A FIRST DESCRIPTION OF THE LARVAL STAGE OF *CULICOIDES FURENSOIDES* WILLIAMS (DIPTERA: CERATOPOGONIDAE), WITH FURTHER NOTES ON THE PUPAL STAGE

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ABSTRACT. The larval stage of *Culicoides furensoides* is described from fourth instar larvae collected at the Malloryville Bog, Tompkins County, New York. The similarities of *furensoides* and *furens* fourth stage larvae are discussed. The pupal stage is redescribed.

During the summer of 1970 the author collected adult female *C. furensoides* in light traps at the Malloryville Bog, Tompkins County, New York. The following summer one pupa was isolated from the *Sphagnum* mat at this bog and was subsequently described (Cochrane, 1971). During the summer of 1972 a number of larvae and pupae were recovered at the same site. This paper provides the first description of the fourth stage larva of *C. furensoides* and expands on the initial description of the pupa.

MATERIALS AND METHODS

Samples of *Sphagnum* taken at the Malloryville Bog during the month of June, 1972, yielded a number of larvae and pupae of *C. furensoides* after being washed using a set of three nested brass gauze sieves, 10, 40, and 80 mesh, and then being subjected to magnesium sulphate flotation (Kettle and Lawson, 1952). Pupae and some of the fourth instar larvae were reared through to adults. Individuals were isolated on moist absorbent cotton in clear plastic boxes measuring 2 cm x 2 cm x 1½ cm for rearing. Some larvae were killed in water just below the boiling point and then transferred to 70 percent alcohol for storage.

Body measurements were made on larvae in 70 percent alcohol using an ocular micrometer mounted in the eyepiece of a Wild dissecting microscope. Other measurements, including those of the head capsule, epipharynx, mandibles, and anal papillae, were made from slide-mounted specimens using a filar micrometer eyepiece mounted on a Wild M20 phase contrast microscope. All measurements or ratios, for both larvae and pupae, are indicated by a mean value, followed by the minimum-maximum values.

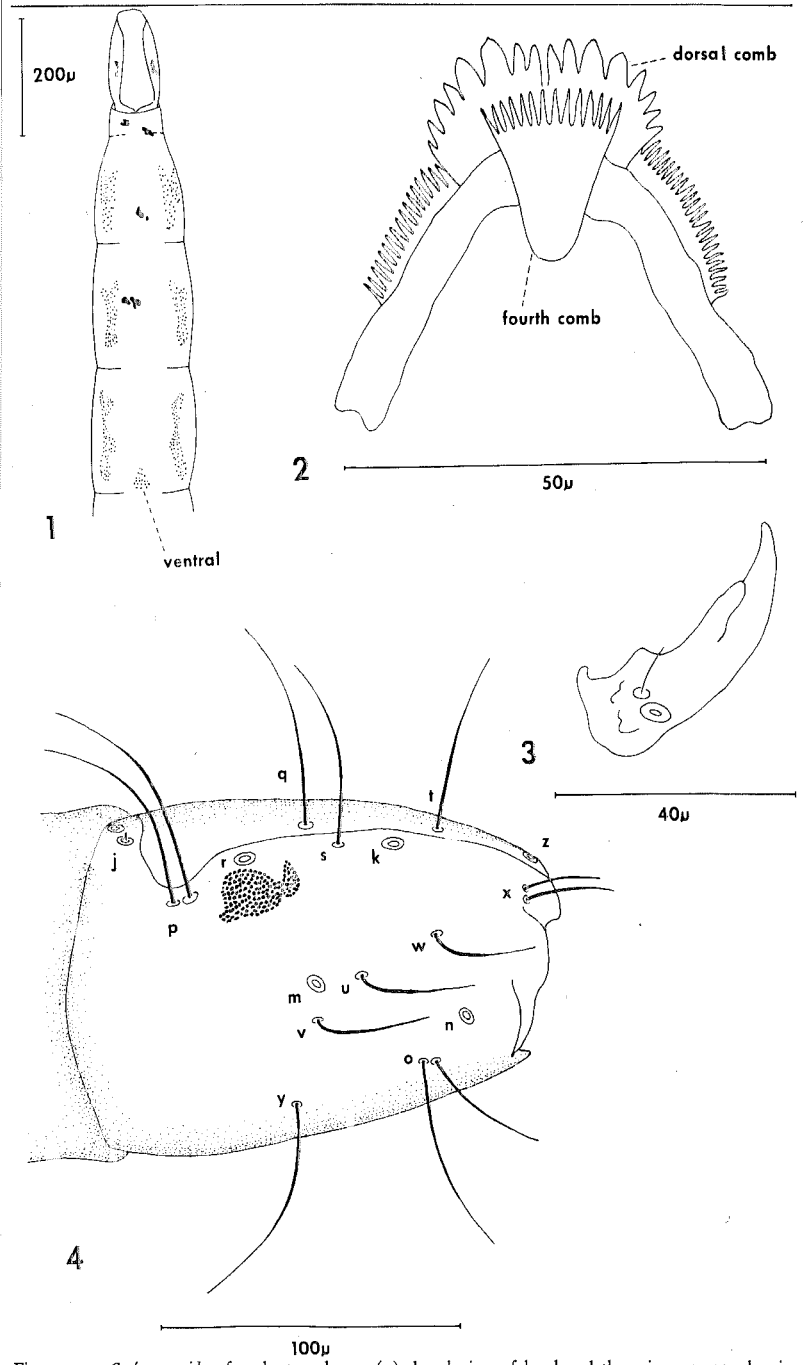
A 10 x 10-square grid micrometer disc was used to make the drawings. Terminology for the setae and sensory pits of the head and for the body setae of the larva is that of Lawson (1951). Terminology for the body tubercles of the pupa is that of Carter *et al.* (1920).

