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To cite this article: R. Szadziewski, M. Gwizdalska-Kentzer, M. A. Bologna & M. Molfini (2022) A new canthariphilous species of the genus *Atrichopogon* Kieffer, 1906 from central Italy (Diptera: Ceratopogonidae), The European Zoological Journal, 89:1, 608-614, DOI: [10.1080/24750263.2022.2066209](https://doi.org/10.1080/24750263.2022.2066209)

To link to this article: <https://doi.org/10.1080/24750263.2022.2066209>



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Published online: 04 May 2022.



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A new canthariphilous species of the genus *Atrichopogon* Kieffer, 1906 from central Italy (Diptera: Ceratopogonidae)

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(Received 24 February 2022; accepted 10 April 2022)

Abstract

The new species *Atrichopogon (Atrichopogon) tolfensis* n. sp. from Tolfa Mountains (Italy, Latium, and Rome) is described and illustrated. Both sexes of the species were collected using cantharidin-baited traps from June 2020 to January 2021. The new species is an atypical member of the genus *Atrichopogon*.

<https://urn.lsid:zoobank.org:pub:3A012331-57D7-4532-B3F9-FDEE7C988FFD>

Keywords: *Atrichopogon tolfensis*, cantharidin, biting midges, species description, Italian fauna, European fauna

Introduction

Biting midges of the genus *Atrichopogon* Kieffer, 1906 (Ceratopogonidae: Forcipomyiinae) are common in moist terrestrial habitats of all regions of the world. Adult females have functional mouthparts with toothed mandibles, and most of them feed on haemolymph of other insects as protein-rich meals are necessary for ovarian development of most biting midges (Downes 1958; Glukhova 1989; Szadziewski et al. 1997). Females of some species, like European *A. pavidus* (Winnertz) from the subgenus *Atrichopogon* s. str., obtain proteins feeding on pollen (Downes 1955; Szadziewski 2001). Also, females can supplement their protein-rich diet with sugar and water from nectar or honeydew. Contrarily, adult males have reduced biting mouthparts, and their diet appears to lack protein-rich meals.

Borkent and Dominiak (2020) listed 513 extant valid species of *Atrichopogon* in the ceratopogonids world fauna. In Europe, this poorly known genus includes 44 described species grouped into five

subgenera: *Atrichopogon* Kieffer, 1906, *Lophomyidium* Cordero, 1929, *Melohelea* Wirth, 1956, *Psammopogon* Remm, 1979, and *Psilokempia* Enderlein, 1936 (Alwin-Kownacka et al. 2016). *Melohelea* is a subgenus proposed by Wirth (1956) to include species which were believed to be unique because they feed upon haemolymph of blister beetles (Coleoptera: Meloidae) and false blister beetles (Coleoptera: Oedemeridae). Beetles belonging to these two families are known to be the only producers of cantharidin, a toxic terpene involved in chemical defence and mating behaviour of several species (Carrel & Eisner 1974; Carrel et al. 1986; Dettner 1997). Females of some *Atrichopogon* species can sequester cantharidin from beetles and pass this terpene to eggs as a defence compound (Frenzel & Dettner 1994). Some evidences suggest that males can also sequester cantharidin in nature, but this phenomenon is still poorly studied (Frenzel & Dettner 1994). However, both males and females of *Atrichopogon* species have been repeatedly collected in cantharidin-baited traps, showing a high

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attraction to cantharidin and its analogues, thus being considered “canthariphilous species” (Frenzel et al. 1992; Hemp & Dettner 2001; Horiuchi et al. 2018).

