



## Diagnosis of *Forcipomyia sahariensis* Kieffer (Diptera: Ceratopogonidae) with the first description of immature stages

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**Abstract:** *Forcipomyia sahariensis* Kieffer, 1923 is diagnosed in all stages. Larvae and pupae reared from rotting roots are described for the first time. *Forcipomyia tuzeti* Huttel et Huttel, 1952 from France and *F. acanthophora* Remm in Havelka, 1976 from Germany are recognized as new junior synonyms of *F. sahariensis*. A supplemented key for identification of known larvae and pupae of Polish species of the subgenus *Forcipomyia* s. str. is also provided.

**Key words:** Diptera, Ceratopogonidae, *Forcipomyia*, diagnosis, larva, pupa, new synonymy, Poland.

### INTRODUCTION

Biting midges of the genus *Forcipomyia* Meigen are distributed worldwide and common in almost all terrestrial habitats. Over one thousand recent species are known in the genus, which are classified into about 30 more or less distinct subgenera (Borkent & Wirth 1997, Borkent 2009). There are known 36 species of the genus *Forcipomyia* in Poland including 16 in the subgenus *Forcipomyia* s. str. (Szadziewski 2007, Dominiak & Michalczyk 2009). Gilka (1996) described immature stages of some species in the subgenus *Forcipomyia* and provided keys for identification of larvae and pupae of nine Polish species. Subsequently *Forcipomyia radicolica* EDWARDS with immatures described by Saunders (1924) and *F. squamigera* (Kieffer) were reported from Poland (Szadziewski & Borkent 2003, Szadziewski et al. 2007).

In this paper we describe larvae and pupae of *Forcipomyia sahariensis* for the first time and we present modified diagnoses for adults and propose new synonyms. Additionally, we illustrate for the first time special organs in the neck region of the larval prothorax of *F. radicolica*. Larvae and pupae of *F. sahariensis*, *F. radicolica* and *F. squamigera* are incorporated into the keys for identification of Polish species of the subgenus.

### MATERIAL AND METHODS

Larvae and pupae of *Forcipomyia sahariensis* were collected in NE Poland: Wyskok near Kętrzyn on 5th April 2009. They were observed within large colonies of *F. radicolica* living in rotting roots of an undetermined umbelliferous plant (Apiaceae) and *Arctium lappa*. In the laboratory we selected 4 larvae and 10 pupae for descriptions, and reared 4 females and 24 males which emerged from 20 April to 1 May 2009. Larvae, pupae and adults were dissected and mounted on slides in a mixture of phenol-Canada balsam as described by Wirth & Marston (1968). They are preserved in the collection of the Department of Invertebrate Zoology, University of Gdańsk. SEM microphotographs of *F. radicolica* were made by Dr Magdalena Kowalewska-Groszkowska of the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw.

## RESULTS

*Forcipomyia sahariensis* Kieffer, 1923

*F. sahariensis* Kieffer, 1923: 663 (1 ♂, Algeria); Szadziewski 1983: 367 (1 ♂, 1 ♀, Algeria, syn. *F. armaticrus*, *F. onusta*).

*F. armaticrus* Kieffer, 1923: 661 (1 ♀, Algeria).

*F. tuzeti* Huttel et Huttel, 1952: 178 (1 ♂, France), n. syn.

