

1 A new species of the haematophagous genus *Austroconops* Wirth & Lee (Diptera:

2 Ceratopogonidae: Leptoconopininae) from middle Cretaceous amber of Charente-

3 Maritime, France

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16 **Abstract.** *Austroconops perrichoti*, a new species of biting midge (Diptera:

17 Ceratopogonidae), is described from uppermost Albian-lowermost Cenomanian amber of

18 Charente-Maritime (NW France), from three female specimens. A similar species,

19 *Austroconops borkenti* Szadziewski & Schlüter, 1992, from Upper Cretaceous, Cenomanian,

20 French amber of Anjou, is redescribed and illustrated. A key to males and females of extinct

21 species of *Austroconops* Wirth & Lee is also provided.

22

23 **Key words.** Biting midge; Insecta; Cretaceous; France

24

25 **Introduction**

50 Pieces of amber from Charente-Maritime are all rather opaque with many bubbles and debris.

51 Two of the three specimens of *Austroconops perrichoti* sp. nov. are embedded in the same

52 piece of amber. Specimen 261.3 also contains an unidentified insect fragment and an

53 incomplete specimen of Psocoptera. All were prepared in order to remove the maximum

54 quantity of amber and subsequently embedded in Canada balsam following the method of

55 Azar *et al.* (1999). Specimens were examined with stereomicroscopes (Nikon SMZ 1500 and

56 Nikon SMZ 25) and an inverted microscope (Olympus CK 40). Photographs were taken with

57 an AmScope FMA 050 camera and reconstructed using Adobe Photoshop professional.

58 Photographs and measurements of *Austroconops borkenti* Szadziewski & Schlüter were taken

59 using the LAS Montage multifocus with the Leica DM6000 B and Leica M205 A

60 microscopes.

61 New name from this article has been registered in ZooBank prior to publication.

62

63 **Systematic Palaeontology**

64

65 Order Diptera Linnaeus, 1758

66 Family Ceratopogonidae Newman, 1834

67 Subfamily Leptoconopininae Noé, 1907

68 Genus *Austroconops* Wirth & Lee, 1958

69 Type species, *Austroconops mcmillani* Wirth & Lee, 1958, by original designation.

70

71 *Austroconops perrichoti* sp. nov.

72 Figs 2–6

73 urn:lsid:zoobank.org:act:140FDF24-F0B6-4113-8B04-46489CAC8F7C

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27 Ceratopogonids are a group of small nematocerous flies represented in the recent fauna by

28 over 6 200 species. They are also well documented as fossils: to date nearly 300 extinct

29 species of 48 genera have been described (Borkent 2016, Szadziewski 2018), with the oldest

30 dated to ca. 142 Ma (Berriasian, Early Cretaceous) (Borkent *et al.* 2013). The “relictual”

31 genus *Austroconops* Wirth & Lee, 1958 includes only two extant species from Western

32 Australia. *Austroconops* is rather well diversified in the Cretaceous (Early and Late) with

33 seven fossil species reported from Lebanon (paleo-continent Arabia-Africa), Spain (an island

34 in the middle of the Atlantic ocean), Myanmar (an island in the middle of Tethys ocean),

35 France, and Siberia (Eurasia) (Szadziewski & Arillo 2003, Szadziewski 2018). Females of

36 extinct *Austroconops* were probably bloodsucking ectoparasites, feeding on vertebrates, like

37 other members of the subfamily and the extant species *A. mcmillani* Wirth & Lee, 1958,

38 which has been observed biting kangaroos and humans (Borkent & Craig 2004).

39 Amber from a quarry near Archingeay/Les-Nouillers, Charente-Maritime, is dated as latest

40 Albian, ca. 100 Ma, and it contains a very rich, diverse arthropod fauna (Perrichot *et al.*

41 2010). However, only one species of biting midge (Diptera: Ceratopogonidae) has been

42 recorded from this amber so far – *Leptoconops daugeroni* Choufani *et al.*, 2011. Herein we

43 describe and illustrate a new biting midge from Upper Cretaceous Charentese amber, in the

44 genus *Austroconops* Wirth & Lee, 1958 (subfamily Leptoconopininae Noé, 1907). We also

45 redescribe and illustrate *A. borkenti* Szadziewski & Schlüter, 1992, from Upper Cretaceous of

46 France.

47

48 **Material and methods**

49

75 **Type material.** Holotype IGR.ARC 226.3 (a nearly complete female with thorax partially

76 opened). Paratypes: IGR.ARC 226.6 (female, originally in the same piece of amber with the

77 holotype); IGR.ARC 261.3 (female). All deposited in the Geological Institute and Museum of

78 the University of Rennes 1, France.

