CONTROL OF *CULICOIDES MELLEUS* (COQ.) (DIPTERA: HELEIDAE) IN SMALL PLOTS, WITH BRIEF DESCRIPTIONS OF THE LARVAE AND PUPAE OF TWO COASTAL *CULICOIDES*[1]

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Many cottages on Long Island have been built near salt marshes and protected sandy beaches which are the breeding areas of coastal *Culicoides*. People living in these cottages often find outdoor activities unpleasant or even unendurable because of these insects.

ANNOYING SPECIES. To determine which species are the most important pests in these areas, annoying adult *Culicoides* were collected in June, July and August over a three-year period. Collections were made by capturing the flies in vials of alcohol. Only those that were actually biting or that caused annoyance by crawling on the face and body were collected. Foote and Pratt (1954) recorded three species of *Culicoides* as being particularly abundant and annoying along the eastern seaboard. As might be expected, we found these species, *C. canithorax* Hoffman, *C. furens* (Poey) and *C. melleus* (Coq.), to be the chief pests on Long Island. *C. melleus* was the most abundant of these species in mid-summer, during the peak of the "tourist season" (fig. 1). *C. furens* was also present during this period but in smaller numbers. *C. canithorax* was abundant in early and late summer, declining greatly in numbers in mid-summer as was noted by Dove *et al.* (1932). Beck (1952) stated that this species is taken in very large numbers during the spring months in Florida.

Since *C. melleus* appeared to be the most important nuisance species, at least from the point of view of summer residents, resort owners, and vacationers, experiments were made to determine the feasibility of reducing larval populations with insecticide. The sampling methods used in these studies, together with notes on the life history, are given in a companion paper (Jamnback and Wall, 1958). This species is unusual in that it breeds only in sandy intertidal areas.

METHODS AND MATERIALS. Test sites were located on protected sandy beaches having high and relatively uniform *C. melleus* larval populations. The width of each plot extended from the low tide level to above the high tide level. The plots ranged from 880 to 2025 square feet. The insecticide was applied at about low tide. Measured amounts of 25 percent DDT emulsifiable concentrate were diluted with two gallons of water to obtain the desired dosages. The resulting emulsions were applied with a 5-gallon knapsack sprayer. DDT emulsion was first applied at the rate of 2.2 pounds * per acre. When this proved to be effective, lower dosages were tested. Larval samples were taken immediately before treatment, one day after treatment, and at irregular intervals thereafter. The results of these tests are summarized in table 1.

RESULTS AND DISCUSSION. Table 1 shows that *C. melleus* larval populations declined more than 90 percent one day after application of DDT emulsion at dosages of 1 pound (technical), or more per acre. A decline of 78.5 percent was recorded one day after a plot was treated with 0.5 pound per acre. Seven days after treatment the larval population in this plot had declined 97 percent, indicating that, with lower dosages, larval populations may continue to decline for several days. A plot treated with 0.3 pound per

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* All dosages given refer to the amount of technical insecticide applied.