Larvae and pupae were slide-mounted directly in Hoyer's mounting medium. For critical examination of the mandibles and epipharynx, it was necessary to dissect these structures from the head capsule prior to mounting in Hoyer's. In a second method of preparation of these structures, larvae were first placed in hot 5 percent sodium hydroxide for 30 minutes, transferred to hot lactic acid in which was dissolved a small amount of acid fuchsin, and then the epipharynx and mandibles were dissected and mounted in Hoyer's medium. This second method, however, did not markedly improve the quality of the preparations.

Following an appropriate drying period, all slide preparations were ringed with Glyptal compound (Travis, 1968).

THE FOURTH STAGE LARVA

Pigmentation (Figure 1). In the living



Figs. 1–4.—*C. furensoides*, fourth stage larva: (1) dorsal view of head and thoracic segments showing pigment distribution; (2) ventral view of epipharynx; (3) mandibles; (4) right lateral view of head.

condition the body white in color; distribution and intensity of the brownish pigment in the thoracic segments in a definite pattern; in all specimens examined, pigmentation of the prothoracic segment much lighter in intensity than that of the other two thoracic segments; a pronounced triangular patch of pigment on the venter of the metathoracic segment; clumps of black pigment commonly present and distributed throughout the body segments, including the head capsule; in living and in slide-mounted specimens, the head capsule a bright yellow.

Body length (n = 20). Mean body length 3.3 (3.0–4.1) mm.

Head dimensions (n = 9). Head size represented by length, breadth, width of the oral ring, and by the head ratio, as defined by Kettle and Lawson (1952); head length 165 (158–175)μ, head breadth 114 (103–124)μ, width of the oral ring 79 (73–86)μ, head ratio 1.45 (1.34–1.57).

The epipharynx (n = 8) (Figure 2). Lateral arms moderately long, heavy, their posterior edges with long thin finger-like processes; the dorsal comb consisting of two sclerites presumably fused anteriorly but separated posteriorly; total width of the dorsal comb measured from the base of the most lateral teeth 21.1 (18–23)μ; total length of the combs of the epipharynx measured from the anterior edge of the fourth comb to the most posterior tip of the teeth of the dorsal comb 24.5 (23–27)μ; teeth of dorsal comb irregular in size and typically the third and fourth teeth from the central margin much enlarged over the others; mean total number of teeth of the comb 16 (14–18); two specimens with 7 teeth on both sides, one with 7 and 8 teeth, one with 7 and 10 teeth, one with 8 teeth on both sides, two with 8 and 9 teeth, one with 9 teeth on both sides.

