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LARVAL HABITATS OF *CULEX TARSALIS* (COQ.) (DIPTERA: CULICIDAE) IN MINNESOTA[1]

MYRTLE E. RUEGER,[2] ROGER D. PRICE,[3] AND THEODORE A. OLSON[2]
University of Minnesota

INTRODUCTION. Most studies on *Culex tarsalis* Coquillett have been carried out in the irrigated sections of the western United States. In the north central area of the country, work on the biology of this medically important species has been much less extensive. The present study of larval habitats in representative sections of Minnesota during 1958 through 1960 was one aspect of a broader investigation on the bionomics of *C. tarsalis* and western encephalitis viral activity (Price, *et al.*, 1960; Olson, *et al.*, 1961).

Minnesota, with its continental climate, differs from the irrigated regions and represents a transitional zone between these western areas and the eastern boundary limits of *C. tarsalis*. The extremes in temperature are great, ranging from a minimum of −59° F. to maximum of 112° F. The mean precipitation varies from 21.04 inches per year in the northwest to 29.23 in the southeast (Strub, 1960), with May and June being the wettest months. Prairie covers the southwestern portion of the lower half of the state and extends upward to Canada through the extreme western tier of counties (Fig. 1). Deciduous forest borders the prairie on the east, forming a diagonal belt narrow at the northern border of the state and widening in the lower eastern half of the state. The eastern two-thirds of the northern half of the state is predominantly coniferous forest. Many of the surface features of the state can be traced to the periods of intense glacial activity. The undulating and hilly surfaces of central and southern Minnesota are directly traceable to successive ice sheets which overspread the state, and the flat northwest corner was once the bed of the glacial Lake Agassiz. *Culex tarsalis* has been found in all parts of the state

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[2] School of Public Health, Minneapolis, Minnesota 55455.

[3] Entomology, Fisheries, and Wildlife, St. Paul, Minnesota 55101.

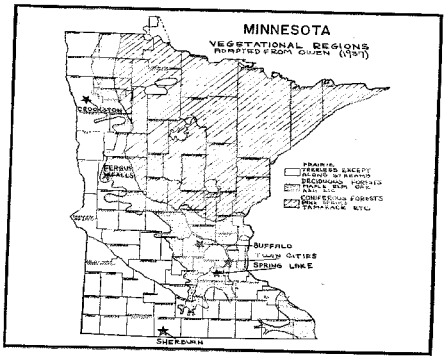

FIG. 1.—Map showing location of study sites and vegetational regions of Minnesota.

except in the coniferous forest area (Owen, 1937; Barr, 1958).

METHODS. Larval habitat studies were carried out in rural areas surrounding pigeon sentinel stations established for the study of western encephalitis viral activity; the locations selected were historically associated with this disease (Olson, *et al.*, 1961). Two types of ecological zones were represented: (1) the prairie section by a northern station at Crookston and a southern station near Sherburn, and (2) the deciduous forest section by a western station at Fergus Falls and an eastern station at Buffalo (Fig. 1). Data from a Spring Lake station and the Minneapolis-St. Paul area were obtained from the broader bionomic study, but these are not included in this paper because both areas were being subjected to the expanding larval control efforts of the Metropolitan Mosquito Control District.

The stations at Crookston, Fergus Falls, and Buffalo were established during the spring and early summer of 1958, and the one near Sherburn in 1959. The selected study areas were similar in that each surrounded a farm with nearby animals, trees, and aquatic habitats. A river and an associated non-flowing oxbow were within the Crookston study site; the Fergus Falls station was located within a lake area; the Sherburn site was adjacent to Fox Lake; and the Buffalo station was near Pelican Lake and extensive marshy areas extending from that lake.

At weekly intervals from approximately 1 June to 1 October 1958, mosquito larvae were collected at Buffalo; at Crookston and Fergus Falls, collecting was done about once a month. The following year, weekly collections were made at the four stations. In 1960, the schedule remained the same except at Crookston where collections were made twice a month. Dipping was done with a white, one pint, enamel dipper. The minimum number of dips at each collection varied from one to five at small sites, and up to fifty to one hundred at lake habitats. Medium- and large-sized sites were examined at several spots. Although individual sites were sampled repeatedly throughout each season, an attempt was made to achieve diversity by checking the variety of habitats available in each area.

Artificial containers and temporary pools were classified as temporary water; these shallow habitats were filled during rains, but the water evaporated within a week unless refilled by further rain. Roadside ditches, marshes, and ponds were classified as semi-permanent water; these contained water of sufficient depth to remain for several weeks without further rain. Marshes and ponds contained vegetation throughout. Lakes and streams were classified as permanent waters; these contained water throughout periods of dryness. Vegetation in the lakes was confined to the edges.