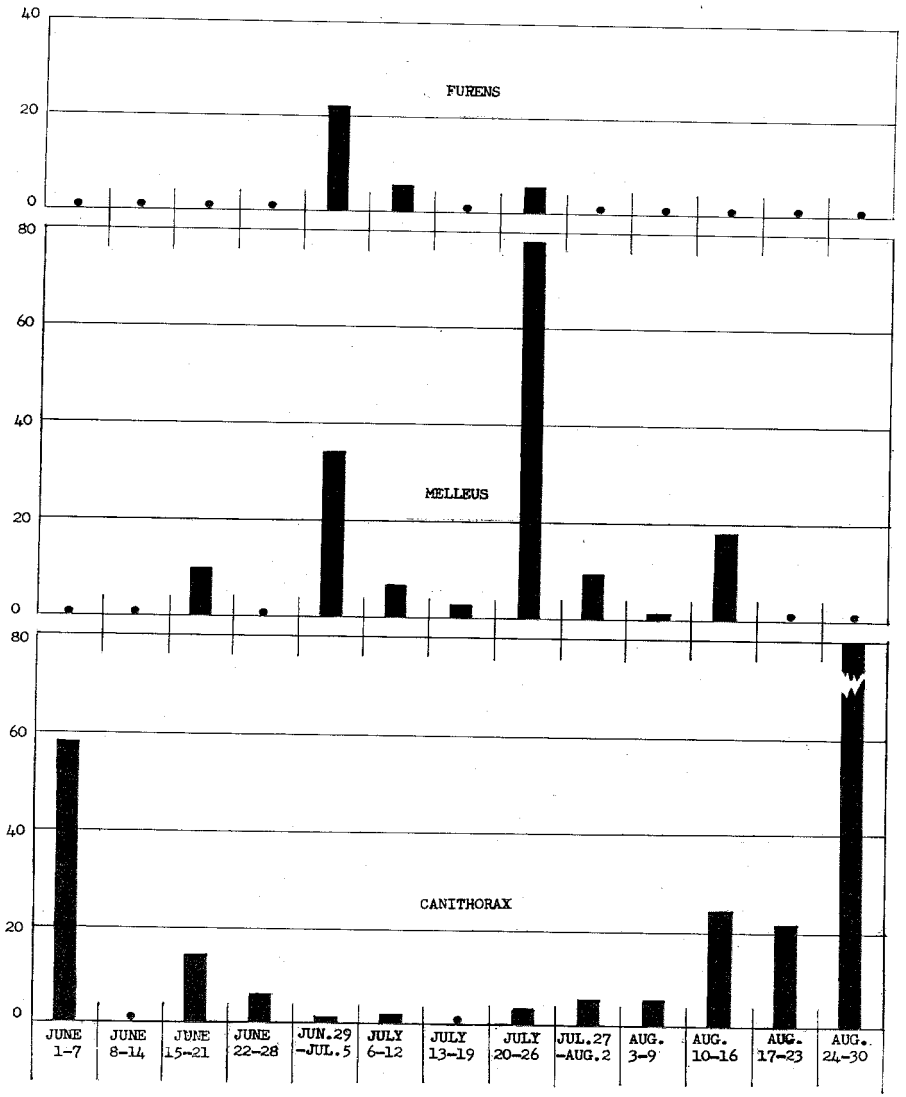


FIG. 1.—Collections of annoying coastal *Culicoides* on Long Island, 1955–1957. Each black bar represents the total weekly collection of a given species. A small black disc indicates that no individuals of that species were collected in the specified period.

Number of collections: 19 in June, 20 in July, 18 in August.

TABLE 1.—Control of *C. melleus* larvae in small plots with DDT emulsion

Dosage lbs./Acre	No. Days After Treatment	Average Number of Larvae		Percent Reduction*
		Treated Plot	Check Plot	
2.2	(before tr.)	50(3)†	50(1)	—
	1	0.7(3)	50(1)	98.6
	21	1(3)	42.5(2)	97.6
1.1	(before tr.)	26.7(3)	44.5(2)	—
	1	1.3(3)	36.5(2)	94.1
1.0	(before tr.)	28.3(3)	22.0(2)	—
	1	1.7(3)	16.5(2)	92.0
	21	8.7(3)	31.0(2)	78.1
0.5	(before tr.)	40.8(4)	44.5(2)	—
	1	5.8(4)	29.5(2)	78.5
	7	0.3(3)	11.0(2)	97.0
0.3	(before tr.)	50(3)	48.5(2)	—
	1	43.7(3)	46.5(2)	8.8
	3	43.3(3)	32.5(2)	(increase)

* Abbott's formula.
† Number of samples averaged given in parentheses.

acre showed no appreciable reduction one day or three days after treatment.

The data presented are considered preliminary since they are based on a small number of tests. Further tests using dosages of less than one pound per acre should be made, and larval populations checked daily for a reasonable period thereafter to determine whether lower dosages, although not so effective within 24 hours, may prove effective after a longer period.

If this method of *C. melleus* control were to be used on a large scale, it would be necessary to treat long strips of intertidal sand within a relatively short period while the tide is low.

