Female third palpal segment slightly swollen, eyes abutting above antennae.....
 *A. szadziewskii* BORKENT (male, female, Lower Cretaceous Lebanese amber)

Archiaustroconops gracilis sp. n.

(Figs 2A-D)

Diagnosis

The only biting midge with a slender sinuous male gonostylus and very short, almost rounded gonocoxite. Palpus 5 segmented, tarsal claws toothed.



Figs 2A-D. *Archiaustroconops gracilis* sp. n., male, holotype. A - flagellomeres 11-13, B - palpus, C - wing, D - genitalia, ventral aspect.

Description

Male. Body slender, total length about 1.1 mm. Flagellum 0.47 mm long, with 13 flagellomeres, two terminal flagellomeres elongate (Fig. 2A), 13th with a subbasal constriction (Fig. 2A); 13th flagellomere 1.6 longer than 12th; plume well developed. Proboscis bent forward. Palpus 5-segmented; segment 3 swollen; segment 5 slender, long (Fig. 2B). Spur of fore tibia distinct, straight, of hind tibia probably indistinct. TR(I) 2.2, TR(II) 2.4, TR(III) 1.1. Each claw with inner tooth. Wing length 0.55 mm; membrane

without macrotrichia; second radial cell twice as long as first; costal vein possibly prolonged beyond end of R3 (Fig. 2C).

Genitalia slightly rotated (Fig. 2D). Sternite IX not well visible, apparently with shallow posterior excavation. Tergite IX with distinct submedian, closely approximated processes. Gonocoxite without special armature, broad, very short, almost spherical. Gonostylus slender, sinuous.

Female. Unknown.

Holotype. In. C-5, male, *Archiaustroconops gracilis* SZADZIEWSKI & POINAR sp. n.

Etymology

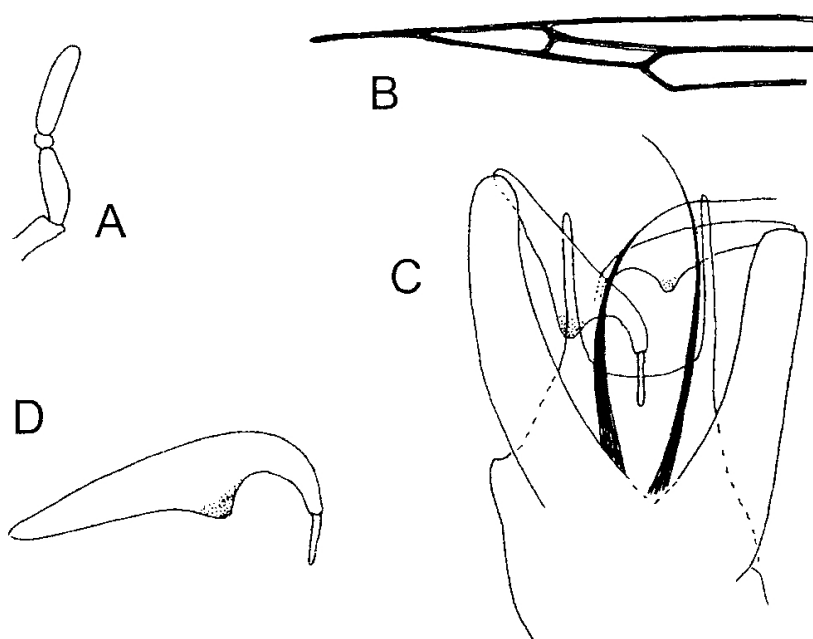
The specific epithet refers to the slender gonostyli of the male genitalia.

Archiaustroconops kotejai sp. n.

(Figs 3A-D)

Diagnosis

The only biting midge with male gonostylus armed with a very elongate apical spine, palpus 5-segmented and tarsal claws with basal teeth.



Figs. 3A-C. *Archiaustroconops kotejai* sp. n., male, holotype. A - palpus, B - wing radial cells, C - ventral aspect of genitalia, D - gonostylus.

