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## BIOLOGICAL NOTES ON *CULISETA MINNESOTAE* BARR AND *CULISETA MORSITANS* (THEOBALD) (Diptera: Culicidae)<sup>1</sup>

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Since the description of *Culiseta minnesotae* from adult specimens by Barr (1957) and the subsequent discussion of the larval and pupal stages by Price (1958), there has been no information offered on the biology of this species. The known distribution of *C. minnesotae* has been extended recently, however, by Burbutis and Lake (1959), who recorded the capture of one larva in 1955 and 318 females in light traps during the summer of 1956 in New Jersey, and by Nielsen and Rees (1959), who reported two collections of adults and larvae in 1956 in Weber County in northern Utah. Coupled with a description of both the male and female of this same species included under the name of the closely related *C. morsitans* (Theobald) by Stage *et al.* (1952) in the northwestern states, this extends the present distribution of *C. minnesotae* from coast to coast across the northern portion of the United States.

The literature on the biology of *C. morsitans*, at least in the United States, may well include a composite of the biologies of both this species and the recently-separated *C. minnesotae* and this has contributed to the necessity of conducting a search for biological differences that might exist between these two species. This could take on added significance if one considers, for example, the feeding habits of *C. morsitans* and *C. minnesotae* and the possible role of these species in the epidemiology of viral encephalitides. Much of the material that follows has been gathered by the author

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in his studies of the Minnesota mosquitoes during the past four years; it is presented here in the hope that some insight, albeit of a preliminary nature, may be gained on the comparative biologies of these two species and that this will stimulate others to contribute to this subject.

During intensive larval collecting in the springs of 1957, 1958, and 1959 at Itasca State Park, Clearwater Co., Minn., 67 collections from 16 different habitats yielded 672 larvae of *C. morsitans* and 11 collections from five habitats produced 66 *C. minnesotae* larvae. From this the general impression was formed that *C. morsitans* larvae consistently occurred among the early collections, in conjunction with the single-brooded spring *Aedes*; *C. minnesotae* larvae appeared only as the season progressed and as the production of the multi-brooded summer species began. This point is illustrated in Figure 1 in which the average stage of development of the species at each collection is plotted against the date on which the collection was made. This average figure was derived by giving values of 1, 2, 3, and 4 to each larva of the respective instar and 5 to each pupa and then dividing the sum by the number of individuals.

*C. morsitans* was associated with larvae of the same or slightly advanced developmental stages of 14 species of *Aedes*. These species and the number of habitats in which the associations occurred were as follows: *Aedes aberratus* (Felt & Young) (4), *Ae. barri* Rueger (16), *Ae. canadensis* (Theobald) (4), *Ae. cinereus* (Meigen) (21), *Ae. diantacus* (Howard, Dyar, & Knab) (9), *Ae. excrucians* (Walker) (24), *Ae. fitchii* (Felt & Young) (16), *Ae. intrudens* Dyar (4), *Ae. punctor* (Kirby) (7), *Ae. riparius* Dyar & Knab (2), *Ae. sticticus* (Meigen) (1), *Ae. stimulans* (Walker) (4), *Ae. trichurus* (Dyar) (5), and *Ae. vexans* (Meigen) (2). It should be noted that all of these species represent mosquitoes that overwinter in the egg stage. Moreover, in addition to these, *C. morsitans* was associated with younger larvae of *Culex territans* Walker (3), *Culiseta inornata* (Williston) (2), *C. minnesotae* (1), *Anopheles earlei* Vargas (3), *An. punctipennis* Say (2), and *An. walkeri* Theobald (1). Most of these are said to overwinter as hibernating females and to breed more or less continuously throughout the summer.

The larvae of *C. minnesotae* were associated with larvae of approximately the same developmental stages of *C. territans* (4), *C. inornata* (1), *An. earlei* (1), *An. punctipennis* (1), and *An. walkeri* (1). The associates that were much further along in their development were *Ae. barri* (1), *Ae. cinereus* (1), *Ae. excrucians* (2), and *Ae. fitchii* (1).