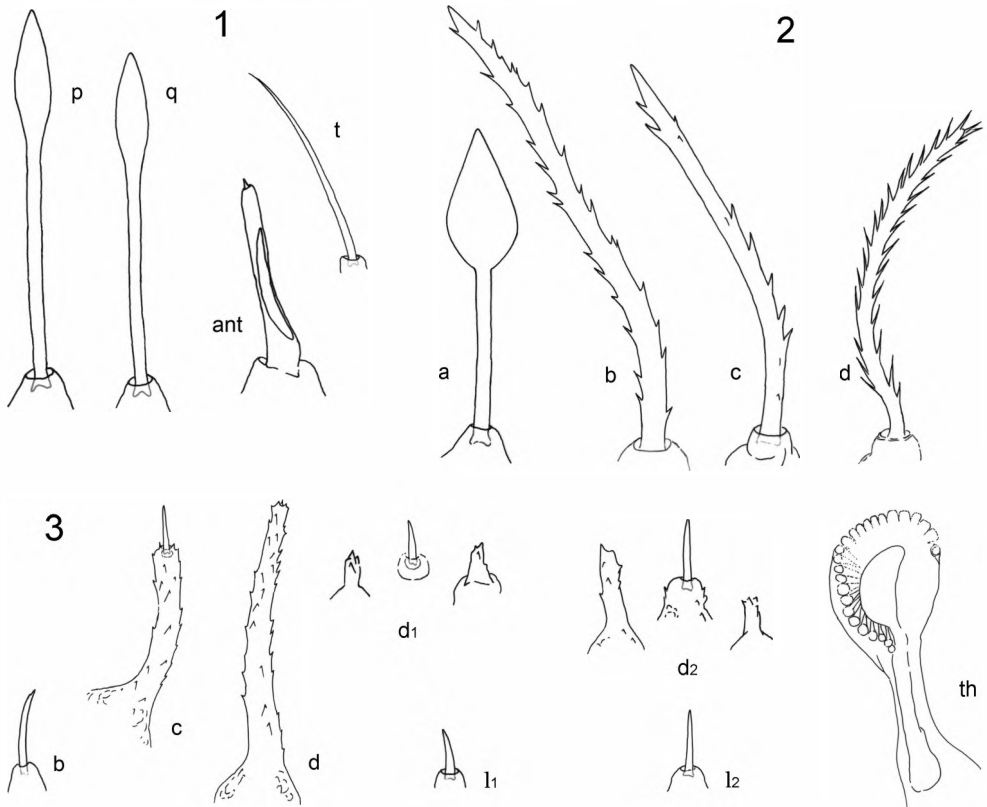
*F. acanthophora* Remm in Havelka, 1976: 227 (1 ♂, Germany), n. syn.

*F. onusta* Remm, 1980: 122 (1 ♂, 1 ♀, Caucasus, Middle Asia, Sakhalin).

**Diagnosis:** Immature stages and adults of *Forcipomyia sahariensis* can be easily distinguished among other species of the subgenus *Forcipomyia* s. str. by the following combination of characters:

Larva: Body seta *b* and *d* densely serrated; seta *a* lanceolate; cuticle covered with short spines; head setae *p* and *q* lanceolate (Figs. 1, 2).

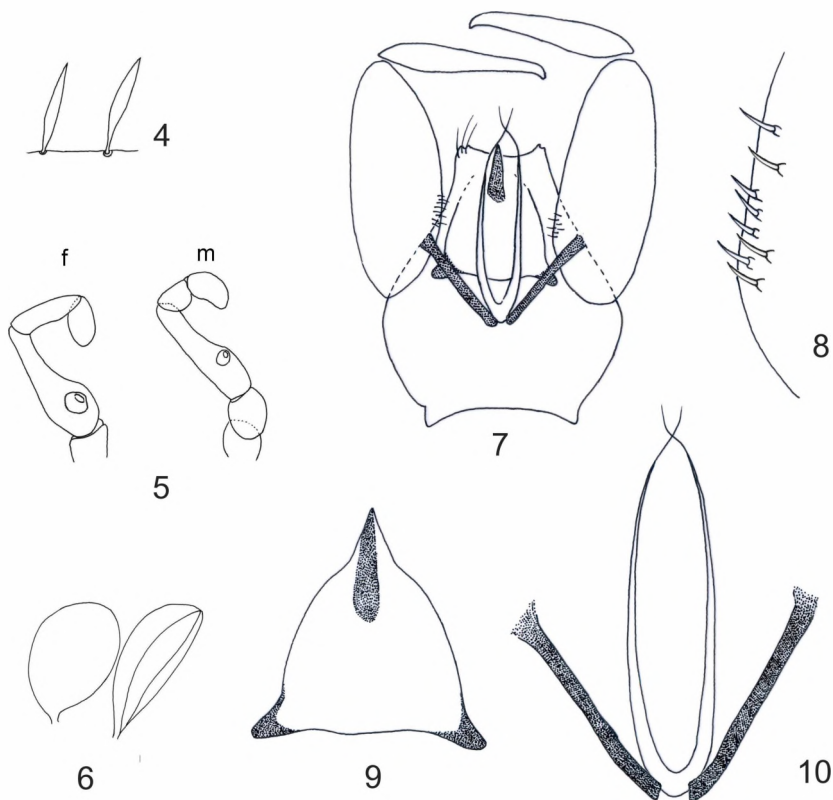
Pupa: Head with 1 pair of processes *b* bearing short seta; thoracic processes *f* absent; abdominal segments 1–4 with 3 pairs of very short dorsal and 1 pair of lateral processes (Fig. 3).