Wirth (1980) and Szadziewski et al. (2007) revised the Holarctic and European species of the subgenus *Melochelea*, respectively, correcting numerous misidentifications and misinterpretations and confirming previous reports that other species besides *Melochelea* are attracted to meloids or cantharidin. In Europe, the following seven species of canthariphilous midges, belonging to three *Atrichopogon* subgenera, have been reported: (i) subgenus *Melochelea*: *A. lucorum* (Meigen, 1818) (= *A. setospennis* Kieffer, 1913) (Wirth 1956, 1980; Bologna & Havelka 1985; Frenzel et al. 1992; Szadziewski et al. 2007; Hashimoto and Tateno 2022), *A. meloesugans* Kieffer, 1922 (Wirth 1956, 1980; Szadziewski et al. 2007), *A. oedemerarum* Storå, 1939 (Wirth 1956, 1980; Frenzel et al. 1992; Szadziewski et al. 2007), and *A. winnertzi* Goetghebuer, 1922 (Szadziewski et al. 2007); (ii) subgenus *Atrichopogon* s. str.: *A. brunnipes* (Meigen, 1804) (Wirth 1980; Frenzel et al. 1992; Szadziewski et al. 2007); and (iii) subgenus *Psammopogon*: *A. albiscapulus* Kieffer, 1918 (without detailed locality records; Frenzel et al. 1998; Havelka and Aguilar 1999) and *A. muelleri* (Müller, 1905) (= *trifasciatus* auct.) (Frenzel et al. 1992; Szadziewski et al. 2007). From the list of canthariphilous species compiled by Hemp and Dettner (2001), both *Atrichopogon illiesi* and *A. (Lophomyidium) rostratus* (Winnertz, 1852) should be excluded. In fact, *A. illiesi* has never been described and represents a typical *nomen nudum* (Bologna and Havelka, 1985), while *A. rostratus* has been erroneously reported by Wirth (1956) due to a misidentification. The old record of the haematophagous *Culicoides obsoletus* (Meigen, 1818) (Bologna & Havelka 1985), never confirmed in other studies, should also be excluded from this list.

The species described below belongs to the subgenus *Atrichopogon* s. str., which is the most difficult to identify and the most neglected group within the genus. Indeed, this subgenus includes very similar species whose characters for taxonomic identification are limited and highly variable.

The purpose of this paper is to describe a new European species in the subgenus *Atrichopogon* s. str. which was collected with cantharidin-baited traps in central Italy.

Material and methods

All examined specimens were collected from two sites in derived pastures within oak (*Quercus* Linnaeus) woodlands at the western base of Tolfa Mountains: site A (Italy, Latium, Rome, Tolfa, 42.058716N,

11.941148E; 48 m a.s.l.) (Figure 1(a,b)) and site B (Italy, Latium, Rome, Tolfa, 42.092617N, 11.974103E; 298 m a.s.l.) (Figure 1(c,d)). Two pairs of funnel traps were placed in each site. Paired traps consisted in one cantharidin-baited trap and one control trap, based on the protocol described in Horiuchi et al. (2018). Paired traps were about 2 m distanced, and the distance between pairs was about 30 m. Traps were active for 24 h every 2 weeks (approximately) for 1 year (June 2020–June 2021). After 24 h, traps were capped with cotton wool and stored at -20°C to euthanize the specimens. Specimens were then preserved in 70% ethanol.

Specimens were mounted on microscope slides in phenol-Canada balsam following the method described by Wirth and Marston (1968). The photograph of a female was taken with a LAS Montage multi-focus camera attached to a Leica stereo microscope M205A (Figure 2). The materials are housed in the collection of extant invertebrates of the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland (CEIG), and the Zoological Museum of Roma (Museo Civico di Zoologia), Italy (MCZ). We employ the traditional terminology of Ceratopogonidae as described in Szadziewski (1986).

Taxonomic accounts

Order: Diptera

Family: Ceratopogonidae Newman, 1834

Subfamily: Forcipomyiinae Lenz, 1934

Tribe: Forcipomyiini Lenz, 1934

Atrichopogon (*Atrichopogon*) *tolfensis* n. sp.
(Figs 2–4).