From July 19 to August 14, 1956, in the northern St. Paul area, Ramsey Co., Minn., 20 larvae of *C. minnesotae* were collected in five visits to one habitat; these represented the first discovery of the immature stages of this species and provided the material for the larval and pupal descriptions (Price, 1958). The period of June 18 through September 12, 1957, yielded 40 additional larvae of the same species on eight occasions from two habitats, one of these the same as that of the previous year. In collections during the spring of 1957 about 35 miles north of St. Paul in the Cedar Creek Natural History Area, Isanti Co., Minn., 45 *C. morsitans* larvae were found in 11 collections from four habitats and 44 *C. minnesotae* occurred in six collec-

tions from two habitats. The larval associates in all of the above generally agreed with the types found for each of the *Culiseta* species at Itasca.

The Metropolitan Mosquito Control District commenced operations in 1958 in the six-county area surrounding Minneapolis and St. Paul and, in conjunction with this, conducted an intensive survey that year for larval breeding areas. Through the courtesy of Mr. A. W. Buzicky, the district director, the dates for 166 collections of larval *C. minnesotae* and six of *C. morsitans* were furnished for inclusion in this paper. This information has been combined with the 30 observations made in this same area by the writer and presented in Figure 2.

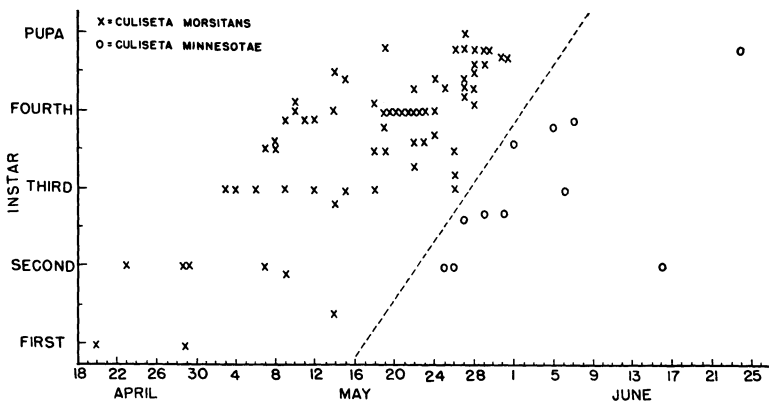


FIG. 1. Average Stage of Development of *Culiseta morsitans* and *Culiseta minnesotae* on Each Collection Date at Itasca State Park, 1957-1959.

All of the habitats in which *C. minnesotae* has been found were of the exposed semi-permanent to permanent sedge-cattail marsh category. *C. morsitans* enjoyed a somewhat wider distribution, inhabiting not only the same marshy sites as *C. minnesotae* but also such places as tamarack swamps and the more sheltered woodland or coniferous pools and marshes. The larvae of both species tended to be located adjacent to vegetation in the water. Experience has shown that they easily may be overlooked during the routine collection of other larvae unless one takes special care to dip water directly from the center of or around the edges of emergent vegetation, especially the dense clumps of grasses or sedges so common to many habitats.

In only two sites studied to date have both *C. minnesotae* and *C. morsitans* occurred during the same season. In both instances, one at Cedar Creek and the other at Itasca, the last larvae of *C. morsitans* were observed from May 23-29; they were all late fourth-instar and obviously approaching pupation. Coincident with this finding, second- and third-instar larvae of *C. minnesotae* were observed from May 23-27; they reached third- and fourth-instar levels during the first week of June and probably did not begin pupating until around June 10, or two weeks after the last stragglers of

*C. morsitans* had pupated. The disappearance of the *C. morsitans* larvae coincided with that of certain early *Aedes* species; the development of *C. minnesotae* paralleled especially that of *C. territans* and several others of similar habits.