79 Type locality and horizon. Font-de-Benon quarry, ca. 1 km east of Archingeay, Charente-

80 Maritime, France (Fig. 1; for detailed geological map see Cockx *et al.* 2016); Cretaceous,

81 uppermost Albian-lowermost Cenomanian (ca. 100 Ma), lithological level A1sl-A.

82 **Etymology.** Named after our friend and colleague Vincent Perrichot, for his important

83 contributions to palaeoentomology.

84 **Diagnosis.** Female. Costa extending beyond apex of R₄₊₅, first radial cell 1.1–1.4 times longer

85 than the second; palpus 4-segmented with only one segment posterior to segment 3, third

86 segment stout; antennal flagellum without visible sensilla coeloconica; mid tibia without

87 apical spur. Male unknown.

88 **Description. Habitus.** Minute, dark-coloured midge with slender, unarmed legs (Fig. 2 a) and

89 markedly upcurved proboscis (Figs 2 a, b; 4 a, c). **Head.** Setae on vertex barely visible, also

90 no visible setae located medially. Eyes bare, narrowly separated dorso-medially. Antennal

91 flagellum with 13 flagellomeres (Figs 2 b, 4 a); flagellomeres 2–4 subcylindrical, 1 and 5–12

92 more slender and longer; flagellomere 13 longest, tapering gradually to apex, apex rounded

93 without setae at tip; sensilla coeloconica not visible on flagellomere 1 (Figs 2 c, 4 b). Palpus

94 4-segmented, only one segment posterior to 3rd palpomere present (Fig. 4 c); segment 3

95 enlarged, capitate sensilla and sensory pit not visible (Fig. 4 c). Maxilla with ca. 10 small

96 teeth, mandible with ca. 11 teeth gradually increasing in size towards apex (Fig. 4 c). **Thorax.**

97 Scutum with sparse long stout setae (Fig. 5 a); paraergite without setae; scutellum with six

98 setae, posterior margin rounded in dorsal view. Wing (Figs 2 a; 3 a, b) with very dark anterior

99 veins; membrane hyaline, without macrotrichia but with numerous microtrichia; macrotrichia

100 present on C, radius and probably on basal portion of M, setae of more or less uniform size
 101 and shape present along wing apex; C ending near wing apex, considerably beyond apex of
 102 Rs; Sc very faint, adpressed to radius; radius joining costa without thickening; base of Rs far
 103 from wing base, nearly perpendicular to R and M; distal part of Rs aligned with r-m
 104 crossvein; M broad, heavily sclerotized basally, r-m nearly perpendicular with M, distal
 105 portion of M not visible, even as a phantom vein; R₁ long, ending on C very close to R₂,
 106 separating cell r₁ from cell r₂; 1st radial cell 1.1 – 1.4 times longer than 2nd, both very broad
 107 (Fig. 3 b); CuA faint but distinct, CuA₁ and CuA₂ well-developed, extending to wing margin;
 108 CuP very faint, nearly adpressed to CuA, ending close to level of fork of CuA; anal vein faint,
 109 reaching mid part of anal area. Hind femur moderately slender, unarmed; mid tibia lacking
 110 apical spur; fore and hind tibiae with apical spur; mid tibia with sparse larger setae; hind tibia
 111 with series of long setae on small protuberances (Fig. 6 a); hind tibial comb with ca. six
 112 spines; hind basitarsus lacking palisade setae but its basal third armed with two rows of stout
 113 spines, shorter than the setae around them (Fig. 6 b); tarsomeres 1-3 of all legs with stout
 114 apical spine; claws small, equal sized on all legs, stout basally (Figs 5 b; 6 c, d), each talon
 115 probably with a small inner sub-basal seta (Fig. 5 b); empodia small but well visible (Fig. 6
 116 d). **Abdomen.** Deformed; female terminalia barely visible, but cercus short, rounded in lateral
 117 view.

