MOSQUITO SURVEILLANCE AND ABATEMENT AT FORT DIX, NEW JERSEY DURING THE EASTERN EQUINE ENCEPHALITIS OUTBREAK OF 1959

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During the second week of August 1959, approximately 50 pheasants of a flock reared by the Rod & Gun Club of Fort Dix displayed disease symptoms. New Jersey State laboratory tests were made and positive isolations of eastern equine encephalitis virus (EEE) from 8 of 50 sick birds were confirmed (5). Since these findings represented a potential threat to the health of the command, special mosquito surveillance of the entire Fort Dix area was immediately initiated, and based upon the results, mosquito control activities were intensified and expanded.

In late August, a sharp focal outbreak of EEE in humans came to notice in several counties along the coastal area of Central and Southern New Jersey (7). EEE virus had been demonstrated in mos-

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quitoes, wild birds, pheasants, and horses for many years in the State, but this was the first instance of confirmed EEE in humans. This unique event, comparable only to the Massachusetts EEE outbreak of 1938 (6), created unusual interest.

It was of particular interest to Army officials in that several major military installations with large troop populations (one of which was Ft. Dix) and several Nike AAA sites were located in the general area of the affected counties. Fort Dix is located 20 miles southeast of Trenton, N. J. The acreage (approx. 33,000 acres) is largely composed of second growth oak and pine woodland, with scattered cedar-type swamps, sassafras, a few abandoned cranberry bogs, and other formerly cultivated fields. The reservation is bordered mostly by woodlands of the same type. Generally, there is a growing season of approximately 205 days each year. The topography ranges from 50 to 200 feet elevation.

PROCEDURE

SURVEILLANCE. Routine mosquito surveillance began as usual at Fort Dix on 1 April. Due to indication of EEE activity in the area, special mosquito surveillance was undertaken on 17 August 1959 in accordance with methods described by Chamberlain 1959 (4). It consisted of adult population determination with 5 New Jersey type light traps and 3 artifical resting containers; larval population determination by routine larval dips; and intense searching for the breeding source of *Culiseta melanura* (Coq.) a known vector of EEE. Mosquito light trap records at Fort Dix for 1955–58 were used to compare the 1959 results. Average weekly meteorological data were obtained from the nearest weather station (1).

From 1 April to 16 August 1959, one light trap was operated at each of the following areas of Fort Dix, the same areas where they were operated throughout the mosquito season for the past five years:

#1—Dependent Housing Area
#2—Troop Housing Area
#3—Bivouac Training Area
#4—Troop Housing Area
#5—McGuire Air Force Base Troop Housing Area

On 17 August, light traps #2 and #4 were re-located at the pheasant farm and the nearby Officers' Open Mess Annex, which were within the woodland section of the post, and from which the nearest cedar-type swamp was about a 3/4 mile distance. Traps 1, 3 and 5 were retained in the original areas which were approximately 3–5 miles distant from the nearest cedar-type swamps.

Artificial mosquito resting containers, consisting of regular size kegs with black interiors, 4 square inch openings, and removable tops, were placed in the general areas of traps 2 and 4 to collect live mosquitoes for virus studies, and to further determine the *Culiseta melanura* population index.

Typical *Culiseta melanura* breeding sources, as described by Burbutis, Lake and Jobbins 1956 and 1957 (2, 3) were used as guides in the intensive search for local breeding of this species. Routine larval collections throughout the post and bivouac training areas continued on a weekly basis.

CONTROL. Mosquito control operations were the responsibility of Post Engineers whereas mosquito surveillance was a medical responsibility. The surveillance team performed weekly inspections of all phases of the mosquito program and reported its findings to the Engineers. Control efforts were usually accomplished within 3 days, but never exceeded one week.

Since Fort Dix was subjected to adult mosquito infiltration from surrounding areas, an adulticiding program consisting of routine thermal aerosol fogging with DDT was continued throughout the summer in the cantonment and bivouac training areas. The installation was divided into zones and each zone treated in succession several times each week.

Routine weekly larval control was accomplished by treating the common mosquito breeding places with standard 5

percent oil based DDT and a combination 4 percent BHC—12-1/2 percent DDT formulation. The latter was dispersed in gelatin capsules commonly known as "tossits."

Due to a high *C. melanura* population index, human activities in selected woodland areas of the post were limited during the period 1 September to approximately 1 November. This ruling affected the dependents' bathing beach, the Officers' Open Mess Annex, and other activities.

