SOME FACTORS INFLUENCING LARVAL POPULATIONS OF *CULEX TARSALIS* AND WESTERN EQUINE ENCEPHALITIS IN UTAH[1]

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In 1956 the South Salt Lake County Mosquito Abatement District began a detailed larval survey to obtain more information about mosquito larval populations and the factors that influence them in Salt Lake County. This survey has been continued in each subsequent year, and in 1959 the Salt Lake City Mosquito Abatement District conducted a similar survey. Inspectors employed by the districts were required to collect a sample of larvae from each spot where they were found and record the date, location, number of larvae per dip, the instar of the larvae, the size of the body of water producing them, and the source or nature of the water. The larvae were later identified in the laboratory. The data obtained in this manner gave valuable information regarding mosquito larval populations and suggested several problems for future investigations which will be conducted by the mosquito abatement districts and the Department of Entomology of the University of Utah. This paper considers some of the data on *Culex tarsalis* and their significance.

Approximately 9,000 samples of mosquito larvae were taken in the four years of the survey in South Salt Lake County. The average number of larvae per dip for all of the pools sampled each year was less when 1 species of mosquito was found than when 2 or more species were found, but the difference was less than would be expected if each species was as numerous in the pools with multiple species as when found alone.

Figure 1 is a graph showing the percentage distribution of pools according to numbers of larvae per dip for single and multiple species for 1959. The patterns for other years are similar.

At least one of the species is reduced in numbers when two or more species

TABLE 1.—Comparison of the number of larvae per dip in pools with single and multiple species for 4 years in Salt Lake County

Year	No. of pools sampled	Average number of larvae per dip		
		Single species	Multiple species	All pools
1956	1206	7.4	7.9	7.5
1957	1825	5.9	6.9	6.2
1958	3171	3.7	4.5	3.9
1959	2666	5.0	5.7	5.3

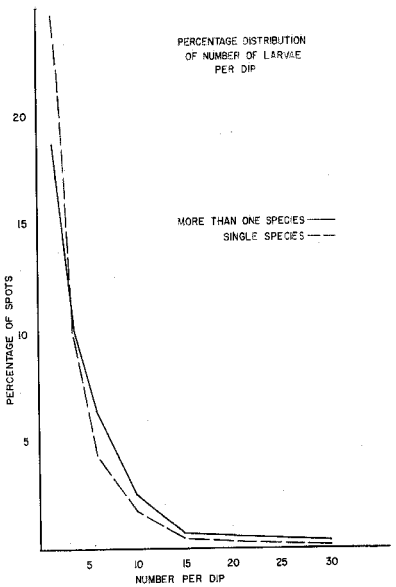

FIG. 1.—Percentage distribution of pools according to numbers of larvae per dip for single and multiple species.

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share the same larval habitat. Although the total number of larvae is greater, field observations indicate that the larvae of all species are less numerous when they share a habitat with other species than when they are alone. A possible explanation for this is that competition, in some form, restricts the density of mosquito larval populations but since different species occupy slightly different niches in the same habitat, competition is reduced to some extent.

Since two or more species of mosquito larvae in any one habitat appear to reduce the numbers of each species compared to the habitats where they are found alone, the number of times the larvae of any particular species can occupy a habitat by itself has a direct relation to the total number of mosquitoes produced.

TABLE 2.—Comparison of the percentage of pools of *C. tarsalis* larvae only with cases of WEE for 4 years in Salt Lake County

Year	Pools	Percentage of pools with *C. tarsalis* only	Cases of WEE in horses
1956	510	46.7	11
1957	982	58.7	77
1958	2230	66.0	224
1959	1333	41.1	21

Table 2 is a table showing the number of times *C. tarsalis* was found, the percentage of times it was found alone and the number of cases of western equine encephalitis reported in horses in Utah, for the 4 years of the larval survey. The apparent relationship between the percentage of times that *C. tarsalis* is found alone and the number of cases of WEE reported in horses in Utah is possibly a reflection of the total numbers of *C. tarsalis* produced.

The seasonal distribution and abundance of *C. tarsalis* partially explain some factors which influence populations. Bates (1954: 41) says of seasonal distribution and abundance "Indeed, the adaptations of a particular species to factors in the physical environment (climate) may be as clearly shown by the seasonal distribution of the species as by the habitat or geographical distribution and it may be as difficult to isolate the particular limiting factors that control abundance in time as it is to isolate those that control distribution in space."

Figure 2 is a graph showing the seasonal distribution of the number of pools with larvae of *C. tarsalis* for the four years of the survey. The graph is based on the number of pools with larvae and is not a direct measurement of larval population, but does indicate changes in larval population during the year and from year to year. Also, increases in the number of spots with larvae of *C. tarsalis*, such as occurred in 1958, indicate greater dispersion of the species in the area which may be an important factor in the transmission of WEE.

The local factors responsible for changes in *C. tarsalis* populations during the year and from year to year are not completely known. Rees *et al.* (1959) attributed the 1958 increase in populations of *C. tarsalis* in Utah and the subsequent epidemic of WEE in horses and humans to an above normal snowfall in the winter and to a dry hot summer requiring increased irrigation. The amount of snowfall during the winter and the amount of precipitation during the summer months can be compared with larval population of *C. tarsalis* from 1956 through 1959. Adequate data on *C. tarsalis* populations prior to 1956 are not available for comparison. However the Bureau of Animal Industry U.S.D.A. has kept records of the numbers of cases of WEE reported in horses in Utah since 1943. Populations of *C. tarsalis* probably fluctuated with the number of cases of WEE in horses during this period.

