

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.

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

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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-

¹ From the Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education, and Welfare, Taunton, Massachusetts.

tory colonies. Wallis (1953) reported that there was no indication of mating or swarming activity among adult mosquitoes reared from a field-collected egg raft of *Culiseta melanura* (Coquillett); no blood meals were taken by the female mosquitoes, and no eggs were obtained from them. Subsequent workers have experienced similar difficulties in attempting to establish *C. melanura* laboratory colonies.

The utilization of information concerning the swarming of *C. melanura* may facilitate the establishment of self-sustaining laboratory colonies of the species.

Basic information on the phenomenon of swarming conceivably might be exploited for the control of various mosquito species. For example, the effects of aerosol or mist type adult mosquito control measures directed against swarming (and mating) mosquitoes could prove worthwhile. In view of the work on the control of screw-worm through the release of flies sterilized by irradiation (Baumhover *et al.*, 1955), information concerning the swarming and mating habits of a mosquito species might be adapted for similar experiments designed to control mosquitoes (Knipling, 1955).

METHODS. The observations on the swarming of *C. melanura* were made as part of studies on eastern equine encephalitis and on the ecology of the potential vectors of this disease. The swarming sites were located at Raynham, Massachusetts, in Hockomock Swamp, a bog-type cedar swamp. Numerous swarms were seen on 13 evenings between June 12 and October 31, 1957, inclusive. The period beginning 1 hour before sunset and continuing until 1 hour after sunset was found to be sufficient for observation of a night's swarming activity. The times of swarm formation and/or of the dispersion of the swarming mosquitoes were recorded each night, except on October 31. On that night, swarming was observed during a brief visit to the swarming area. Specimens were collected intermittently by passing an insect net through the swarms. The times of such collections were re-

corded, and the specimens obtained were returned to the laboratory to be identified. Examination of male terminalia slides prepared from many of the specimens confirmed the identifications.

SWARMS. *C. melanura* swarms were observed as low as 4 feet from the ground and up to heights of approximately 30 feet, but the majority of the swarms occurred between heights of 10 to 20 feet. The swarms characteristically formed beneath the leaves on branch tips of deciduous trees. It was noted that certain swarming sites were always occupied. One such site occurred beneath the leaves of a red maple (*Acer rubrum*) branch tip about 12 feet above the ground. The diameter of the swarms at this swarming site varied between 2 and 3 feet, and their upper perimeter usually remained within 6 inches of the leaves. As the deciduous trees lost their leaves in the autumn, more swarming was noted to occur near and above the Atlantic white cedar (*Chamaecyparis thyoides*).

A compilation of some of the swarming data is presented in Table 1. From an inspection of these data, it is apparent that swarming regularly commenced about sunset and continued for approximately one-half hour. Rain caused the early cessation of swarming on June 12. Very high winds prevented swarm formation on the evening of July 10. The evening of October 27 was windy, clear, and cold (about 35° F.), and no swarms formed; whereas, the evening of October 31 was calm, overcast, and mild (about 45° F.), and swarming occurred.

Female mosquitoes were observed within the swarms, or obtained in collections from the swarms, on only 3 evenings. On one occasion, several mating pairs of mosquitoes were seen. The mating adults remained paired for only 2 or 3 seconds and did not fall out of the swarm, but they did lose altitude. Fertile eggs were laid by a female obtained from the swarm in which the mating pairs were seen.

The number of males in the swarms, which seemed to average several hundred,

TABLE 1.—Swarming time and sky cover observed for *Culiseta melanura* in Massachusetts during 1957.

Date	Commenced		Dispersed		Type of Sky Cover
	Time ^a	Minutes from Sunset	Time	Minutes in Swarm	
June 12	—	—	2022	—	Overcast
20	2026	+1	—	—	Clear
26	2031	+5	—	—	Overcast
July 10	—	—	—	—	Clear
18	2030	+12	2105	35	Clear
25	2011	-1	2050	39	Clear
31	2013	+7	2051	38	Clear
Aug. 8	1954	-2	2026	32	Clear
15	1948	+2	2016	28	Overcast
28	1924	-2	2000	36	Clear
Sept. 4	1912	-2	1955	43	Overcast
19	1845	-3	1915	30	Clear
30	1824	-4	1902	38	Clear
Oct. 27	—	—	—	—	Clear
31	—	—	—	^b	Overcast

^a Eastern Daylight Saving Time.

^b Swarms were present at approximately 1800 hours.

remained rather constant until after the middle of September. The average number of swarming males then became reduced to about a dozen per swarm, and some swarms of only 4 or 5 males were seen.

It was noted that the individuals within a swarm would simultaneously react to sharp sounds, such as a whistle or a shout, by flying several inches away from the sound source. This resulted in a rapid shifting of the swarm. After such a movement, the swarm gradually returned to its original location.

No insects other than *C. melanura* were obtained from the many samples collected from the swarms. Passing a net through the swarms caused only momentary disturbances, and the swarming was continued persistently.

Gentle winds did not interfere with swarming. Swarms formed and continued uninterrupted on evenings with either clear or overcast skies.

DISCUSSION. Evening swarming of *C. melanura* in the vicinity of their breeding area was observed to be a very routine phenomenon which commenced about the

time of sunset. Their swarming beneath branches and their repeated use of certain swarming locations resembled swarm characteristics previously described for *Aedes punctator* by Frohne and Frohne (1952). However, the *A. punctator* swarms were reported (*loc. cit.*) to terminate, rather than to commence, about the time of sunset.

The formation of swarms at the time of sunset, generally within ± 5 minutes, seems to correlate this activity with light intensity. Swarming commenced at about sunset whether the sky was clear or overcast. Other investigators (*e.g.*, Nielsen and Greve, 1950; Frohne, 1953; and Bates, 1949) have thought light intensity to be the principal stimulus for swarm formation.

The exact time of swarm dispersion was harder to ascertain than the time of swarm formation. As it became darker, it became more difficult to see whether or not a few of the mosquitoes were still swarming.

Mating mosquitoes were rarely seen in the swarms. Additional observations will be necessary to determine whether or not swarms are the principal mating sites.

Culiseta incidens is believed to be the only North American representative of the genus for which mating swarms (Hubert, 1953) have been described. Mating in swarms has not been observed among the other known North American species, namely: *C. alaskaensis* (Frohne, 1954), *C. impatiens* (Frohne, 1953), *C. inornata* (Rees and Onishi, 1951), *C. macrackenae* (Ryckman and Arakawa, 1952), and *C. morsitans* (Frohne, 1954). No mating observations have been reported for the recently described *Culiseta minnesotae* (Barr, 1957).

The usual *C. melanura* adult emergence period in the Hockomock Swamp swarming area probably is from late May to mid-October, similar to the emergence period described for the species in New Jersey (Burbutis and Lake, 1956). However, adult emergence during August and September 1957 virtually ceased in the Hockomock Swamp, because of an unusually severe drought which resulted in the drying of the usual breeding sites. The presence of large numbers of males in the swarms during September and October was particularly interesting, since it indicated that the majority of the males observed during these months had survived at least 3 months.

SUMMARY. Evening swarms of *Culiseta melanura*, predominantly males, were observed on 13 nights between June and October 1957 in southeastern Massachusetts. It was noted that the swarms occurred regularly starting at about sunset near the mosquito breeding sites in a large swamp, that swarms usually formed beneath the foliage on branch tips, and

that particular swarming sites were always occupied. Mating was observed in the swarms occasionally.

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