Type material

Holotype: Male, site A, 29.09.2020, leg. M. Molfini (CEIG). **Paratypes:** 14 males and 21 females from sites A and B. **Site A** (11 males, 19 females): 2 males, 3 females—22.06.2020 (CEIG); 5 females—05.07.2020 (CEIG); 2 males, 5 females—04.08.2020 (CEIG); 1 male—19.08.2020 (CEIG); 1 male, 1 female—29.09.2020 (CEIG); 1 male, 1 female—29.09.2020 (MCZ); 3 females—14.10.2020 (CEIG); 1 male—28.10.2020 (CEIG); 2 males, 1 female—11.11.2020 (CEIG); 1 male—28.01.2021 (CEIG). **Site B** (3 males, 2 females): 1 female—19.08.2020 (CEIG); 3 males, 1 female—29.09.2020 (CEIG).



Figure 1. Sample areas: site A (a, b) and site B (c, d).

Diagnosis

Small, dark brown biting midge with wing length 0.95–1.35 mm. Both sexes have pubescent eyes, terminal flagellomere blunt or with conical to cylindrical apical prolongation, single seta on paratergite, 0–3 setae on anterior anepisternum and four marginal bristles on scutellum; female ([Figures 2 and 3](#)) with single ovoid seminal capsule, wing membrane with macrotrichia in cells r_{2+3} , m_1 and few in m_2 ; male with wing membrane bare and unique aedeagus bearing slender hourglass-like caudomedian projection with dark semi-elliptic base in ventral view ([Figure 4](#)).

Description

Female ([Figures 2 and 3](#)) Body dark brown with yellowish legs and pale halteres; sometimes shoulders and scutellum paler ([Figure 2](#)). Eye pubescent. Flagellum 0.50–0.54 mm long, antennal ratio (AR) 1.52–1.70, proximal flagellomeres 2–8 spherical ([Figure 3\(a\)](#)), apex of terminal flagellomere blunt or with conical to cylindrical prolongation, not constricted at base ([Figures 3\(a,b\)](#)). Proboscis short, palpus 5-segmented, palpomere 3

slender, 0.050–0.072 mm long, with sensory pit on distal half ([Figure 3\(c\)](#)). Mandible armed with distinct 17–19 teeth, largest at mid-length. Anterior anepisternum B-shaped, broadly bilobed posteriorly, bearing usually 2 (1–2) short setae at mid-length ([Figure 3\(d\)](#)). Paratergite ovoid with one long seta ([Figure 3\(d\)](#)). Scutum covered with numerous short setae. Scutellum bearing four marginal bristles. Wing length 1.00–1.25 mm, costal ratio (CR) 0.64–67; first radial cell slit-like, second one distinct, wing membrane with macrotrichia in apical portion in cells r_{2+3} , m_1 and few in m_2 ([Figure 3\(e\)](#)). Legs slender, yellowish, claws with single pointed apices, empodium with simple hairs, tarsal ratio (TR) of foreleg TR(1) 3.2–3.6, of midleg TR(2) 3.1–3.4, of hind leg TR(3) 2.4–2.9. Seminal capsule single, almost spherical with short neck ([Figure 3\(f\)](#)), dark brown with pale dots at neck, length with neck 0.087–0.100 mm.

Male ([Figure 4](#)) Similar to female, with usual sexual differences. Eyes pubescent. Flagellum with 13 separated flagellomeres, total length 0.65–0.75 mm, distal four flagellomeres elongate, plume well developed, terminal flagellomere with blunt apex or with conical to cylindrical apical prolongation without constriction at base. Third palpal



Figure 2. Female of *Atrichopogon (Atrichopogon) tolfensis* n. sp., total habitus.

segment 0.055–0.062 mm long. Anterior anepisternum bearing usually 2 (0–3) short setae at mid-length. Wing length 0.95–1.35 mm, CR 0.61–0.65, wing membrane without macrotrichia. Tarsal ratio of foreleg (TR1) 3.3–3.4, of midleg TR(2) 3.2–3.4, of hind leg TR(3) 2.5–2.7. Genitalia (Figure 4). Sternite 9 with straight caudal margin. Tergite 9 with rounded margin, without apicolateral projections. Gonocoxite slender, with long ventral apodemes (gonocoaxal roots), dorsal apodemes not developed. Parameres absent. Aedeagus (ventral plate) arch shaped; basal arch high; aedeagal arch with two pointed lateral projections and apical ventral rounded broad expansion and dorsal hourglass-like long and slender expansion; base of hourglass expansion dark, semi-elliptic in ventral view.