Description

Male. Body length about 1.1 mm. Flagellum barely visible, length 0.44 mm, with 13 flagellomeres, terminal 2 flagellomeres elongate, 13th 1.2 times longer than 12th; plume well developed. Proboscis bent forward. Palpus 5-segmented; segment 3 slender; segment 5 slender, slightly longer than 3rd (Fig. 3A). Spur of fore tibia slender, straight, hind tibia without distinct spur. TR(I) 2.9, TR(II) 2.6, TR(III) 1.1. Tarsal claws sharply bent, with

basal inner teeth. Wing length 0.58 mm, CR 0.83; membrane without macrotrichia; 2nd radial cell slightly longer than 1st; costal vein prolonged considerably beyond end of R3 (Fig. 3B).

Genitalia as in Fig. 3C. Sternite IX not visible. Tergite IX with extremely long, apicolateral processes with narrowly rounded apices. Gonocoxite slender, long, without special armature. Gonostylus expanded at basal 2/3, with greatly curved slender apex armed with elongate apical spine (Fig. 3D). Parameres symmetrical, with very slender, converging pointed apices that extend well beyond gonocoxite.

Female. Unknown.

Type

Holotype. In. C-4, male *Archiaustroconops kotejai* SZADZIEWSKI & POINAR sp. n.

Etymology

The species name is dedicated to our late friend Jan Koteja in recognition of his enthusiastic support for research on fossil insects.

Genus *Leptoconops* SKUSE, 1889

Type species: *Leptococops stygius* SKUSE, 1889, by monotypy.

Range. Lower Cretaceous to Recent.

Remarks

Leptoconops is a relatively large genus including 134 extant and 13 named fossil species (BORKENT 2001, SZADZIEWSKI & ARILLO 2003, SZADZIEWSKI 2004). Larvae of extant species live in moist or dry, usually saline soil of desert areas and in sand in coastal and inland beaches. They burrow in the soil or sand and feed on microorganisms found there. Adults are diurnal; females feed on the blood of mammals, birds and reptiles. Most species of the genus are distributed in tropical and subtropical regions throughout the world. However, there are species described from as far north as the Moscow district in Europe and the Yukon Territory in Canada.

Extinct species have been described from Tertiary Baltic amber (*L. succineus* SZADZIEWSKI), Upper Cretaceous Siberian amber (*L. boreus* KALUGINA, *L. sibiricus* SZADZIEWSKI), New Jersey amber (*L. curvachelus* BORKENT, *L. copiosus* BORKENT), Canadian amber (*L. primaevus* BORKENT), Hungarian amber (*L. clava* BORKENT), Lower Cretaceous Lebanese amber (*L. amplificatus* BORKENT, *L. antiquus* BORKENT), Spanish amber (*L. zherikhini* SZADZIEWSKI & ARILLO), and Burmese amber (*L. burmiticus* SZADZIEWSKI, *L. myanmaricus* SZADZIEWSKI and *L. rossi* SZADZIEWSKI). Unnamed *Leptoconops* are also recorded from Palaeocene amber from Sakhalin and Upper Cretaceous French amber (SZADZIEWSKI 1990, SZADZIEWSKI & SCHLÜTER 1992).

Among the 22 biting midges studied here, 11 belong to *Leptoconops*. They represent two distinct species in the subgenus *Leptoconops* s. str. (female with 12 flagellomeres, tergite IX in male genitalia with distinct apicolateral processes).

Undetermined

In. **C-9**, 1 male, barely visible, together with *Archiaustroconops* indet.(see above). **C-13**, 1 male, 1 female, + Hymenoptera. 1 poorly preserved female with claws having a basal tooth. Male flagellum with relatively long terminal flagellomere. **C-14**, 1 female; flagellum short, apical flagellomere short; third palpal segment short, stout, proboscis short, stout; claws with basal tooth; cerci slender, moderately long. **C-15**, 1 female in a very small piece of amber; claws with tooth, cerci narrow and long. **C-16**, 1 female; proboscis short, stout, 3rd palpal segment stout; claws with basal tooth, hind tibia with strongly curved tibial spur, TR(III) 1.9, cerci long and slender. **C-17**, 1 female, claws simple, no distinct hind tibial spur. **C-18**, 1 female, barely visible. **C-19**, 1 female, barely visible. A key to the described species of fossil *Leptoconops* is presented below.