118 **Measurements. Female holotype, IGR.ARC 226.3 (Figs 2–3):** length of flagellomeres I to
 119 VIII 0.26 mm, IX to XIII 0.20 mm, antennal ratio 0.77; third palpomere length 0.065 mm,
 120 width ca. 0.025 mm, palpal ratio 2.6; fourth palpomere length 0.03 mm; wing length 0.60
 121 mm, width 0.26 mm; costa 0.59 mm long, costal ratio 0.98; first radial cell 0.16 mm long,
 122 second radial cell length 0.11 mm. **Female paratype, IGR.ARC 226.6 (Figs 4–5):** length of
 123 flagellomeres I to VIII 0.26 mm, IX to XIII 0.20 mm, antennal ratio 0.77; third palpomere
 124 length 0.065 mm, width 0.025 mm, palpal ratio 2.6; fourth palpomere length 0.03; wing

149 **Material.** Holotype female (a barely visible specimen with incomplete wings and legs)
 150 labelled as follows: Ceratopogonidae, g. et sp. indet., Cer Ce Bez 1, det. Schlüter, 1978: 98/
 151 *Austroconops borkenti* Szadziewski et Schlüter, 1992, holotype ♀, Nr. inv. 22225.
 152 Type locality and horizon. Stratum typicum - C4; Bezonnais Dept. Sarthe, collected by W. C.
 153 Kühne, L. Kubig and T. Schlüter 1971. In the collection of the Museum of the Earth, Warsaw,
 154 Poland.

155 **Diagnosis.** Female. Palpal segment 3 stout, only one segment beyond 3; antennal flagellum
 156 without sensilla coeloconica; mid tibia with apical spur. Male unknown.

157 **Description. Habitus.** Minute, darkly coloured midge with unarmed legs (Figs 7 a, 8 a) and
 158 markedly upcurved proboscis (Fig. 7 c). **Head.** Eye bare. Antennal flagellum with 13
 159 flagellomeres (Fig. 7 b); flagellomeres 2–4 subcylindrical, 1 and 5–12 longer, more slender;
 160 13 longest, tapering gradually distally, apex rounded; sensilla coeloconica not visible on
 161 flagellomere 1. Palpus 4-segmented, only one segment posterior to third (Fig. 7 c); third
 162 segment stout (Fig. 7 c), capitate sensilla and sensory pit not visible. **Thorax.** Posterior
 163 margin of scutellum rounded, setae not visible. Wing incomplete (Fig. 8 a), membrane
 164 hyaline; anterior veins very dark; membrane covered with microtrichia only. Hind femur
 165 moderately stout, unarmed; mid tibia with well-developed apical spur (Fig. 8 b); hind tibia
 166 with a series of long setae on small tubercles (most setae are missing but their tubercles are
 167 clearly visible); at least tarsomeres 1–2 of mid leg with single stout apical spine; claws of fore
 168 and mid legs small, equal sized, each talon probably with a small inner tooth or small inner
 169 sub-basal seta (Fig. 8 c); empodia not visible (Fig. 8 c).

170 **Abdomen.** Details not visible (Figs 7 a, 8 a), but cercus rather short.

171 **Measurements. Female holotype (Figs 7–8):** total flagellum length 0.54 mm, length of
 172 flagellomeres I to VIII 0.30 mm, IX to XIII 0.24 mm, antennal ratio 0.82; third palpomere
 173 length 0.074 mm, width 0.024 mm, palpal ratio 3.1; fourth palpomere length 0.05 mm;

125 length 0.61 mm, width 0.25 mm; fore tibial spur 0.02 mm long; fore tarsal ratio 2.3. **Female**
 126 **paratype, IGR.ARC 261.3 (Fig. 6):** third palpomere length ca. 0.065 mm, width ca. 0.023
 127 mm, palpal ratio 2.9; fourth palpomere length 0.04; wing length 0.71 mm, width 0.32 mm;
 128 costa 0.70 mm long, costal ratio 0.98; first radial cell length 0.13 mm, second radial cell
 129 length 0.115 mm; fore leg basitarsus 0.18 mm long, second tarsomere 0.12 mm, tarsal ratio
 130 1.5; mid leg basitarsus 0.18 mm long, second tarsomere 0.07 mm, tarsal ratio 2.4; hind leg
 131 basitarsus 0.16 mm long, second tarsomere 0.13 mm, tarsal ratio 1.2.