Figs 1–3. *Forcipomyia sahariensis* Kieffer, 1923, larva (1, 2) and pupa (3). 1 – head setae of larva, 2 – thoracic setae of larva, 3 – processes and thoracic horn of pupa. Abbreviations: d – dorsal, l – lateral, <sub>1</sub> or <sub>2</sub> – the first or the second abdominal segment, th – thoracic horn, ant – antenna, p, q, t – head setae of larva, a, b, c, d – setae and processes of larva or pupa.

Female: All tibiae with lanceolate scales (Fig. 4); third palpal segment enlarged on basal portion (Fig. 5 f); antennal ratio AR 0.6–0.8; wing length 1.3–1.4 mm; two seminal capsules present (Fig. 6).

Male: Ventral surface of gonocoxite with a group of 8–10 distinct spines (Fig. 8). Parameres basally fused, u-shaped, with slender x-crossing apices (Fig. 10). Gonostyle usually pale (Fig. 7). Aedeagus triangular with simple pointed apex (Fig. 9). Wing length 1.3–1.5 mm.



Figs. 4–10. *Forcipomyia sahariensis* Kieffer, 1923, female (4, 5f, 6) and male (5m, 7–10). 4 – lanceolate scales of hind tibia, 5 – palpus, 6 – seminal capsules, 7 – male genitalia, 8 – ventral surface of gonocoxite with setulae, 9 – aedeagus, 10 – parameres.

**Description:** Larva (4th instar). Total length 3.7–3.9 mm. Pale yellow.

Head. Antenna slightly curved, pointed. Setae *p* and *q* lanceolate, smooth. Seta *t* smooth and slender with pointed tip (Fig. 1).

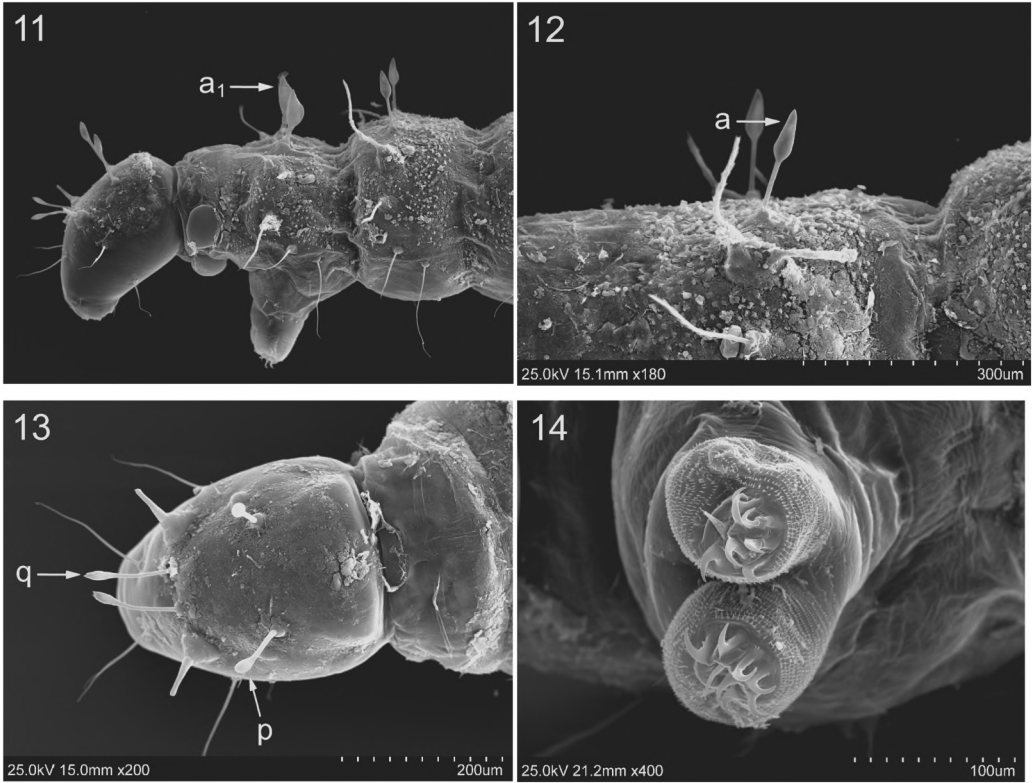
Thorax. Prolegs slightly bilobed, hooklets placed centrally. Seta *a* lanceolate, relatively short, of same shape on all body segments. Seta *b* and *d* dark, placed on distinct tubercles, seta *d* slightly curved, serrated, seta *b* shorter with dense serrations. Seta *b* on segment 11 devoid of spines, short and slender. Seta *c* dark with short sparse spines and pointed apex (Fig. 2). Cuticle covered with short spines.