DESCRIPTIONS. The immature stages of European species have been studied extensively (Hill, 1948; Lawson, 1951; Kettle and Lawson, 1952; Jobling, 1953, and others). Except for the *C. obsoletus* group, the European species apparently are not found in North America. Other North American species have been described and/or illustrated by Malloch, (1915), Painter (1926), Dove *et al.* (1932), Thomsen (1937), Fox (1942), Williams (1951) and Wirth (1952a, b).

Wirth described the larvae and pupae of *C. melleus* for the first time in 1952 (b). These stages of *C. canithorax* have apparently not been described previously. The following descriptions of the larvae and pupae of these two species are based primarily on reared specimens. Most of the characters used can be seen under a low-power dissecting microscope. They were selected by comparing the two species with each other, with some freshwater species, and with published descriptions of *C. melleus* and other species. In some instances, characters which are similar in *C. melleus* and *C. canithorax* but dissimilar in other species are included in the descriptions.

The names given to the sclerites, sutures, and ridges which make up the head capsule of *Culicoides* larvae differ considerably from one author to another. Jobling (1953) reviewed the terminology and gave a detailed description of the first instar larvae of *C. vexans* Stager. Unless otherwise indicated, we have followed his usage. Many of the structures used in the descriptions are labeled in the illustrations. The dimensions of the head capsule and parts of the pharynx were taken from cast skins of last instar larvae.

The terminology used by Lawson (1951)

in describing the pupae has been followed, for the most part. Fox (1942) and others have noted that the detailed shape and structure of the respiratory horn of *Culicoides* pupae is somewhat variable but that it usually has a characteristic appearance for a particular species. This is true of *C. melleus* and *C. canithorax*. The operculum of the male may differ slightly from that of the female in outline, but both have the same general pattern of spines. There are specific differences in the shape of the operculum and the pattern of spines. As was noted by Williams (1951) the angle of the apicolateral spines sometimes may vary from one specimen to another in a given species. For the two species described below it appeared to be fairly constant.

Culicoides melleus (COQ).

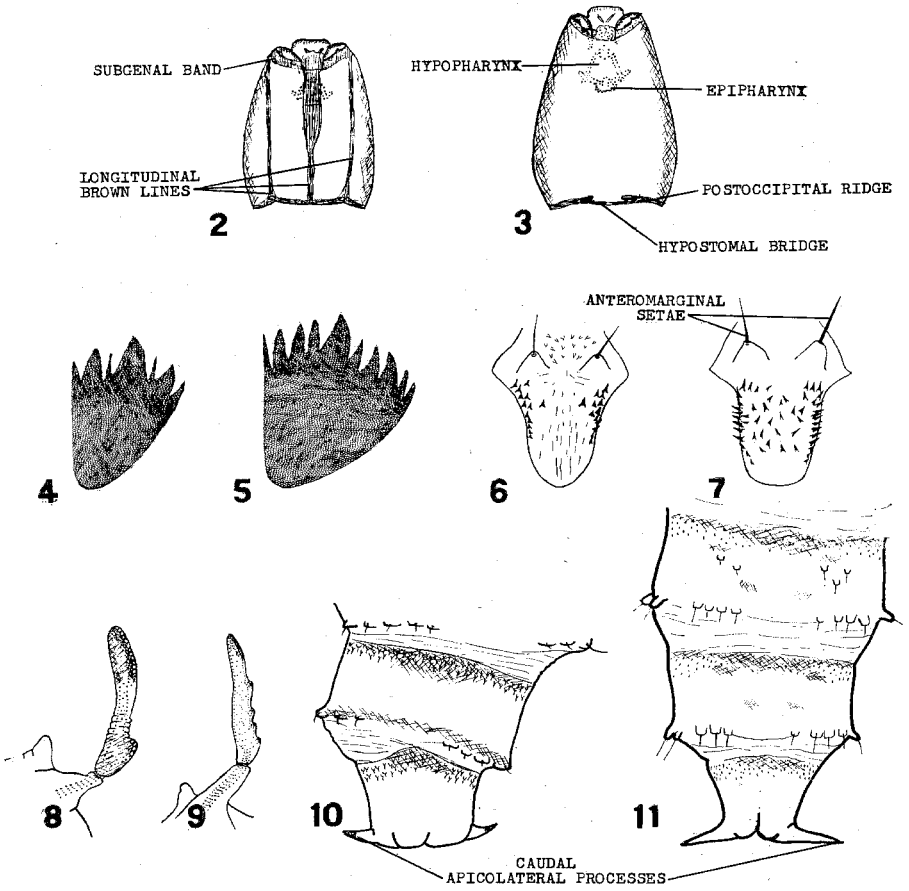
All of the reared specimens of *C. melleus* were collected from intertidal sand bordering the small bays or inlets of Peconic Bay. Two females were reared from larvae to adults, 3 females and 1 male were reared from larvae to pupae, and 7 females and 5 males were reared from pupae to adults (one male with a larval skin attached).

