CENTRAL UTAH COUNTY, UTAH, MOSQUITO SURVEY STUDIES

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INTRODUCTION

Under the sponsorship of the City-County Health departments of Utah County, and at their request the Zoology and Entomology Department at Brigham Young University conducted a mosquito survey of Central Utah Valley in Utah County from July 1, 1958 through August 31, 1959.

Principal objectives were the determination of species present, and their geographic distribution; the seasonal population and the general biology of each species; the determination of vector potential for transmissible diseases especially encephalitis, and the formulation of recommendations for control.

Roy J. Myklebust, sanitarian and entomologist (at present with the Washington State Department of Health), was employed as director of the survey from July 1958 until April 1959, with D. Elden Beck of the Brigham Young University Zoology Department as project supervisor. Several graduate students from the Brigham Young University and members of the City-County Health departments served as field and laboratory technicians under the direction of Stanley K. Taylor, graduate student. Dr. Lewis Neilsen, entomologist at the University of Utah, assisted with certain technical aspects of the project, as did also Glen C. Collett of the Salt Lake City Mosquito Abatement District, and Jay Graham of Salt Lake County Abatement District. The Rocky Mountain Laboratory, U.S.P.H.S., at Hamilton, Montana, supplied biological materials and cooperated in giving inservice training to some of the personnel employed on the survey. Dr. James M. Brennan of the Rocky Mountain Laboratory was especially helpful in counsel, regarding research on *Culex tarsalis*. Mr. Stanley K. Taylor made a special study of *Culex tarsalis* during the period of this survey. His project was in part supported by research funds from the Provo City, Utah, Rotary Club. Much of the information in this report on *Culex tarsalis* is taken from Taylor's data. The Utah State Department of Health, the U.S.D.A., Animal Disease Eradication Division, and the U. S. Soil Conservation Service also contributed valuable data and other services to the survey. The people of Central Utah Valley cooperated wholeheartedly in every instance, which made the work pleasant and contributed much to its success.

METHOD OF STUDY AND GENERAL OBSERVATIONS. After preliminary surveys, 125 collection stations were established. The stations were selected to facilitate studies of all possible aspects of mosquito biology. They were visited weekly throughout the breeding season. Periodic and systematic collections were made so that population data could be analyzed on a statistical basis. Most of the larval collections were returned alive to the laboratory and reared to adults. Adults were collected by aspiration, sweep netting and by light traps. The laboratory procedures involved rearing immature forms to adulthood, mounting the specimens for identification and organizing data to be used for future analyses.

Utah County as a whole has a total area of 2,143 square miles. Most of the land is unirrigated, range and forest land, constituting approximately 1,709 square miles. Utah Lake covers about 145 square miles, varying in size with seasonal change in water supply and drainage. Provo River is the main stream emptying into Utah Lake. Crop and pasture land constitutes about 235 square miles. Municipalities, airports, industrial plants, roads etc. constitute about 58 square miles. Central

Utah Valley, which contains Utah Lake covers approximately 438 square miles.

A survey of the natural and man-made mosquito situations revealed the following 5 genera and 20 species to be present. The figures in parentheses following some of the names indicate the relative density of the ten most common species, (1) being the most abundant, (2) next, etc.: *Anopheles freeborni* (9); *Culiseta incidens, C. inornata* (2); *C. impatiens; Mansonia perturbans; Aedes campestris* (10); *Ae. dorsalis* (3); *Ae. excrucians; Ae. fitchii; Ae. flavescens; Ae. increpitus, Ae. melanimon; Ae. nigromaculis* (5); *Ae. niphadopsis* (6); *Ae. vexans* (7); *Ae. cinereus; Culex erythrothorax* (4); *C. pipiens* (8); *C. salinarius,* and *C. tarsalis* (1).

Larval habitats in the valley were separated into nine general categories, as shown below. Unusual species (rare), or those representing an isolated single brood appearance are not listed.

1. Permanent roadside pools more or less due to subsurface flow: Here were found *Anopheles freeborni, Culiseta inornata; Aedes campestris; Ae. dorsalis; Ae. increpitus; Ae. nigromaculis; Ae. vexans; Culex pipiens; C. tarsalis,* with *C. erythrothorax* being found occasionally and the others in varying populations.