Second and third combs not observed and presumably absent or extremely reduced in size.

Fourth comb readily observable lying ventral to the dorsal comb; base in the shape of a half cone and with 14 (12–15) well-developed elongate sharp teeth along its posterior edge.

Mandibles (n = 4) (Figure 3). Each mandible with a moderately heavy base and then tapering to a slightly hook-shaped pointed apex; 43 (42–44)μ in length; a finger-like process a short distance from the apex on the inner surface; a small seta and what appears to be a sensory pit on the base.

Chaetotaxy of the head (Figure 4). Thirteen pairs of setae and 7 pairs of sensory pits, exclusive of those on the mouthparts, on the head capsule; setae 'x' moderately developed, all other setae well developed; sensory pits 'j' each with a small central conical process, all other sensory pits lacking the conical process.

Chaetotaxy of the body (Figures 5, 6, 7). The thoracic segments each with 12 pairs of fine and delicate setae, abdominal segments 1–7 with 13 pairs, abdominal segment 8 with 9 pairs; the 'g' seta complex of the thoracic segments consisting of 2 moderately developed ventral setae and 2 very much reduced dorsal setae; the anal segment with 10 pairs of moderately-well developed setae.

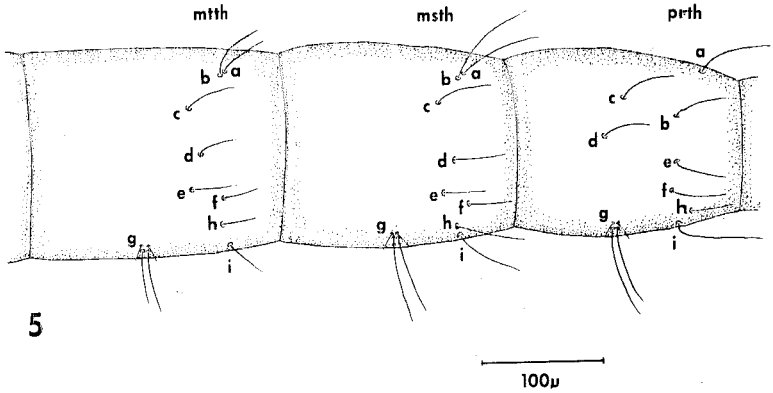
Anal papillae (n = 1) (Figure 8). The anal papillae appearing to arise from the wall of the rectum as four bulbous bases each divided distally into two finger-like processes; six of the papillae of equal length measuring approximately 106 μ from the basal cleft, two papillae distinctly shorter than the others measuring approximately 82 μ; each shorter papilla arising from a separate base along with a longer papilla; each papilla slightly indented at the tip and on each papilla a small notch a short distance distal to the basal cleft.

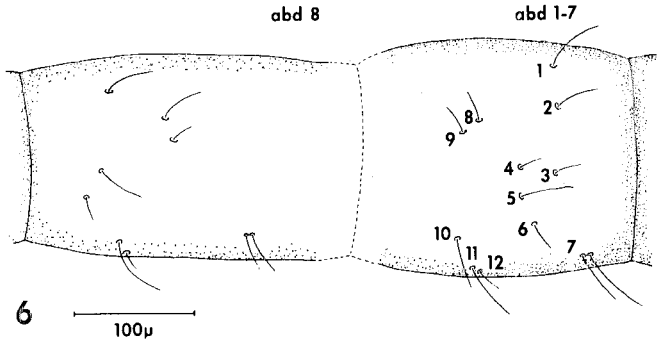
THE PUPA

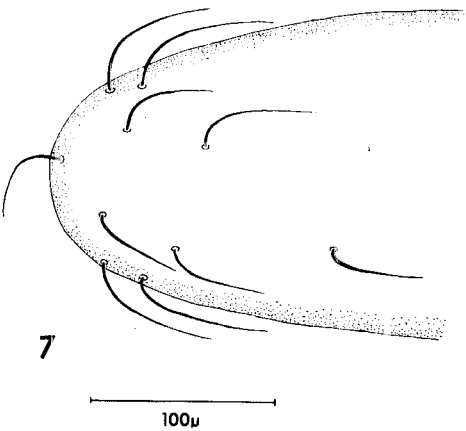
Pigmentation. As in original description.