DESCRIPTION OF FOURTH INSTAR LARVA. Length about 4.4 mm. (a few up to 4.8 mm.). Dorsal head length 178 microns; greatest width 125 microns. Head capsule pale yellow with posterior margin delimited by light brown sclerotized ridge, consisting ventrally of the hypostomal bridge and laterally of the post-occipital ridge. Dorsally the posterior margin of the head (occipital and post-occipital ridges fused) not darkened. Ventral surface of head capsule with three narrow longitudinal brown lines extending anteriorly with hypostomal bridge, consisting of one median line and one on each side extending from posterior tentorial pits to light brown subgenal band (of Lawson, 1951), (fig. 2). These lateral lines appear to be homologous to the hypostomal membrane of Jobling (1953). Frontoclypeus with two indistinct lateral brownish longitudinal lines just mediad to the epicranial suture. These are best seen in cast skins. Epipharynx (mola cibarialis of Jobling, 1953) with dorsal comb about 25 microns wide, consisting of two halves; proceeding from the outermost tooth, each side usually with 3 smaller teeth a large tooth and 3 to 4 smaller teeth (fig. 4). This structure can usually be seen in cleared, slide-mounted whole specimens. Combs 2 to 4 (see Kettle and Lawson, 1952) present but difficult to distinguish except in dissected specimens. Suspensorial sclerites of hypopharynx about 51 microns apart at tips. Posterior fringe of hypopharynx about 4 microns long.

Thoracic and abdominal markings not apparent on most specimens whether preserved in alcohol or alive. A few specimens have diffuse dorsal and lateral darkening of the prothorax and somewhat more distinct light gray elongate dorsolateral markings (lateral bodies of Kettle and Lawson, 1952) on the meso- and metathorax. The anal segment bears short, inconspicuous setae, which are shorter than the width of the anal segment at the middle.

DESCRIPTION OF PUPA. Length about 2.4 mm. Pupal respiratory horn slightly more than one-sixth dorsal length abdomen, about 5 times as long as wide; distal section (beyond constriction) more than 3 times longer than basal section. Base of distal section with enlarged dorsal knob, narrowed beyond with transverse wrinkles; apex clavate. Basal section whitish, distal section dark brown except for white band across narrowed median portion; usually with 4 spiracular papillae at enlarged base of distal portion and a row of 16–22 spiracular papillae at apex (fig. 8). Operculum with large spines confined almost entirely to lateral margins posterior to anteromarginal setae (fig. 6). The two anterior seta-bearing dorsomedian tubercles on each side of the mesothorax confluent, not pigmented; appearing as transparent spots on yellowish background of pupal skins.

Abdomen without fine reticulate lines, with small spines scattered in irregular rows near anterior margins of segments



FIGS. 2–11.—Larval and pupal structures of *Culicoides melleus* and *Culicoides canithorax*.

C. melleus. LARVAE: fig. 2, head capsule, ventral aspect; fig. 4, dorsal comb of epipharynx (one side), ventral aspect. PUPAE ♀ ♀: fig. 6, operculum, lateral aspect; fig. 8, respiratory horn, lateral aspect; fig. 10, abdomen, posterior end, ventral aspect.