2. Intermittent roadside pools due to spring snow melt, rainfall run-off from torrential rains, and drainage resulting from excess irrigation in nearby fields: Present were *A. freeborni; Culiseta inornata; Ae. campestris; Ae. dorsalis; Ae. nigromaculis; Ae. niphadopsis; Ae. vexans; Culex erythrothorax; C. pipiens; C. tarsalis,* with *Aedes dorsalis, Ae. nigromaculis, Ae. niphadopsis, Ae. vexans, Culex pipiens;* and *C. tarsalis* predominating.

3. Marshland pools associated with the rise and fall of lake level, flooding due to snow melt and spring run-off, torrential rains plus change in ground water level and natural springs: Present were *Culiseta incidens; C. inornata; Aedes campestris; Ae. dorsalis; Ae. nigromaculis; Ae. vexans; Culex erythrothorax; C. pipiens; C. tarsalis,* with *Ae. vexans* and *Culex tarsalis* predominating.

4. Slowly moving streams with abundant plant growth at stream banks or as emergent vegetation in the streams themselves: Present were *Anopheles freeborni; Culiseta inornata; Aedes vexans; Culex erythrothorax; C. pipiens; C. tarsalis* with *Anopheles freeborni, Aedes vexans, Culex erythrothorax* and *C. tarsalis* predominating.

5. Artesian wells: Present were *Anopheles freeborni; Aedes dorsalis; Ae. vexans; Culex tarsalis,* with *Anopheles freeborni* and *Culex tarsalis* predominating.

6. Irrigation ditches on farm and pasture lands: Present were *Culiseta inornata; Aedes campestris; Ae. dorsalis; Ae. vexans; Culex erythrothorax; C. pipiens; C. tarsalis* with *Aedes campestris, Ae. dorsalis, Ae. vexans* and *Culex tarsalis* predominating.

7. Abandoned excavations as gravel pits, excavation for levee construction, cellars etc.: Present were *Anopheles freeborni; Culiseta inornata; Aedes dorsalis; Ae. nigromaculis; Ae. vexans; Culex erythrothorax; C. tarsalis* with *Aedes dorsalis, Ae. vexans, Culex erythrothorax* and *C. tarsalis* predominating.

8. Street gutters, gutter underpasses at street intersections in cities and towns: Present were *Aedes dorsalis; Ae. vexans; Culex erythrothorax; Culex pipiens; C. tarsalis,* with *Ae. dorsalis, Culex erythrothorax* and *C. tarsalis* predominating.

9. City park ponds and ornamental residential pools: Present were *Culiseta inornata; Aedes dorsalis; Ae. nigromaculis; Ae. vexans; Culex erythrothorax; C. pipiens; C. tarsalis,* with *Aedes dorsalis, Culex pipiens* and *C. tarsalis* predominating.

Several species were collected in the larval stage during the winter. Most of these were found in marshland situations in pools of water covered by ice. The following were collected in such places: *Culiseta incidens; C. inornata; Aedes campestris; Culex erythrothorax* and *C. pipiens.*

Overwintering adult mosquitoes collected during this survey were *Anopheles freeborni,* found in abandoned buildings, barns and airplane hangers; *Culex erythrothorax,* for the most part in potato and fruit cellars, and also in abandoned build-

ings, associated with *Anopheles freeborni;* and *Culex tarsalis,* found under rocks in stream beds at the mouths of American Fork, Provo and Rock Canyon, beneath stones in talus slopes at the north end of the valley near Saratoga and at the south end of the county near Goshen.

Anopheles freeborni and *Aedes niphadopsis* were rarely caught in the light trap. *Aedes campestris* and *Aedes nigromaculis* were taken as occasional visitors. The species which were abundant in light traps were *Aedes dorsalis; Ae. vexans, Culex erythrothorax; C. pipiens;* and *C. tarsalis.* It might be suspected that *Aedes increpitus, Ae. cinereus, Ae. excrucians, Ae. fitchii* and *Ae. flavescens* would have come to light traps had the traps been placed in the areas of breeding, namely, at higher elevations and in mouths of nearby canyons.