Seta *d* of anal segment (12) short and slender, setae *a* and *b* of similar shape as on other body segments (Fig. 2). Anal papillae bilobed.

Pupa. Total length 2.8–2.9 mm. Pale yellowish to yellow.

Head. Process *a* absent; *b* bearing very short apical seta (Fig. 3).

Thorax. Processes *c*, *d* and *e* stout and serrated. Process *c* with short seta. Process *f* reduced to a small tubercle. Horn short, about twice longer than broad, bulb-shaped, with 12–20 spiracular openings (Fig. 3). Caudomedian prolongation reaching middle of 1st abdominal segment.



Figs 11–14. *Forcipomyia radicolica* Edwards, SEM photos of larva. 11 – lateral aspect of head and prothorax, 12 – lanceolate setae of mesothorax, 13 – dorsal aspect of head, 14 – prolegs.

Abdomen. Proximal abdominal segments (1–4) each with 4 pairs of processes: 3 dorsal (*d*), and 1 lateral (*l*). Dorsal processes very short, stout and finely serrated. One pair of dorsal and lateral processes with apical short seta (Fig. 3). Segment 5th only with 2 pairs of processes, 1 dorsal and 1 lateral.

**Distribution:** *Forcipomyia sahariensis* is widely distributed in the Palearctic region. It is recorded from Europe (France, Germany, Poland, Slovakia), Middle Asia (Kazakhstan), Far East (Sakhalin), Near East (Caucasus) and North Africa (Algeria). Larvae and pupae live in wet rotting roots of *Arctium lappa* and Apiaceae.

#### DISCUSSION

Preimaginal stages of *Forcipomyia sahariensis* are described here for the first time. They are very similar to those of *F. squamigera*. Larvae of both species have similar head setae *p* and *q* and thoracic setae – *a*, *b* and *d* (Szadziewski et al. 2007). The thoracic setae *a* are short and lanceolate, while *b* and *d* serrated and placed on separate tubercles. Pupae of *F. sahariensis*

and *F. squamigera* have different number and specific shape of short abdominal processes (see key below).

In the male genitalia of *Forcipomyia sahariensis* there are characteristic u-shaped parameres and a group of 8–10 small spines on the ventral surface of the gonocoxite. The same diagnostic structures we found in males of *F. tuzeti* and *F. acanthophora* described from Europe. We believe that these features properly indicate that all these names concern one species and propose to treat *F. tuzeti* and *F. acanthophora* as new junior synonyms of *F. sahariensis*. *Forcipomyia ashantii* Ingram & Macfie, 1924 from tropical Africa and *F. ventralis* Borkent, 1997 (= *abdominalis* Tokunaga, 1940) from Japan have also ventral spines on gonocoxites like *F. sahariensis*. However, their females have no lanceolate scales on their tibiae.

In the neck region of *Forcipomyia radicola* larvae there are three ovoid pillow-like ventral fields of thin and smooth cuticle (Fig. 11). We suggest that they play certainly role in cuticular respiration of apneustic larvae of this species. Such structures in the genus *Forcipomyia* are observed for the first time.