Key to fossil *Leptoconops*

Leptoconops clava BORKENT described from a male from Upper Cretaceous Hungarian amber (BORKENT 1997) is not included in the key.

1. Costal vein long, reaching apex of wing (subg. *Palaeoconops* BORKENT).....
 - *L. amplificatus* BORKENT (female, male, Lower Cretaceous Lebanese amber),
 - *L. antiquus* BORKENT (female, Lower Cretaceous Lebanese amber)
- . Costal vein short, terminating at apex of R3 (subg. *Leptoconops* s. str.).....2
2. Hind tibial spur large.....3
 - . Hind tibial spur indistinct..... 4
3. Apicolateral processes of tergite IX of male genitalia pointed.....
 - *L. rossi* SZADZIEWSKI (female, male, Lower Cretaceous Burmese amber)
- . Apicolateral processes of tergite IX of male genitalia blunt.....
 - *L. subrossicus* sp. n. (male, Lower Cretaceous Burmese amber)
4. Female claws with basal inner tooth.....5
 - . Female claws simple.....6
5. Female flagellomeres 2-11 cylindrical.....
 - *L. myanmaricus* SZADZIEWSKI (female, male, Lower Cretaceous Burmese amber)
- . Female flagellomeres 2-11 more or less spherical.....
 - *L. copiosus* BORKENT (female, male, Upper Cretaceous New Jersey amber),
 - *L. curvachelus* BORKENT (female, Upper Cretaceous New Jersey amber),
 - *L. sibiricus* SZADZIEWSKI (female, male, Upper Cretaceous Siberian amber)
6. Cerci very short, broad.....
 - *L. burmiticus* SZADZIEWSKI (female, Lower Cretaceous Burmese amber)
- . Cerci long, slender.....
 - *L. zherikhini* SZADZIEWSKI & ARILLO (Lower Cretaceous Spanish amber),
 - *L. succineus* SZADZIEWSKI (female, male, Tertiary, Baltic amber),
 - *L. boreus* KALUGINA (female, Upper Cretaceous Siberian amber),
 - *L. primaevus* BORKENT (female, Upper Cretaceous Canadian amber)

Leptoconops burmiticus SZADZIEWSKI, 2004*Leptoconops burmiticus* SZADZIEWSKI, 2004: 116 (female, Burmese amber).**Diagnosis**

The only fossil species of *Leptoconops* with females having very short cerci (1.4 times longer than broad).

Material examined

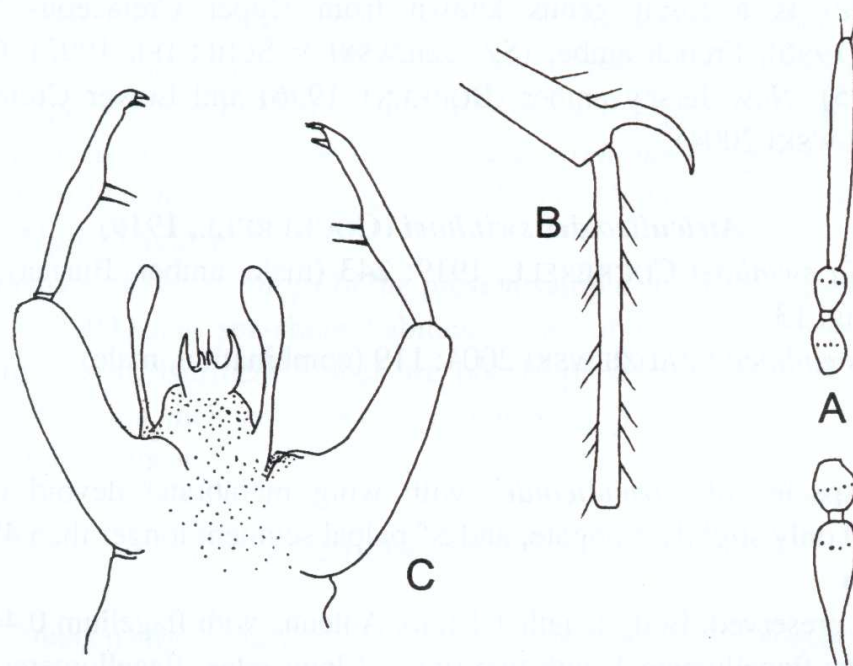
C-11, 1 female, well preserved. Mouthparts with lacinia bearing more than 30 teeth.