132 **Discussion.** This new species is very similar to *A. borkenti* Szadziewski & Schlüter, 1992,
 133 described from the Cenomanian French amber of Anjou (94–101 Ma). Both species are known
 134 only from females which within *Austroconops* usually have little to no diagnostic value. They
 135 differ only in the shape of their third palpal segment and apical spine on the mid tibia (see the
 136 key below). In *A. perrichoti*, the third palpal segment is more slender with palpal ratio (PR)
 137 2.6–2.9 and the mid tibia lacks an apical spur, whereas in *A. borkenti* the third palpal segment
 138 is stouter with PR 3.1 and the mid tibia has a stout apical spur.

139 In females of *A. perrichoti* with complete wings that we examined (IGR.ARC 226.3,
 140 IGR.ARC 261.3), the first radial cell is longer than the second. In all other species of the
 141 genus with known wing venation, both fossil and extant, the first radial cell is at least slightly
 142 shorter than the second (in *A. borkenti* the wing is incomplete – see the redescription below).
 143

144 *Austroconops borkenti* Szadziewski & Schlüter

145 Figs 7–8

146 Ceratopogonidae species C: Schlüter 1978: 98 (France, Upper Cretaceous)

147 *Austroconops borkenti* Szadziewski & Schlüter, 1992: 78 (France, Upper Cretaceous)

148

174 fragment of wing ca. 0.50 mm long; mid tibial spur 0.025 mm long; mid leg basitarsus 0.18
 175 mm long, second tarsomere 0.075 mm, tarsal ratio 2.4.

176 **Discussion.** According to Szadziewski & Schlüter (1992) and Szadziewski (1996) the third
 177 palpal segment in *A. borkenti* was slender, but only when compared to the extant *A. memillani*
 178 Wirth & Lee, 1958. In fact, the female holotype we re-examined has an enlarged, rather stout
 179 (palpal ratio 3.1) third palpal segment. The length of the third palpal segment given by
 180 Szadziewski & Schlüter (op. cit.) is also incorrect – it is around 0.074 mm and not 0.044 mm
 181 as stated in the original description.
 182

183 **Key to fossil species of *Austroconops* Wirth & Lee, 1958**

- 184
- 185 1. Females.....2
- 186 - Males.....7
- 187 2. Palpus with two segments beyond segment 3.....
- 188 *gondwanicus* Szadziewski, 1996 (Lower Cretaceous, Lebanese amber)
- 189 - Palpus with one segment beyond segment 3.....3
- 190 3. Fore, mid, hind basitarsus with single stout sub-basal ventral
- 191 spine..... *gladius* Borkent, 2000 (Lower Cretaceous, Lebanese
- 192 amber)
- 193 - At least fore and mid basitarsus without single stout ventral spine in sub-basal portion.....4
- 194 4. Third palpal segment slender, apical spur of fore tibia
- 195 large..... *megaspinus* Borkent, 2000 (Lower Cretaceous,
- 196 Lebanese amber)
- 197 - Third palpal segment swollen, apical spur of fore tibia slender5

198 5. Mid tibia without apical spur..... *perrichoti* sp. nov. (Lower Cretaceous, French amber of
199 Charente-Maritime)
200 - Mid tibia with apical spur..... 6
201 6. Flagellomere 1 with two distinct groups of sensilla trichoidea.....*fossilis*
202 Szadziewski, 1996 (Lower Cretaceous, Lebanese amber)
203 - Flagellomere 1 without two distinct groups of sensilla trichoidea.....*borkenti*
204 Szadziewski & Schlüter, 1992 (Upper Cretaceous, French amber of Anjou)
205 7. Palpus with two segments beyond segment 3..... *gondwanicus* Szadziewski, 1996
206 (Lower Cretaceous, Lebanese amber)
207 - Palpus with one segment beyond segment 3..... 8
208 8. Mid tibia with apical spur.....9
209 - Mid tibia without apical spur.....11
210 9. Fore and hind basitarsus with single stout sub-basal ventral spine..... *gladius*
211 Borkent, 2000 (Lower Cretaceous, Lebanese amber)
212 - Fore and mid basitarsus without single stout sub-basal ventral spine..... 10
213 10. Flagellomere 1 with two distinct groups of sensilla trichoidea; apical spur of fore
214 tibia small.....*fossilis* Szadziewski, 1996 (Lower Cretaceous, Lebanese amber)
215 - Flagellomere 1 without two distinct groups of sensilla trichoidea; apical spur of fore tibia
216 large.....*megaspinus* Borkent, 2000 (Lower Cretaceous, Lebanese amber)
217 11. Gonostylus with small apical tooth.....*sibiricus* Szadziewski, 1996 (Upper
218 Cretaceous, Siberian amber)
219 - Gonostylus with very large apical tooth.....*asiaticus* Szadziewski, 2004 (Lower
220 Cretaceous, Burmese amber)
221
222 **Concluding remarks**