Species of mosquitos collected by net sweeping and by baiting (human and domestic stock) were: *Anopheles freeborni,* which fed most actively after dusk and at dawn; *Culiseta inornata,* which actively fed on cattle and horses during day and night; *Mansonia perturbans,* which was observed to bite man in early evening; *Aedes campestris,* which fed on man both day and night but more so in late afternoon and evening; *Aedes dorsalis,* which fed on man both day and night but was most active at dusk and dawn. *Aedes increpitus* fed on man in late afternoon and evening; *Aedes nigromaculis* fed on both man and domestic stock during day and night, but was most active during evenings; *Aedes niphadopsis* fed on man and cattle during the day and evenings but was most active during late afternoon and evening; *Aedes vexans* actively fed on man during the day when the sky was overcast, and in shaded situations, but was most active at dusk and after dark; *Culex erythrothorax* was observed to bite both day and night but was most active in the evening; *Culex tarsalis* feeding on man, started to bite at dusk, but was most active about one hour after dark. It is interesting to note that *Aedes dorsalis, Ae. niphadopsis, Culex erythrothorax,* and *C. tarsalis* were found distributed more than six miles from a known point of larval origin. Other species seemed to be relatively close to their larval habitats.

DISCUSSION. Central Utah Valley is a catchment basin for waters from the high Wasatch Mountain Range and from those mountain ranges still further to the east. Some of the drainage courses are permanent, as rivers and smaller streams, while in others the flow is periodic, resulting from spring snow melt or seasonal torrential rains. There are also many springs which issue at the foothills, benchlands, and marshlands bordering the eastern side of the valley, all of these waters reaching the basin to form Utah Lake.

Since the date of the first pioneer settlement in the valley, irrigation has been practiced in crop production. Diversion of waters from their natural courses has made marked changes in mosquito ecology. It was concluded from this survey that the primary source for mosquito production affecting the welfare of man in Central Utah Valley was either directly or indirectly related to the diversion of these waters for purpose of irrigation.

The principal mosquito-breeding situations in cities and towns of Central Utah Valley were due to improper curb and gutter construction, especially at street intersections. Water continually running in the gutter channels prevented mosquito breeding at the intersections or elsewhere. However when the flow was discontinuous, the water ponded in the culverts beneath the street intersections and allowed for a most favorable source of mosquito breeding. Discontinuous flow came about from periodic watering turns in urban garden irrigation. Parking sprinklers also contributed to ponding in gutters attended by trash accumulation.

Another factor which contributed to county-wide mosquito production was a combination of poor irrigation in farm management, associated with improper highway construction. When fields were flooded, excess water drained to highway borrow pits, which were so constructed

that the water did not drain away. Also in farm management, apart from drainage to highway borrow pits was the accumulation of water on farmlands themselves which contributed to mosquito breeding.

It is interesting to note there is no published record of a disease organism found in the body of a mosquito species occurring in Utah Valley. Nevertheless, Western equine encephalitis, a mosquito borne disease has been identified in both man and domestic stock in Utah Valley with fatal consequences to both. Following is a list of species of mosquitoes which were found to occur in Central Utah Valley, which have been convicted as vectors of disease organisms in other parts of the country.

Species of Mosquito	Disease
Anopheles freeborni	Western equine encephalitis, malaria
Culiseta inornata	Western equine encephalitis
Mansonia perturbans	Western equine encephalitis
Aedes dorsalis	St. Louis encephalitis, Western equine encephalitis
Aedes vexans	Western equine encephalitis
Culex pipiens	St. Louis encephalitis, Western equine encephalitis, virus of fowl pox, heart worm of dogs
Culex tarsalis	Western equine encephalitis

Those species of pest importance to man include *Aedes dorsalis, Ae. campestris, Ae. nigromaculis, Ae. niphadopsis, Ae. vexans, Culex erythrothorax, C. tarsalis, Mansonia perturbans,* and *Anopheles freeborni.*

Culiseta inornata, Ae. dorsalis, Ae. campestris, Ae. nigromaculis, Ae. niphadopsis, Ae. vexans, Culex pipiens, C. tarsalis and *Anopheles freeborni* were found to attack domestic stock as well as man. *Culex tarsalis* and *Culex pipiens* were especially bothersome to poultry.