Leptoconops subrossicus sp. n.

(Figs 4A-C)

Diagnosis

The only fossil species of *Leptoconops* with males having simple claws; hind tibial spur large, curved; tergite IX very short with very long, blunt apicolateral processes.



Figs 4A-C. *Leptoconops subrossicus* sp. n., male, holotype. A – flagellomeres 1-2 and 12-13, B – hind tibial spur, C – ventral aspect of genitalia.

Description

Male. Body length 1.2 mm. Antenna with 13 flagellomeres, length 0.43 mm; flagellomere 13 greatly elongated, 0.12 mm long, 6 times longer than 12 (Fig. 4A). Palpus 4 segmented. Hind tibia with large curved apical spur (Fig. 4B), tarsal claws simple. TR(III). 2.2. Wing length 0.67 mm, CR 0.30. Genitalia very unusual (Fig. 4C). Tergite IX very short, but with large, elongate, widely separated apicolateral processes, which lack apical setae on their blunt, expanded apex.

Female. Unknown.

Holotype. Male, In. C-12, *Leptoconops subrossicus* SZADZIEWSKI & POINAR sp. n. In the same amber piece are 2 mites (Acari).

Etymology

The specific epithet refers to *L. rossi* SZADZIEWSKI from Burmese amber, which it resembles in having enlarged hind tibial spurs.

Subfamily: **Forcipomyiinae** LENZ, 1934

Tribe: **Atriculicoidini** SZADZIEWSKI, 1996

Genus *Atriculicoides* REMM, 1976

Type species: *Atriculicoides macrophthalmus* REMM, 1976, by original designation.

Range. Lower to Upper Cretaceous.

Remarks

Atriculicoides is a fossil genus known from Upper Cretaceous Siberian amber (SZADZIEWSKI 1996), French amber (SZADZIEWSKI & SCHLÜTER 1992), Canadian amber (BORKENT 1995), New Jersey amber (BORKENT 1996) and Lower Cretaceous Burmese amber (SZADZIEWSKI 2004).

Atriculicoides swinhoei (COCKERELL, 1919)

Johannsenomyia swinhoei COCKERELL, 1919: 243 (male, amber, Burma); ROSS & YORK 2000: 13, Fig. 13.

Atriculicoides swinhoei: SZADZIEWSKI 2004: 119 (combination, male).

Diagnosis

The only species of *Atriculicoides* with wing membrane devoid of macrotrichia, flagellomere 10 only slightly elongate, and 5th palpal segment longer than 4th.

Description

Male. Well preserved. Body length 1.1 mm. Antenna with flagellum 0.44 mm long, with 13 flagellomeres; flagellomere 1 with two rings of long setae; flagellomeres 11-13 elongate; 10 slightly elongate. Palpus 5-segmented. Legs slender, unarmed; first tarsomere of hind leg somewhat stout, with numerous strong setae on ventral surface, fourth tarsomeres cylindrical. TR(I) 2.3, TR(II) 2.5, TR(III) 1.8. Wing length 0.53mm. Both radial cells relatively long, CR 0.71. Wing membrane with distinct microtrichia; macrotrichia absent. Genitalia barely visible. Gonostylus with evenly expanded apex, slightly arched. Tergite IX with long, pointed apicolateral processes. Paramere single, with long ventrally curved apex.

Female. Unknown.