248 **References**

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223
224 *Austroconops perrichoti* sp. nov. described in this paper is the eighth named fossil species in
225 the extant genus *Austroconops* regarded as a living fossil (Szadziewski 1996, 2008). Extinct
226 species are reported from the Northern Hemisphere while two extant species occur only in
227 Western Australia. The distribution of the genus in the Lower Cretaceous was probably
228 worldwide, similar to that of relictual coniferous genus *Araucaria* de Jussieu, 1789
229 (Szadziewski 2008). The latter genus occurred in the Northern Hemisphere from the Jurassic
230 until the end of the Cretaceous. At present, 19 extant species of *Araucaria* are known from
231 restricted populations in the Southern Hemisphere (South America, Eastern Australia, New
232 Guinea, New Caledonia and Norfolk Island) (Grimaldi & Engel 2005).
233 The genus *Austroconops* was probably common in mid-Cretaceous Europe, as in
234 addition to two named species from France, it was reported also from Spain (unnamed
235 females, Szadziewski & Arillo 2003).
236 It is worth mentioning that in *A. perrichoti* the first radial cell is longer than the second,
237 a character state unique within the genus. In all other *Austroconops* species with preserved
238 wing venation the first radial cell is at least slightly shorter than the second.
239
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244 Warsaw (Poland) for the opportunity to examine the holotype of *Austroconops borkenti*
245 Szadziewski & Schlüter. We are very grateful to the anonymous reviewers and Editor for all
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247