#### KEY TO LARVAE (4<sup>TH</sup> INSTAR) OF POLISH SPECIES OF THE SUBGENUS *FORCIPOMYIA*

1. Body setae *a* on segments 2–12 lanceolate (Figs. 2, 12) ..... 2
  - Body setae *a* on segments 2–12 not lanceolate ..... 9
2. Setae *a* on prothorax and segments 2–12 lanceolate, of similar length ..... 3
  - Setae *a* on prothorax boot-like, short (Fig. 11) ..... *F. radicola* Edwards
3. Head setae *p* and *q* hair-shaped, serrated ..... *F. costata* (Zetterstedt)
  - Head setae *p* and *q* lanceolate, smooth (Fig. 1) ..... 4
4. Setae *b* and *d* on common tubercle; cuticle smooth; apices of prolegs irregular .....
  - ..... *F. nigrans* Remm, *F. hygrophila* Kieffer
  - Setae *b* and *d* on separated tubercles; cuticle with distinct spines, apices of prolegs round ..... 5
5. Prolegs deeply bilobed on 2/3 total length ..... *F. bipunctata* (L.)
  - Prolegs shallowly bilobed on 1/4 total length ..... 6
6. Seta *b* straight, with fine and sparse serrations. Body length up to 5 mm. .... *F. ciliata* (Winnertz)
  - Seta *b* curved, broom-like, with long dense serrations. Body length up to 2,5 mm ..... 7
7. Seta *d* smooth ..... *F. pulchrithorax* Edwards
  - Seta *d* with dense serrations (Fig. 2) ..... 8
8. Head seta *t* bare (Fig. 1) ..... *F. sahariensis* Kieffer
  - Head seta *t* with short spines ..... *F. squamigera* Kieffer
9. Anal papillae bilobed ..... *F. kaltenbachi* (Winnertz)
  - Anal papillae single ..... 10
10. Body seta *a* very long, gradually cylindrical ..... *F. nigra* (Winnertz)
  - Body seta *a* short, swollen at middle with distinct serrations ..... *F. brevipennis* (Macquart)

#### KEY TO PUPAE OF POLISH SPECIES OF THE SUBGENUS *FORCIPOMYIA*

1. Head with processes (Fig. 3) ..... 4
  - Head without processes ..... 2
2. Thoracic horn with more than 30 openings. Posterior prolongation of thorax short, reaching middle of 1st abdominal segment ..... *F. ciliata* (Winnertz)
  - Thoracic horn with less than 30 openings. Posterior prolongation of thorax long, reaching almost end of 1st segment or 2nd abdominal segment ..... 3
3. Thorax with long and slender processes ..... *F. bipunctata* (L.)
  - Thorax with short processes and tubercles ..... *F. pulchrithorax* Edwards

4. Abdominal segments 2–4 with 1 pair of dorsal processes .....5  
 - Abdominal segments 2–4 with 2 pairs of dorsal processes (Fig. 3) .....6
5. Dorsal process of 1st abdominal segment short, without seta; dorsal processes of abdominal segments 2–5 without setae; thoracic process *c* with apical short seta ..... *F. kaltenbachi* (Winnertz)  
 - Dorsal process of 1st abdominal segment long, with long apical seta; dorsal process of abdominal segments 2–5 with long setae; thoracic process *c* with very long apical seta ..... *F. nigrans* REMM, *F. hygrophila* Kieffer
6. Thoracic process *c<sub>l</sub>* present .....7  
 - Thoracic process *c<sub>l</sub>* absent (Fig. 3) .....8
7. Posterior prolongation of thorax short; thoracic process *f* present ..... *F. brevipennis* (Macquart)  
 - Posterior prolongation of thorax long; thoracic dorsal process *f* absent, replaced by tubercle ..... *F. squamigera* (Kieffer)
8. Head with 2 pairs of processes ..... *F. nigra* (Winnertz)  
 - Head with 1 pair of processes (Fig. 3) .....9
9. Head processes with long terminal seta ..... *F. radicolica* Edwards  
 - Head processes without or with short terminal seta .....10
10. Lateral process of abdominal segments long; dorsal thoracic process *f* present; head process without apical seta ..... *F. costata* (Zetterstedt)  
 - Lateral process of abdominal segments very short; thoracic dorsal process *f* absent; head process with apical seta (Fig. 3) ..... *F. sahariensis* Kieffer

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STRESZCZENIE

**[*Forcipomyia sahariensis* KIEFFER (Diptera: Ceratopogonidae) – diagnoza i opis nieznanych wcześniej stadiów preimaginalnych]**

W niniejszej pracy przedstawiono diagnozy wszystkich stadiów rozwojowych *Forcipomyia sahariensis* Kieffer. Szczegółowo opisano nieznaną dotąd larwę i poczwarkę tej szczeciorki. *Forcipomyia tuzeti* Huttel et Huttel, 1952 oraz *F. acanthophora* Remm, 1976 zostały uznane za młodsze synonimy *F. sahariensis* Kieffer. Uzupełniono także klucze do oznaczania larw i poczwarek podrodzaju *Forcipomyia* w Polsce, dodając obecnie omawiany gatunek szczeciorki wraz z dwoma innymi: *F. squamigera* Kieffer i *F. radlicola* Edwards.

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