Etymology

The specific name refers to the Tolfa Mountains near Rome, the type locality of the new species.

Conclusive remarks

The new species has unique aedeagus with hourglass dorsal caudomedian expansion with semi-elliptic dark base (Figure 4). Such a character is unknown in all other species of the subgenus described from Europe, North Africa, the Middle East, the Caucasus, and Central Asia (Goetghebuer 1934; Clastrier 1956; Remm 1967, 1980; Szadziewski 1984, 1986, 2001; Szadziewski et al. 1996; Alwin-Kownacka et al. 2016).

Noteworthily, this new species represents an atypical member of the genus *Atrichopogon* as its terminal flagellomere 13 is blunt or without apical nipple-like prolongation, i.e. it has no constriction at base (Figure 3(b)). Indeed, to the best of our knowledge, all adults of European species within the tribe Forcipomyiini (including two genera: *Forcipomyia* Meigen, 1818, and *Atrichopogon*) have very characteristic nipple-like prolongation on apex of terminal flagellomere. Moreover, *A. tolfensis* n. sp. has the anterior anepisternum bearing 2 (0–3) short setae, which is totally bare in the European congeneric species.

A. tolfensis n. sp. is the eighth on the list of canthariphilous Ceratopogonidae in Europe. The presence of

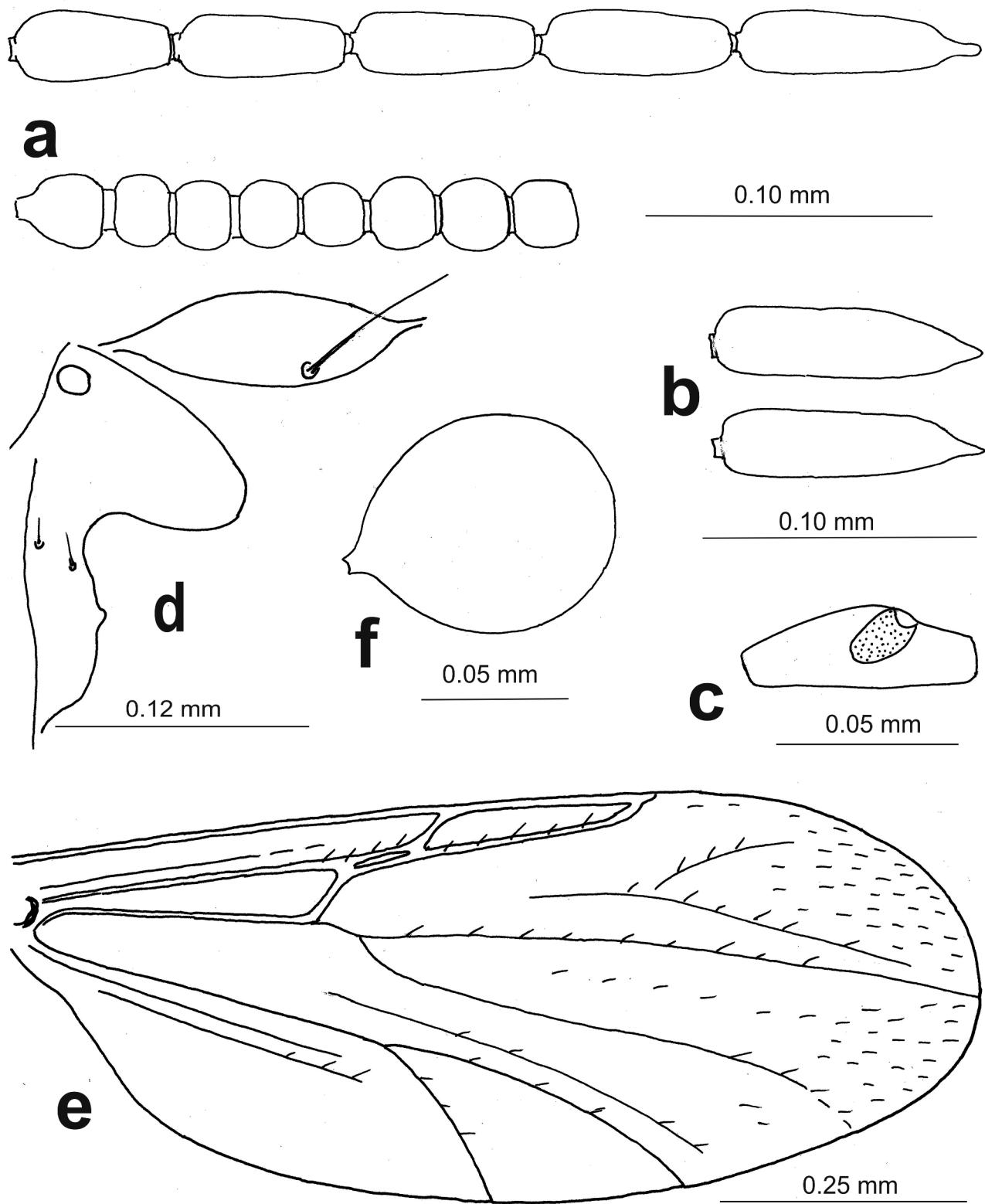


Figure 3. *Atrichopogon (Atrichopogon) tolensis* n. sp., female: (a) flagellum, (b) terminal flagellomere, (c) third palpal segment, (d) paratergite and anterior anepisternum, (e) wing, and (f) seminal capsule.