RESULTS AND DISCUSSION. For the study period, the total number of attempted collections of mosquito larvae for each habitat type and the percentage of each of these containing *C. tarsalis* is given in Figure 2. The total collections include both those in which mosquito larvae were present and those which contained no specimens. As in studies by others, the larvae of *C. tarsalis* were found in a variety of habitats. The habitat types predominating in our study resulted for most

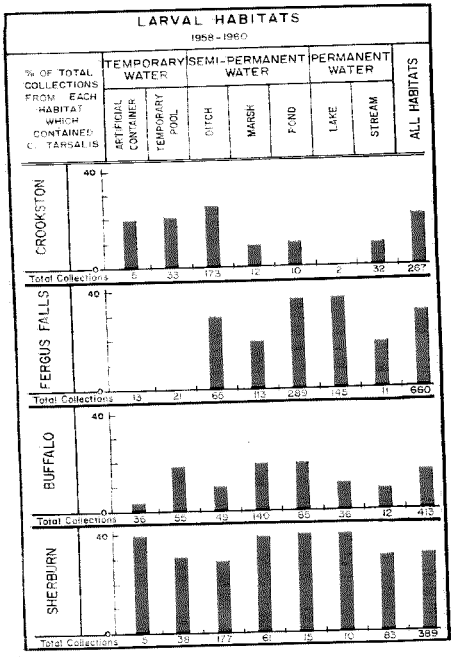

FIG. 2.—Habitat associations of *C. tarsalis* larvae for each of the 4 study areas.

part from the topographical features of each area. For example, at Crookston, ditches were virtually the only habitat available for mosquito breeding; 65 percent of the collections and 77 percent of the *C. tarsalis* collections were from this habitat type (Table 1). Collections from ditches also predominated at Sherburn. Ponds constituted the principal aquatic habitat in the Fergus Falls area, and marshes at Buffalo. Although 41 percent of the *C. tarsalis* collections at Sherburn were from ditches, this species was found there in every type of habitat sampled. On an overall average, Sherburn ranked with Fergus Falls in having slightly over 30 percent of the total collections positive for *C. tarsalis;* at Crookston and Buffalo this percentage was lower (Fig. 2).

At Fergus Falls, although only about half as many collections were made from lakes as from ponds (Table 1), these collections contained *C. tarsalis* as often as those from ponds (37%; Fig. 2). Only about 3 percent of the *C. tarsalis* collections made by Owen (1937) were from lakes, which are seldom mentioned as a usual habitat for the species. Near Fergus Falls, however, *C. tarsalis* were found regularly throughout the season along lake shorelines in water up to about three feet deep. The aquatic plant *Potamogeton pectinatus* Linnaeus found in these areas undoubtedly protected the larvae from wave action and predation. During the 3-year study, collections from lakes were most often positive for *C. tarsalis* during August (49%) when small ponds and marshes often became dry; they were less often positive in June, July, and September (30%, 31%, and 22%, respectively). The larvae more often than not occurred unassociated with other species of mosquitoes, but when the water line receded during periods of dryness, *Culex restuans* Theobald, *Culex salinarius* Coquillett, *Culex territans* Walker, *Culiseta inornata* (Williston), *Aedes dorsalis* (Meigen), *Aedes vexans* (Meigen), and *Anopheles earlei* Vargas were found associated with *C. tarsalis* in shallow pools

TABLE 1.—Percent of total collections and of *C. tarsalis* collections from 7 habitat types in each of 4 Minnesota regions. (Figures for *C. tarsalis* enclosed in parentheses).

Station	Artificial container	Temporary pool	Ditch	Marsh	Pond	Lake	Stream
Crookston	2 (2)	12 (12)	65 (77)	4 (2)	4 (2)	1 (0)	12 (5)
Fergus Falls	2 (0)	3 (0)	10 (9)	17 (10)	44 (53)	22 (26)	2 (1)
Buffalo	9 (1.5)	13 (16)	12 (8)	34 (42)	20 (25)	9 (6)	3 (1.5)
Sherburn	1 (1)	10 (10)	45 (41)	16 (19)	4 (5)	3 (3)	21 (21)

formed along the lake shores by wave action or rains.

In the Sherburn area a small creek, heavily polluted with creamery waste, on occasions contained up to 200 *C. tarsalis* per dip. When first sampled in 1959, this species occurred in almost pure culture, but within two to three weeks, it was replaced almost entirely by *Culex pipiens* Linnaeus. During the latter part of the 1960 season, *C. tarsalis* also were found at a lake edge in the Sherburn area; three weeks later over 400 *C. pipiens* per dip were found at this same site while the *C. tarsalis* density remained about the same (5–10 per dip).

The earliest finding of *C. tarsalis* larvae was 4 June 1959 at Buffalo, and the latest was 31 October 1960 at Fergus Falls. The latter were from two ponds covered with about one inch of ice. Larval collections were not made during the first several weeks at some stations because college students who did most of the collecting were not available until mid-June; therefore, larvae may have been present earlier than our data indicate.

SUMMARY. Because of the distribution of western encephalitis during the 1941 epidemic, a survey of larval habitats of *C. tarsalis* was carried out in ecologically divergent sections of Minnesota during the period of 1958 through 1960. Larvae were taken from a variety of habitats from June through October, with an unexpected number of *C. tarsalis* collections from lakes. Data are presented on the habitat associations of this species for the study areas.

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