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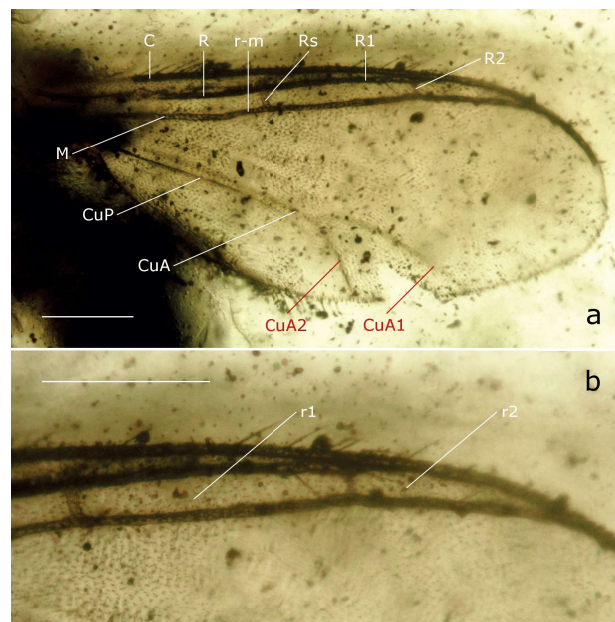
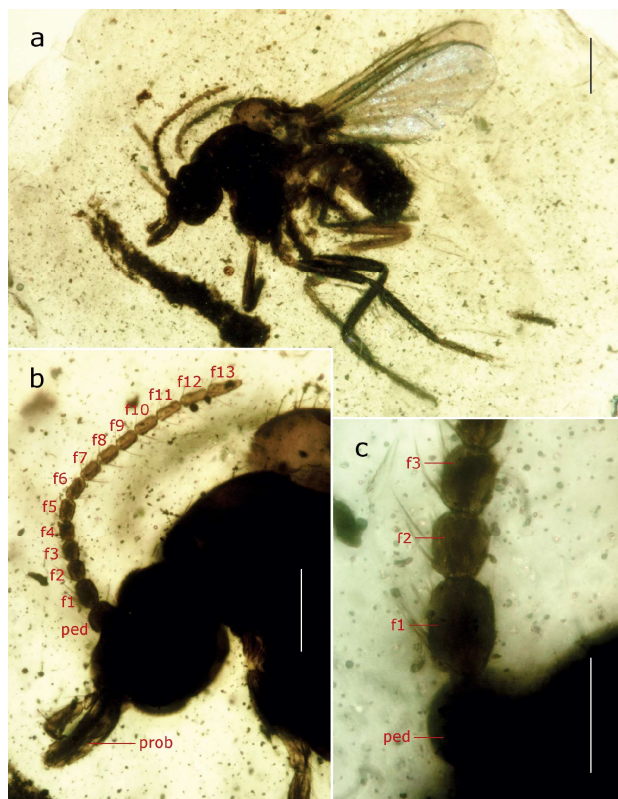
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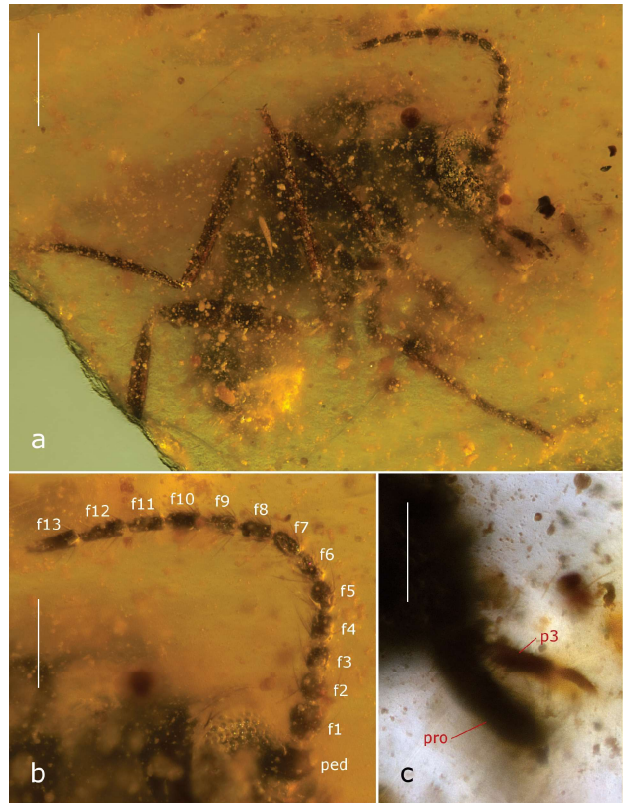
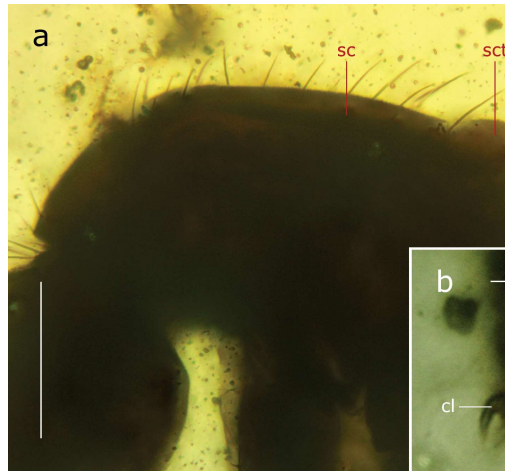
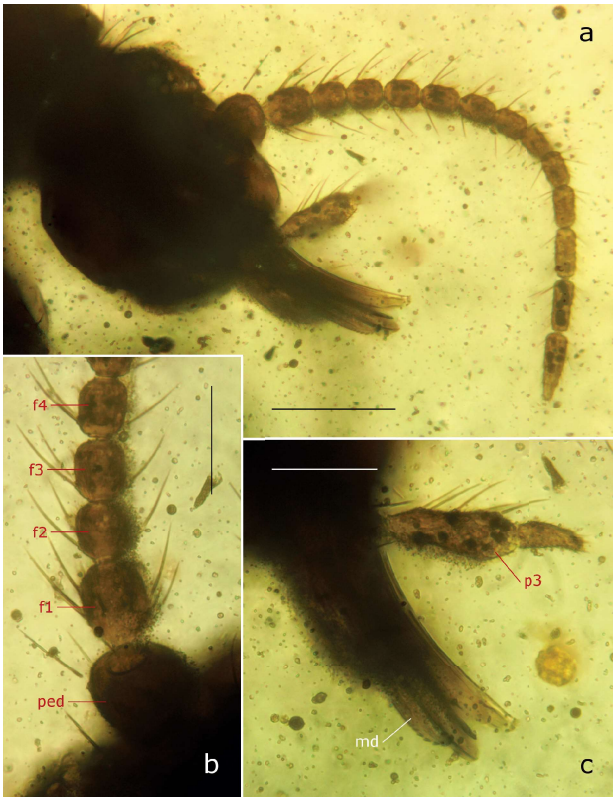
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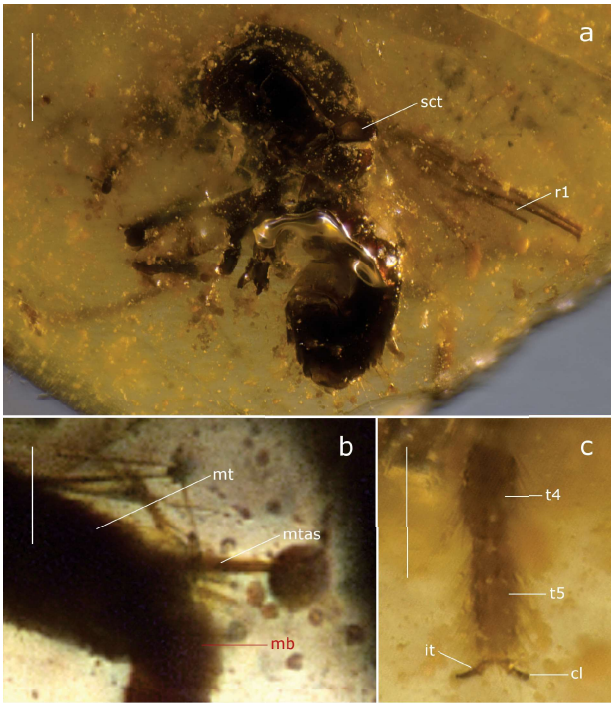