Based upon the Itasca observations in Figure 1, the length of larval life of *C. morsitans* is estimated to range from four to six weeks. The larval stages of *C. minnesotae* probably pass by more rapidly, this being principally a reflection of the warmer waters later in the season. A few specimens of this latter species have been reared from third or early fourth instar larvae to adults in the laboratory. Under conditions of continual aeration in pond

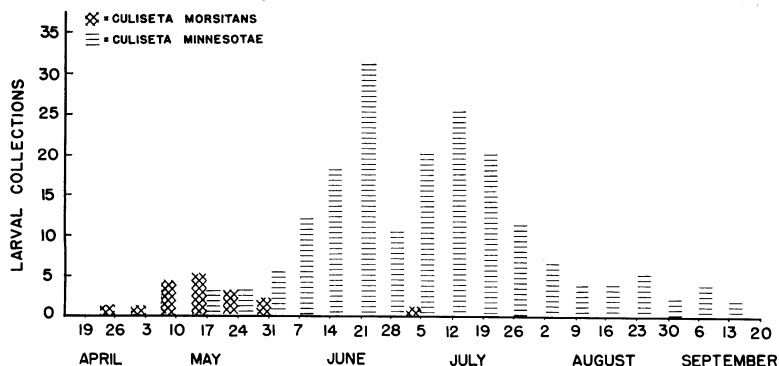


FIG. 2. Weekly Seasonal Distribution of 202 Collections of Larvae of *Culiseta morsitans* and *Culiseta minnesotae* in the Minneapolis-St. Paul Area, 1956-1958.

water kept at laboratory temperature and with no additional food provided, the fourth-instar stage lasted four to six days and the pupal stage, two to three days.

Many European workers (*e.g.*, Natvig, 1948) believe that *C. morsitans* overwinters chiefly in the late larval instars; no confirmation of this type of cycle has been reported in North America. The larval seasonal distributions as given in Figures 1 and 2 indicate an overwintering of this species, at least in Minnesota, either as an egg or as an inseminated female. In support of the former idea, the eggs of *C. morsitans* are said to be laid singly and to be able to withstand desiccation for weeks, probably months (Shute, 1933). Martini (1930) and Callot and Ty (1944) further postulate that this species in Europe may overwinter as an egg in addition to the larval form. Howard *et al.* (1915), from observations in the United States, state that probably the egg is deposited singly and that the late summer and all winter is passed in this stage. The egg of *C. morsitans* would thus seem to be more like an *Aedes* egg than like that of the raft-forming *Culiseta* and *Culex* species. If, on the other hand, *C. morsitans* hibernates as a female, then the life cycle would be similar to the *Culiseta impatiens* type of cycle as reported by Frohne (1954) in Alaska. This would involve for *C. morsitans* a single-broodedness with an extremely long-lived female capable of living from May or June of one year through the vicissitudes of both summer and winter to late April of the next year. A cycle of this nature would be unique

among Minnesota mosquitoes, but this in itself would not preclude its occurrence. Should one assume the female to overwinter, then the larval associates reveal that she must become active distinctly earlier than any of a number of other species of similar hibernation habits. The homogeneity of larval age class within any specific habitat indicates the hatching of either a group of submerged overwintering eggs or of recently-inundated eggs laid early that spring by hibernating females. In spite of the fact that the rather inconclusive evidence to date may be construed to fit either method of overwintering as outlined above, the present author tends to favor the overwintering egg hypothesis to that of the hibernating female; only further work will show the validity of making such an assumption. Regardless of how overwintering is accomplished, most studies, including the present one, agree that there is only a single generation each year.

Contrasted to the above, *C. minnesotae* appears to be more conventional in its type of life cycle. The larval collections as well as light trap samplings indicate a continual breeding of this species throughout the late spring, summer, and early fall (see Fig. 2); it is probably the females produced in the later part of the season that contribute to the overwintering population. Of the 83 specimens taken by two light traps during four years of operation in the St. Paul area, all but one specimen (on June 12) were captured between July 4 and September 30. Barr (1957) reported the capture from May 2-7, 1953, of what he believed to be old, overwintered females of this species; the life cycle as postulated here is in agreement with this finding. He did, however, state that adults had been taken only from April to June and from September to October; on the basis of our present knowledge, the occurrence of adult *C. minnesotae* should be broadened to include the entire period from spring to fall.

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