Material examined

Poinar collection, C-3: One male. Associated fauna: 1 Lepidoptera, incomplete, only wings and 1 leg preserved; Diptera – Scatopsidae, 1 male, without head.

Discussion

Atriculicoides swinhoei is not a typical member of the genus as the male wing

membrane lacks macrotrichia, and the antenna has a short 10th flagellomere. In other known species, macrotrichia are always present on the wing membrane and the 10th flagellomere in males is elongated. The current generic assignment of this species was made on the basis that males have a single paramere similar to other species of *Atriculicoides*. However, it is also possible that *A. swinhoei* is a member of *Protoculicoides*, the most basal lineage of biting midges.

CONCLUDING REMARKS

The biting midges fauna preserved in Burmese amber includes five previously described species in three genera: *Austroconops* (1 specimen, 1 species), *Leptoconops* (9 specimens, 3 species) and *Atriculicoides* (4 specimen, 1 species) (COCKERELL 1919, SZADZIEWSKI 2004) and the following four new species in two additional genera: *Leptoconops subrossicus* sp. n., *Archiaustroconops gracilis* sp. n., *A. kotejai* sp. n., and *Protoculicoides burmiticus* sp. n. These specimens, in addition to those housed at the Natural History Museum in London, demonstrate that the biting midge fauna in Lower Cretaceous amber of Myanmar is represented by nine named species. They belong to two extant genera, *Austroconops* WIRTH & LEE (1 species, Lower Cretaceous - Recent) and *Leptoconops* (4 species, Lower Cretaceous - Recent) as well as to three fossil genera, *Archiaustroconops* (2 species, Lower Cretaceous), *Protoculicoides* (1 species, Lower - Upper Cretaceous) and *Atriculicoides* (1 species, Lower - Upper Cretaceous).

The predominance of *Leptoconops* in the present sample confirms the earlier suggestion by SZADZIEWSKI (2004) that sea-shore habitats were not far from the amber producing forests. Biting midges in Burmese amber are poorly preserved and look as if they were quickly desiccated during their entombment in the resin. This suggests that these midges lived in dry, warm habitats.

REFERENCES

- BORKENT A. 1995. Biting midges in the Cretaceous amber of North America (Diptera: Ceratopogonidae). Backhuys Publishers, Leiden, 237 pp.
- BORKENT A. 1996. Biting midges from Upper Cretaceous New Jersey amber (Ceratopogonidae: Diptera). *American Museum Novitates* **3159**, 29 pp.
- BORKENT A. 1997. Upper and Lower Cretaceous biting midges (Ceratopogonidae: Diptera) from Hungarian and Austrian amber and the Koonwarra Fossil Bed of Australia. *Stuttgarter Beitrage zur Naturkunde, Serie B (Geologie und Palaeontologie)* **249**: 1-10.
- BORKENT A. 2000. Biting midges (Ceratopogonidae: Diptera) from Lower Cretaceous Lebanese amber with a discussion of the diversity and patterns found in other ambers. In: GRIMALDI D. (ed.). *Studies in fossils in amber, with particular reference to the Cretaceous of New Jersey*, Backhuys Publishers, Leiden, pp. 355-451.
- BORKENT A. 2001. *Leptoconops* (Diptera: Ceratopogonidae), the earliest extant lineage of biting midge, discovered in 120-122 million-year-old Lebanese amber. *American Museum Novitates* **3328**, 11 pp.
- BORKENT A., CRAIG D.A. 2004. *Austroconops* WIRTH and LEE, a Lower Cretaceous genus of biting midges yet living in Western Australia: a new species, first description of the immatures and discussion of their biology and phylogeny (Diptera: Ceratopogonidae). *American Museum Novitates* **3449**, 67 pp.