From a seasonal point of view, those species which were active in early spring as biters were *Anopheles freeborni, Ae. campestris, Ae. fitchii, Ae. increpitus, A. niphadopsis, Culex erythrothorax,* and *C. tarsalis. Aedes campestris* and *Ae. niphadopsis* appeared early in the spring and had peak population in early summer. All other pest species made their appearance in early spring and had population peaks in mid and late summer. This was especially true of *Ae. dorsalis, Ae. vexans, Culex erythrothorax, C. pipiens,* and *C. tarsalis.*

Space does not allow inclusion of the seasonal population analyses which were obtained for each of the twenty species examined in this study. Ten species were significant in the larval collections. Listed in descending order of population density were *Aedes dorsalis, Culex tarsalis, Culiseta inornata, Aedes nigromaculis, Culex erythrothorax, Ae. vexans, Culex pipiens, Ae. campestris, Ae. niphadopsis, Anopheles freeborni.* These data on population were obtained from larval counts made from collections taken at selected field stations. In light trap collections, the predominant species in descending order of abundance were, *Culex erythrothorax, C. tarsalis, Ae. dorsalis, Ae. nigromaculis,* and *Ae. campestris.* Figures 1, 2, 3, and 4 present a graphic analysis of four of the most numerous species.

Information on hibernation was mentioned previously for those species of larvae which were found overwintering under ice. Most attention in the hibernation studies was directed to *Culex tarsalis,* due to its being suspect in western equine encephalitis transmission. It was found to hibernate under rocks in talus slopes at various places around the valley and beneath stones in creek beds at the mouths of canyons along the Wasatch Range.

Searching for adult *Culex tarsalis* in cellars, barns, abandoned buildings in and around residential areas, farmstead hay stacks, and along overhanging stream banks revealed instead the presence of other species of gravid female mosquitoes. The most common species in these places was *Culex erythrothorax,* which was found in populations of from one to fifty or more specimens. The next most common was *Anopheles freeborni.* The latter species, when returned to the laboratory immediately became active, fed readily on humans, and later laid eggs. For some unknown reason, the larvae from these eggs did not develop further than the third instar.

RECOMMENDATIONS FOR CONTROL. It was proposed that first priority be given to

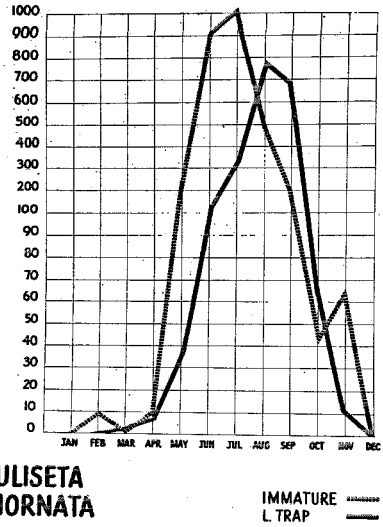

FIG. 1.—Seasonal variation in collections of larvae (immature), and adults from light traps in one year.

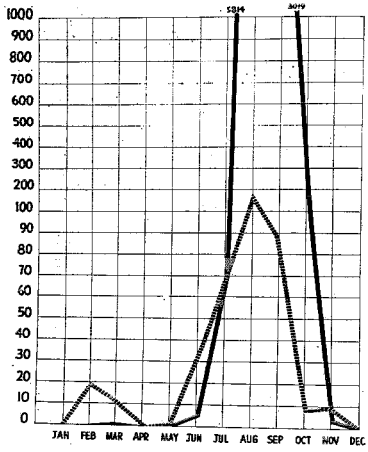

FIG. 2.—Seasonal variation in collections of larvae (immature), and adults from light traps in one year.

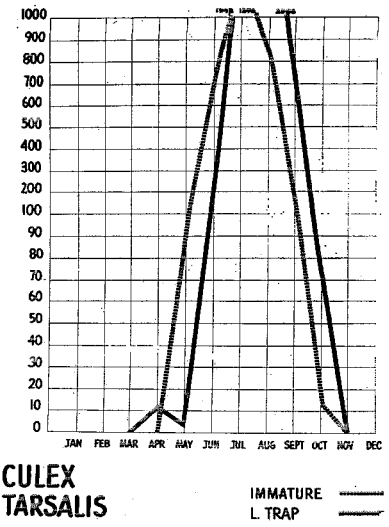

FIG. 3.—Seasonal variation in collections of larvae (immature), and adults from light traps in one year.