Figure 1. Location map of Font-de-Benon quarry (marked with red dot) in Charente-Maritime department, France.

Figure 2. *Austroconops perrichoti* sp. nov., female holotype, no. IGR.ARC 226.3: a – habitus, lateral view; b – antenna; c – pedicel and flagellomeres 1-3. ped – pedicel; f 1-13 – flagellomeres 1-13; scale bars: a – 0.2 mm, b – 0.1 mm, c – 0.05 mm

Figure 3. *Austroconops perrichoti* sp. nov., female holotype, no. IGR.ARC 226.3: a – wing; b – radial cells. C – costa; R – radius; r-m – radial-medial; Rs – radial sector; R1 – radius branch 1; R2 – radius branch 2; M – media; CuP – posterior branch of cubitus; CuA – anterior branch of cubitus; CuA1 – cubitus branch 1; CuA2 – cubitus branch 2; r1 – first radial cell; r2 – second radial cell; scale bars: a, b – 0.1 mm

Figure 4. *Austroconops perrichoti* sp. nov., female paratype, no. IGR.ARC 226.6: a – antenna; b – pedicel and flagellomeres 1-4; c – maxillary palp and mouthparts. ped – pedicel; f 1-4 – flagellomeres 1-4; p3 – third palpomere; md – mandible; scale bars: a – 0.1 mm, b, c – 0.05 mm

Figure 5. *Austroconops perrichoti* sp. nov., female paratype, no. IGR.ARC 226.6: a – thorax, lateral view; b – fore leg claws. sc – scutum; set – scutellum; cl – claw; ss – sub-basal seta; scale bars: a – 0.1 mm, b – 0.02 mm

Figure 6. *Austroconops perrichoti* sp. nov., female paratype, no. IGR.ARC 261.3: a – hind leg tibia; b – hind leg basitarsus, basal portion; c – mid leg tarsomeres 3-5 and claws; d – hind leg claws. hts – hind tibia setae; hbs – hind basitarsus setae; t 3-5 – tarsomeres 3-5; cl – claw; emp – empodium; scale bars: a, b, c – 0.05 mm, d – 0.02 mm

Figure 7. *Austroconops borkenti* Szadziewski & Schlüter, 1992, female holotype: a – habitus, lateroventral view; b – antenna; c – maxillary palp. ped – pedicel; f 1-13 – flagellomeres 1-13; p3 – third palpomere; pro – proboscis; scale bars: a – 0.2 mm, b, c – 0.1 mm

Figure 8. *Austroconops borkenti* Szadziewski & Schlüter, 1992, female holotype: a – habitus, laterodorsal; b – apical spur of mid tibia; c – fore leg tarsomeres 4-5 and claws. set – scutellum; r1 – first radial cell; mt – mid tibia; mtas – apical spur of mid tibia; mb – mid

basitarsus; t 4-5 – tarsomeres 4-5; cl – claw; it – inner tooth; scale bars: a – 0.2 mm, b – 0.02 mm, c – 0.05 mm