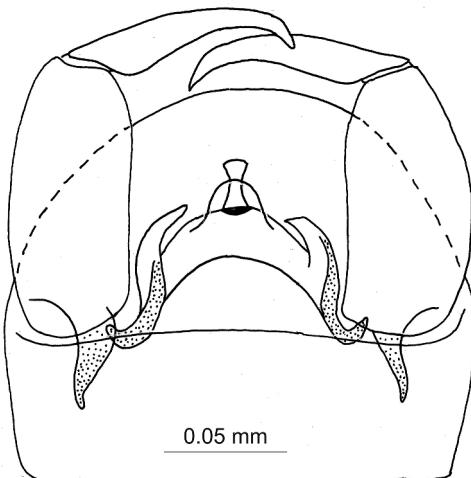


Figure 4. *Atrichopogon (Atrichopogon) tolfensis* n. sp., male genitalia, ventral view.

males (15) and females (21) in cantharidin-baited traps evidences that both sexes are attracted to cantharidin with no significant difference: binomial test p -value >0.05 ($= 0.256$). Nevertheless, it should be emphasised that the attraction to cantharidin of biting midges does not demonstrate by itself interspecific interactions with cantharidin-producing species. Indeed, some species could just confuse cantharidin with similar plant or fungal molecules used in food search (Frenzel et al. 1992; Hashimoto & Hayashi 2014). Further investigations are needed to understand the canthariphilous behaviour of this species and the evolution of canthariphily in Ceratopogonidae.

Acknowledgements

We are much indebted to Dr Elzbieta Sontag of the Department of Invertebrate Zoology and Parasitology, University of Gdańsk, Poland, for taking the photo of the *Atrichopogon tolfensis* female presented in this work.

Funding

The Grant of Excellence Departments, MIUR (ARTICOLO 1, COMMI 314–337 LEGGE 232/2016) to Department of Science, University Roma TRE, is gratefully acknowledged.

Disclosure statement

No potential conflict of interest was reported by the authors.

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