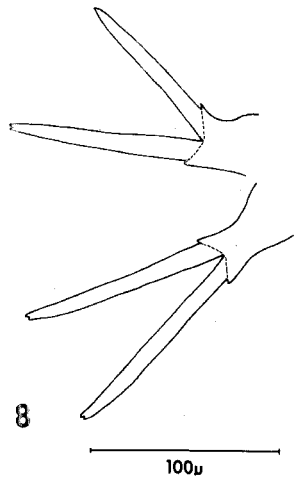
Length (n = 10). Of slide-mounted specimens (1.8 (1.6–2.0) mm.

Respiratory horn (n = 11). As in original description. The number of lateral spiracular openings usually 2, (1, n = 2; 2, n = 6; 3, n = 3); the number of api-









Figs. 5–8.—*C. furensoides*, fourth stage larva: (5) right lateral view of thoracic segments; (6) right lateral view of abdominal segments 1–7, 8; (7) right lateral view of anal segment; (8) anal papillae.

cal spiracular openings usually 5, (4, n = 3; 5, n = 8); each lateral spiracular opening usually on a pronounced dorsal protuberance, but occasionally protuberances reduced or appearing absent; in most specimens the horn distinctly tapered distally but sometimes only slighty tapered; average length 152 (141–166)μ and average maximum width 33 (28–41)μ; L/W ratio 4.7 (3.7–5.1).

Operculum (n = 11). As in original description. *am* setae measuring 55 (49–65)μ in length; maximum width 141 (126–151)μ.

Cephalothoracic chaetotaxy (n = 11). Tubercles and associated setae as in original description. *d* tubercles 1 and 2 separated by 17 (13–21)μ, 2 and 3 separated by 44 (34–50)μ, and 4 and 5 separated by 27 (23–31)μ; seta 1, 14 (12–16)μ; seta 2, 16 (13–20)μ, seta 3, 4 (3–5)μ, and seta 4, 52 (39–63)μ *d.l.* setae measuring 12 (11–14)μ, 56 (40–68)μ, and 13 (11–18)μ. *a.d.* setae measuring 11 (8–13)μ and 40 (25–47)μ. *v.l.* setae measuring 27 (23–34)μ and 55 (50–63)μ *v.m.* setae measuring 21 (15–32)μ and 35 (25–42)μ.

Abdominal chaetotaxy (n = 10). Each abdominal segment, exclusive of the caudal segment, with a band of very minute teeth on both the anterior and posterior margins, anterior teeth sharply pointed, posterior teeth smoothly rounded; teeth absent elsewhere on the segments. Tubercles and associated setae as in original description, excepting *d.p.m.* setae 3 and which were absent in all specimens. *d.a.s.m.* seta 1, 15 (13–18)μ; 2, 39 (26–50)μ. *d.p.m.* seta 1, 35 (25–44)μ; 2, 12 (10–15)μ; 5, 3 (3–5)μ. *v.p.m.* seta 1, 6 (4–8)μ; 2, 41 (32–50)μ; 3, 14 (13–16)μ. *l.a.s.m.* seta 13 (11–19)μ. *l.p.m.* seta 1, 12 (11–13)μ; 2, 44 (40–49)μ; 3, 12 (9–15)μ.

Caudal segment. As in original description except distal one-third to one-half of apicolateral processes darkly pigmented.

DISCUSSION

As noted by Linley and Kettle (1964) the value of the chaetotaxy of the head in specific larval determinations is very limited. The arrangement of the setae and sensory pits seems to be constant within the genus with only minor differences between species. In this study head chaetotaxy was carefully examined and illustrated to confirm the similarities of this chaetotaxy with that of other species (Lawson, 1951; Wirth, 1952; Linley and Kettle, 1964; Linley, 1970).

Due to the doubtful taxonomic value of the antennae, labrum and maxillae (Linley and Kettle, 1964) these structures were not studied.

The value of the body chaetotaxy, exclusive of that of the anal segment, is also of questionable significance. However, again to confirm the similarities of this chaetotaxy with that of known species (Lawson, 1951; Linley and Kettle, 1964) the body chaetotaxy of *furensoides* was carefully studied and illustrated.