- BORKENT A., WIRTH W.W., DYCE A.L. 1987. The newly discovered male of *Austroconops* (Ceratopogonidae: Diptera) with a discussion of the phylogeny of the basal lineages of the Ceratopogonidae. *Proceedings of the Entomological Society of Washington* **89**: 587-606.
- COCKERELL T.D.A. 1919. Insects in Burmese amber. *The Entomologist* **52**: 241-243.
- CRUICKSHANK R.D., KO K. 2003. Geology of an amber locality in the Hukawng Valley, northern Myanmar. *Journal of Asian Earth Sciences* **21**: 441-455.
- GRIMALDI D.A., ENGEL M.S., NASCIBENE P.C. 2002. Fossiliferous Cretaceous amber from Myanmar (Burma): its rediscovery, biotic diversity, and paleontological significance. *American Museum Novitates* **3361**: 1-72.
- LENZ F. 1934. 13a. Heleidae (Ceratopogonidae). In: LINDNER E. (ed.). *Die Fliegen der palaearktischen Region* **3**: 95-133 (Lfg. 78), Stuttgart.
- NEWMAN E. 1834. Attempted division of British insects into natural orders. *Entomological Magazine* **2**: 379-431.
- NOÉ G. 1907. Due nuove specie di ditteri appartenenti ad un genere nuovo. *Archivio Zoologico Italiano: Pubblicato Sotto gli Auspicii Della Unione Zoologica* **3**: 101-164, 3 pls.
- RASNITSYN A.P., ROSS A.J. 2000. A preliminary list of arthropod families present in the Burmese amber collection at The Natural History Museum, London. *Bulletin of The Natural History Museum, Geology Series* **56**: 21-24.
- REMM H. 1976. Midges (Diptera, Ceratopogonidae) from the Upper Cretaceous fossil resins of the Khatanga depression. *Paleontologitsekij Zhurnal* **3**: 107-116. [In Russian].
- ROSS A. J., YORK P.V. 2000. A list of type and figured specimens of insects and other inclusions in Burmese amber. *Bulletin of The Natural History Museum, Geology Series* **56**: 11-10.
- SKUSE F.A.A. 1889. Diptera of Australia. Part VI. - The Chironomidae. *Proceedings of the Linnean Society of New South Wales* **4**: 215-311, pls. 11-14.
- SZADZIEWSKI R. 1988. Biting midges (Diptera, Ceratopogonidae) from Baltic amber. *Polskie Pismo Entomologiczne* **58**: 1-283.
- SZADZIEWSKI R. 1990. Biting midges (Insecta: Diptera: Ceratopogonidae) from Sakhalin amber. *Prace Muzeum Ziemi* **41**: 77-81.
- SZADZIEWSKI R. 1996. Biting midges from Lower Cretaceous amber of Lebanon and Upper Cretaceous Siberian amber of Taimyr (Diptera, Ceratopogonidae). *Studia Dipterologica* **3**: 23-86.
- SZADZIEWSKI R. 2004. Biting midges (Diptera: Ceratopogonidae) from Burmese amber, Myanmar. *Journal of Systematic Palaeontology* **2**: 115-121.
- SZADZIEWSKI R., ARILLO A. 1998. Biting midges (Diptera: Ceratopogonidae) from the Lower Cretaceous amber from Alava, Spain. *Polskie Pismo Entomologiczne* **67**: 291-198.
- SZADZIEWSKI R., ARILLO A. 2003. The oldest fossil record of the extant subgenus *Leptoconops* (*Leptoconops*) (Diptera: Ceratopogonidae). *Acta Zoologica Cracoviensia* **46** (suppl. - Fossil Insects): 271-275.
- SZADZIEWSKI R., SCHLÜTER T. 1992. Biting midges (Diptera: Ceratopogonidae) from Upper Cretaceous (Cenomanian) amber of France. *Annales de la Société de Entomologie de France (N.S.)* **28**: 73-81.
- WIRTH W.W., LEE D.J. 1958. Australasian Ceratopogonidae (Diptera, Nematocera). Part VIII: A new genus from Western Australia attacking man. *Proceedings of the Linnean Society of New South Wales* **83**: 337-339.
- ZHERIKHIN V.V., ROSS A.J. 2000. A review of the history, geology and age of Burmese amber (Burmite). *Bulletin of The Natural History Museum, Geology Series* **56**: 3-10.

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