C. canithorax. LARVAE: fig. 3, head capsule, ventral aspect; fig. 5, dorsal comb of epipharynx (one side), ventral aspect. PUPAE ♀ ♀: fig. 7, operculum, lateral aspect; fig. 9, respiratory horn, lateral aspect; fig. 11, abdomen, posterior end, ventral aspect.

and elongate seta-bearing tubercles mostly near posterior margins of segments. Abdomen without dark pigmented spots but with faint, narrow, transverse band on anterior margin of each segment. Caudal apicolateral processes without scales, apical third dark brown in contrast to the rest of the abdomen which is yellowish; projecting at about right angles to the longitudinal axis of the body (fig. 10).

Culicoides canithorax HOFFMAN

The reared specimens of *C. canithorax* were collected as larvae or pupae from salt marsh sod samples that were dried in Berlese funnels. Three females and 4 males were reared from larvae to adults; 3 females and 3 males were reared from larvae to pupae, and 3 females and 1 male were reared from pupae to adults (one female with larval skin attached).

DESCRIPTION OF FOURTH INSTAR LARVA. Length about 4.0 mm. Dorsal head length 219 microns; greatest width 160 microns. Head capsule pale yellow with posterior margin delimited by dark brown sclerotized ridge consisting of the hypostomal bridge and the postoccipital ridge. Hypostomal bridge with a non-pigmented mid-ventral light area. Postoccipital ridge wide laterally; dorsally (occipital and postoccipital ridges fused) the pigmented ridge narrow and not readily apparent, a distinct mid-dorsal notch (coronal branch of epicranial suture) present. No longitudinal brown lines present on venter of head capsule (fig. 3). Epipharynx (mola cibarialis of Jobling, 1953) with dorsal comb about 34 microns wide, made up of two halves; proceeding from outermost tooth on each side, there are 4–6 subequal medium size teeth, a larger tooth and 4–6 slightly smaller teeth (fig. 5). Combs 2–4 (see Kettle and Lawson, 1952) present but difficult to distinguish except in dissected specimens. Tips of suspensorial sclerites of hypopharynx about 60 microns apart. Posterior fringe of hypopharynx about 4 microns long.

Thorax distinctly pigmented; dorsally and laterally prothorax with a general mottled purplish coloring except for paler cervical region. Mesothorax similar to prothorax but has, in addition, distinct dorsolateral circular purplish pigmented spots. Metathorax with a lighter general pigmentation, less distinct posteriorly. Dorsolateral spots more elongate than those of mesothorax. Abdomen without dark pigmentation. Anal segment with short, inconspicuous setae, which are shorter than width of anal segment at middle.

DESCRIPTION OF PUPA. Length about 2.6 mm. Pupal respiratory horn about one-fifth dorsal length of abdomen, about 7 times as long as wide; distal section (beyond constriction) less than 2 times longer than basal section. Distal portion with 3 or 4 distinct dorsal projections, each with a spiracular opening; lacking distinct transverse wrinkles, tip with a row of 11–15 spiracular papillae, apical one-fourth dark brownish-black; rest of respiratory organ light brown (fig. 9). Operculum with spines present only behind anteromarginal setae, with row of spines along the lateral margin and others distributed irregularly across the central portion (fig. 7). The two anterior seta-bearing dorsomedian tubercles on each side usually not confluent, lightly pigmented.

Abdomen without fine reticulate lines, with small spines scattered in irregular rows near anterior margins of segments. With elongate seta-bearing tubercles mostly near posterior margins of segments. Abdomen brown with distinct darker brown pattern. This can best be seen in cast skins. The pattern of the developing adult, if present, may obscure the pupal pattern. Dorsally, segment 1 with 2 dorsolateral spots and 1 median spot just behind them; segments 2–7 with a narrow transverse anterior band which tapers laterally, 2 dorsolateral spots just behind it and 2 dorsomedian spots about halfway back; segment 8 with a similar but less distinct pattern which, except for the transverse band, is lacking on the terminal segment. Ventrally, segments 3–9 with pattern similar to corresponding dorsal segments. Caudal apicolateral processes with incon-

spicuous squamous setae, not readily apparent in some specimens; uniformly light yellow; projecting at nearly right angles to the longitudinal axis of the body (fig. 11).