Jamnback (1965) places *C. furensoides* in the *furens* group (subgenus *Oecacta*) Included in this grouping are the species *baueri, dickei, furens, furensoides, haematopotus*, and *stellifer*. Of these species only *furens* has been described in the larval stage in detail (Wirth, 1952; Linley and Kettle, 1964).

As a common larval feature of this grouping Jamnback states that the thoracic pigmentation varies from extensive over most of the dorsum to faint lateral spots only. In *furens* the pigmentation is distributed over the entire dorsum whereas in *furensoides* it follows a definite pattern in the thoracic segments. Indeed, for rapid identification of larvae, Kettle and Lawson (1952) found thoracic pigmentation pattern a most useful character.

The head capsule of the two species is yellow and the head chaetotaxy shows some features in common. The sensory pits 'j' of both species have small central conical processes. There does appear to be specific differences in these sensory pits. Illustrations of species such as *C. hoffmani* (Linley and Kettle, 1964) and *C. arboricola* (Linley, 1970) do not in-

dicate this central conical process. Wirth (1952) does not illustrate sensory pits for *C. melleus* but rather a single seta in their place, while Williams (1951) illustrates a very small seta associated with each of these sensory pits for *C. tristriatulus*. The two setae 'x' are moderately developed in *furens* and *furensoides* whereas in other species such as *nubeculosus* (Lawson 1951) and *hoffmani* (Linley and Kettle, 1964) they are very reduced.

The body chaetotaxy of *furens* and *furensoides* appears to be very similar. However, Linley and Kettle (1964) do not illustrate the pair of very minute dorsal setae of the 'g' seta complex.

The anal segment of *furens* and *furensoides* lacks the much enlarged perianal bristles found on species such as *hoffmani* (Linley and Kettle, 1964) and *arboricola* (Linley, 1970). The anal papillae of *furens* are long, slender, slightly curved, equal in length and sharply pointed (Linley and Kettle, 1964), whereas in *furensoides* they are slender, straight, unequal in length, and have tips that are more or less blunt with a slight median indentation. In both species, however, there is a small notch on each papilla a short distance distal to the basal cleft. This notch is not illustrated for species such as *nubeculosus* (Lawson, 1951), *tristriatulus* (Williams, 1951), *hoffmani* (Linley and Kettle, 1964), and *arboricola* (Linley, 1970).

The epipharynx of the two species is notably different. Linley and Kettle (1964) show all four combs present in *furens*. They note, however, that the second comb is very reduced and difficult to see but the third comb is more readily visible. In spite of careful preparations, the second and third combs in *furensoides* could not be seen in the present study. The second and third combs have also been found missing in species such as *chiopterus* and *pseudochiopterus* (Lawson, 1951).

Similar mandibular features are shared by *furens* and *furensoides*. In both there is the finger-like process on the inner surface and the minute seta on the basal portion. However, *furensoides* appears to have a single sensory pit on the basal portion adjacent to the seta but no such pit has been reported for *furens*.

The degree to which larval features are shared by the species within the *furens* group can only be determined following detailed descriptions of other larvae of this group.

The examination of additional pupal pelts yielded variation in a number of characters as compared to their original description based on a single specimen. The total length was, in all specimens, greater than that of the original specimen. The respiratory horn diverged notably in the number of lateral spiracular openings. In many specimens, these openings were on distinct dorsally-directed and well-developed protuberances, as is characteristic of the *furens* group. The mean length and mean maximum width were also considerably greater than the same values for the original specimen.

The abdominal segments each had a narrow band of spines both anteriorly and posteriorly. The posterior band was not detected in the original specimen due to a telescoping of segments. The apicolateral processes of the caudal segment differed from that of the original specimen in that the distal portion was darkly pigmented.

The *d.p.m.* setae 3 and 4 were absent. These setae appeared to be present in the original specimen but were very fine and hyaline and difficult to see. Mean setal lengths in most cases closely approximated setal lengths of the original specimen. However, the *a.m.*, d_2 and d_4, *v.m.*, *d.p.m.*, and *l.a.s.m.* setae showed considerable size variation from corresponding setae of the original specimen.

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