Certain weather factors seemed to be related to changes in *C. tarsalis* populations in the 4 years of the survey. These same weather factors showed the same relationship to cases of WEE reported in horses in Utah since 1943 (Table 3). The weather factors which are apparently responsible for increased *C. tarsalis* popula-

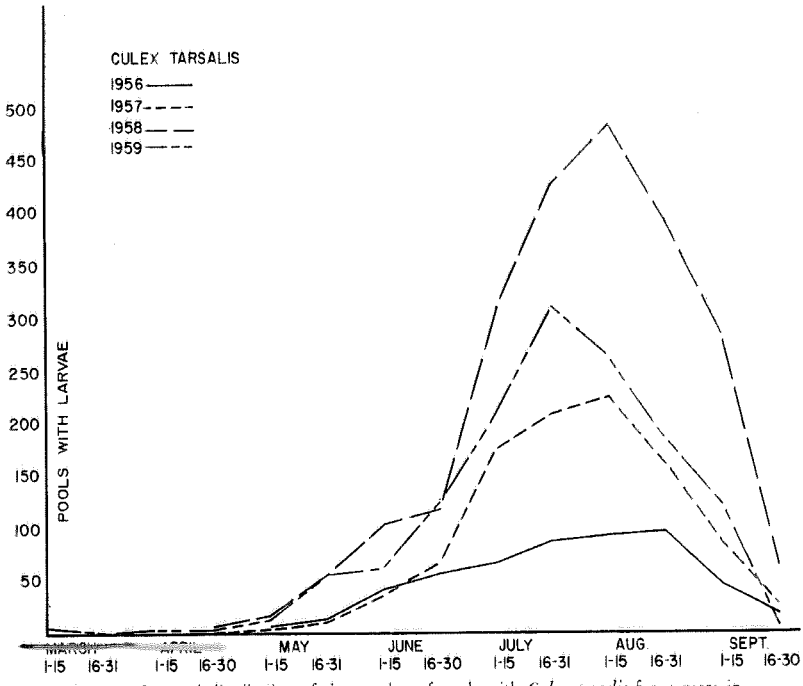

FIG. 2.—Seasonal distribution of the number of pools with *Culex tarsalis* for 4 years in Salt Lake County.

TABLE 3.—Comparison of some weather factors with cases of WEE in horses in Utah from 1943 through 1959 arranged in order of decreasing numbers of cases of WEE.

No. of horse cases of WEE in Utah	Year	Snow pack percent of normal	Precipitation deviation from normal to nearest 0.5 inch	
			June	July
249	1952	225	+.5	—.0
224	1958	125	—1.0	—.5
167	1943	65	+1.5	—.5
77	1955	110	+.5	—.5
70	1947	95	+2.0	—.5
62	1944	175	+2.0	—.5
59	1945	75	+1.5	—.0
39	1946	90	—.5	—.0
36	1948	105	+1.5	—.5
24	1955	136	—.0	—.5
21	1959	80	+.5	—.5
18	1949	170	—1.0	—.5
11	1956	110	—.5	—.5
9	1950	105	—1.0	+.5
8	1953	70	+.5	+.5
5	1954	80	—.0	+.0
0	1951	70	—1.0	+1.5

tions and the incidence of WEE in horses in Utah are above normal precipitation early in the year, usually in June but sometimes in May or April or as snowfall during the preceding winter months, and an unusually dry period beginning in July and extending through at least half of August. Above normal snowfall will affect the amount of moisture available later in the year because snow in the higher mountains does not melt until May or June. Madsen (1934) reports a large number of horse cases of WEE in Utah in 1933. This year also fits the above precipitation pattern of above normal precipitation early in the year and below normal precipitation during the summer. Since normal summer precipitation in Utah is only about one inch per month, below normal precipitation results in almost no rain.

Years in which low numbers of cases of WEE reported in horses generally have below normal precipitation in June and preceding months and above normal rainfall in July. Apparently rainfall during July and early August is detrimental to the transmission of WEE in horses in Utah due possibly to the effects of rainfall on *C. tarsalis* populations. In this regard it is interesting to note that the number of sites with *C. tarsalis* larvae in 1959 reached a peak in the last half of July rather than the first half of August as in the other three years of the larval survey. The decline of *C. tarsalis* populations that occurred in the first half of August in 1959 may have been due to rainstorms that occurred during that period.

Most mosquito production in Utah is the result of the activities of man, particularly irrigation practices. The reaction of man to the above weather conditions is therefore a significant factor in changes in mosquito populations.

SUMMARY AND CONCLUSIONS. The South Salt Lake County Mosquito Abatement conducted detailed larval surveys from 1956 through 1959. The Salt Lake City Mosquito Abatement District conducted a similar survey in 1959. Approximately 9,000 pools were sampled in the survey in South Salt Lake County.

The average number of larvae per dip for all pools sampled each year was slightly greater when more than one species was found in a pool than when one species was found alone. However, the number of larvae of each of the species in pools with multiple species were less numerous than when the species was found alone. Apparently competition in some form restricts the density of larvae in each pool, but since different species occupy slightly different niches in the same habitat, competition between individual larvae is reduced. The number of times a species of mosquito can occupy a larval habitat alone has a direct relationship to the total number of mosquitoes produced. For the four years of the survey there was a positive correlation between the percentage of times *C. tarsalis* larvae were found alone and the number of cases of WEE reported in horses.

Certain weather factors seemed to be related to changes in *C. tarsalis* populations in the four years of the survey. These same weather factors showed the same relationship to cases of WEE reported in horses since 1943. The weather factors which apparently result in increased *C. tarsalis* population and increased incidence of WEE in horses in Utah are (1), above normal precipitation early in the year, usually in June but sometimes in May or in the winter months; and (2), and an unusually dry period beginning in July and extending through at least half of August. Irrigation practices are an important factor in changes in mosquito populations.

References

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