SUMMARY. Collections of annoying adult *Culicoides* on Long Island indicate that *C. melleus* (Coq.) is the most important species in midsummer. DDT emulsion applied at the rate of one pound per acre (technical), or more, greatly reduced larval populations of *C. melleus*. Lower dosages were less effective. The larvae and pupae of *C. melleus* and *C. canithorax* Hoffman, two of the most important pest species on Long Island, are described.

References Cited

BECK, E. C. 1952. Notes on the distribution of *Culicoides* in Florida (Diptera, Ceratopogonidae). Fla. Ent. 35:101–107.

DOVE, W. E., HALL, D. G. and HULL, J. B. 1932. The salt marsh sand fly problem (*Culicoides*). Ann. Ent. Soc. Amer. 25:505–527.

FOOTE, R. H. and PRATT, H. D. 1954. The *Culicoides* of the eastern United States (Diptera, Heleidae). Public Health Monog. 18:1–53.

FOX, I. 1942. The respiratory trumpet and anal segment of the pupae of some species of *Culicoides* (Diptera: Ceratopogonidae). Puerto Rico Jour. Public Health & Trop. Med. 17:412–425.

HILL, M. A. 1947. The life cycle and habits of *Culicoides impunctatus* Goetghebuer and *Culicoides obsoletus* Meigen, together with some observations on the life cycle of *Culicoides odibilis* Austen, *Culicoides pallidicornis* Kieffer, *Culicoides cubitalis* Edw. and *Culicoides chiopterus* Meigen. Ann. Trop. Med. Parasit. 41:55–115.

JAMNBACK, H. and WALL, W. 1958. A sampling procedure for *Culicoides melleus* (Coq.) (Diptera: Heleidae) with observations on the life histories of two coastal *Culicoides*. Mosq. News 18:85–88.

JOBLING, B. 1953. On the blood-sucking midge *Culicoides vexans* Stager, including the description of its eggs and first-stage larva. Parasitology 43:148–159.

KETTLE, D. S. and LAWSON, J. W. H. 1952. The early stages of British biting midges *Culicoides* Latreille (Diptera: Ceratopogonidae) and allied genera. Bull. Ent. Res. 43:421–467.

LAWSON, J. W. H. 1951. The anatomy and morphology of the early stages of *Culicoides nubeculosus* Meigen (Diptera: Ceratopogonidae = Heleidae). Trans. R. Ent. Soc. Lond. 102:511–570.

MALLOCH, J. R. 1915. The Chironomidae, or midges, of Illinois, with particular reference to the species occurring in the Illinois River. Bull. Ill. State Lab. of Natural Hist. 10:275–543.

PAINTER, R. H. 1924. The biology, immature stages and control of the sandflies (biting Ceratopogoninae) at Puerto Castilla, Honduras. Ann. Rept. United Fruit Co., Medical Dept. 15:245–262.

THOMSEN, L. C. 1937. Aquatic Diptera. Part V. Ceratopogonidae. Cornell Univ. Agr. Expt. Sta. Mem. 210:57–80.

WILLIAMS, R. W. 1951. The immature stages of *Culicoides tristriatulus* Hoffman (Diptera, Heleidae). Ann. Ent. Soc. Amer. 44:430–440.

WIRTH, W. W. 1952a. The Heleidae of California. Univ. Calif. Publ. Ent. 9:95–266.

———. 1952b. The immature stages of two species of Florida salt marsh sand flies (Diptera, Heleidae). Fla. Ent. 35:91–100.

OBSERVATIONS ON THE SWARMING OF *CULISETA MELANURA* (COQUILLETT)

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Details on the swarming habits of most mosquito species are lacking. For a number of species, swarming is thought to be a stimulus for mating and a basic behavior mechanism concerned with the perpetuation of the species. In a discussion of sexual behavior of mosquitoes, Bates (1949) reviewed much of the literature on swarm formation. He pointed out that most of the work done was stimulated by a search for methods which would induce mating in captivity, so that the different species could be maintained as labora-

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