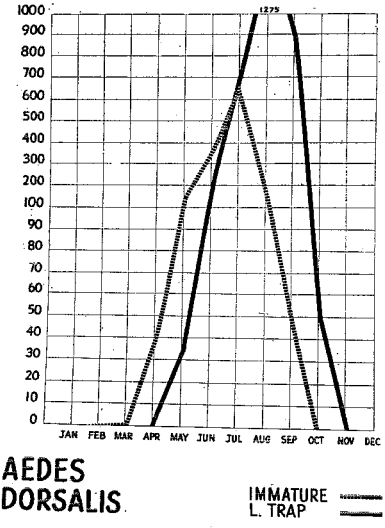

FIG. 4.—Seasonal variation in collections of larvae (immature), and adults from light traps in one year.

measures of permanent control (sanitation), and that temporary control by insecticides be secondary. It was recommended that long range, county-wide, overall planning be immediately considered to establish the control measures. The various agencies which would be involved were:

1. Departments concerned with the supervision and construction of streets, curbs, gutters, and sewers in towns and cities.
2. Departments concerned with county, state, and federal highway construction.
3. Departments involved with private or public agencies which impound or distribute water for recreational, agricultural or other purposes such as boat harbors, land reclamation and airport construction.
4. Agricultural and industrial organizations, individuals or institutions.
5. Public and private agencies concerned with sewage and garbage disposal.

As an overall policy, it was recommended that sound engineering planning and construction of public and private game preserves, boat harbors, airports, and parks to be used for commercial or recreational purposes should include measures for control of mosquito breeding situations.

In accordance with accepted policy of good mosquito control anywhere, it was recommended that a full-time supervisor or manager be employed to head the direct organization of control.

References

CARPENTER, S. J., and LACASSE, J. 1955. Mosquitoes of North America. University of California Press. Berkeley and Los Angeles.

FERGUSON, F. F. 1954. Biological factors in the transmission of arthropod-borne virus encephalitides. Public Health Monograph. No. 23, pp. 1–37: Government Printing Office. Washington, D. C.

HALES, WAYNE B. 1948. Characteristics of prevailing winds at the Provo Municipal Airport. Proc. Utah Academy of Sciences, Arts and Letters 25:117–126.

HOLDEN, P., and HESS, A. D. 1959. Cache valley virus a previously undescribed mosquito-borne agent. Science 130 (3383):1187.

HOPLA, C. E. 1947. A taxonomic study of the adult mosquitoes of Utah County with notes on the biology and distribution of more common species. Unpublished Master's Thesis. Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

HOWITT, B. F., DODGE, H. R., and BISHOP, L. K. 1949. Recovery of the virus of eastern equine encephalomyelitis from mosquitoes (*Mansonia perturbans*) collected in Georgia. Science 110:141–142.

KEENER, G. C. 1952. Observations on overwintering *Culex tarsalis* Coquillett in western Nebraska. Mosquito News 12 (3):205–209.

KING, W. V., BRADLEY, G. H., and MCNEEL, T. E. 1942. The Mosquitoes of the Southeastern States. U.S.D.A. Misc. Publication No. 336.

REES, D. M. 1943. The Mosquitoes of Utah. Bulletin of the University of Utah, Vol. 33, No. 7.

REES, D. M., NIELSEN, L. L., and COLLETT, G. C. 1958. Summary of the twenty-ninth annual report of the Salt Lake City Mosquito Abatement District, Salt Lake City, Utah.

RUSH, W. A., BRENNAN, J. M., and EKLUND, C. M. 1958. A natural hibernation site of the mosquito *Culex tarsalis* Coquillett in the Columbia River basin, Washington. Mosquito News 18 (4): 288–293.

STAGE, H. H., GJULLIN, C. M., and YATES, W. W. 1952. Mosquitoes of the northwestern states. U.S.D.A. Agriculture Handbook 46:1–95.

THOMAS, LEO A., and SMITH, JAMES V. 1959. The 1958 encephalitis outbreak in Northern Utah. II. Infection rates in birds, mammals, and mosquitoes. Mosquito News 19 (4):223–226.