On 15 September, additional adult mosquito control measures were recommended and immediately employed. The woodland areas showing high *Culiseta melanura* counts were subjected twice weekly to a mist-blown application of standard issue 5 percent DDT. Bivouac training areas and housing areas having lower *Culiseta melanura* counts were treated once per week.

Because of difficulties experienced in gaining entrance into the extensive ordnance impact area (the nearest source of *Culiseta melanura*), and as a last resort, additional adult mosquito control by means of aircraft spraying was recommended. On 29 September and 2 October, approximately 11,000 acres comprising approximately one-third of the entire post area were sprayed by C-47 aircraft from the U.S. Air Force Special Aerial Spray Flight. Malathion insecticide was dispersed at the rate of .2 to .3 pounds per acre.

RESULTS AND DISCUSSION

Adult *Culiseta melanura* was first encountered in light traps during the week of 25–31 May (only 4 specimens), again on 10 June (only 1 specimen), and not again until August at which time the number had increased enormously. Figure 1 is a graph showing the quantitative mosquito light trap collection at Fort Dix

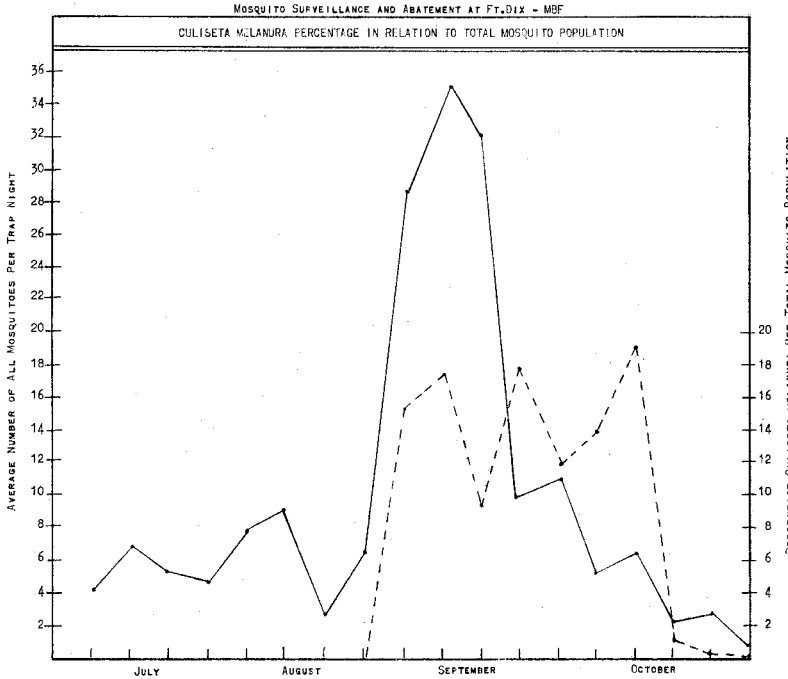

FIG. 1.

from 29 June to 31 October 1959. It compares the percentage of *Culiseta melanura* to the total mosquito collection.

Culiseta melanura ranged from 22 percent of the total mosquito collection per trap/week (31 Aug.–6 Sept.) at the Officers' Open Mess Annex (trap 4) to 4 percent per trap/week throughout the Post cantonment and bivouac training areas (traps 1, 3 and 5). Trap #2, which was located at the pheasant farm, produced relatively few *Culiseta melanura*. Traps #2 and #4 were approximately three-quarters of a mile from the nearest *C. melanura* breeding source. Traps #1, 3 and 5 were approximately 3–5 miles from the nearest *C. melanura* breeding source.

The general mosquito population index remained constantly high while routine larviciding and fogging were the only chemical measures employed for control; however, personnel within the cantonment and bivouac-training areas reported temporary relief from adult mosquitoes due to the fogging program.

Immediately after commencing the DDT misting operation (15 September), the general mosquito population index (including *C. melanura*) dropped from 34 mosquitoes per trap night to 9, and remained about that level until the late aerial spray which further reduced the index to 4 mosquitoes per trap night. Three days after the aerial spray (29 Sept. and 2 Oct.), the mosquito population index began to rise rapidly until cold weather (12–18 Oct.) suddenly reduced the index to near zero.

Adulticiding (misting and aerial spraying) successfully reduced the general mosquito population index (including *C. melanura*); however, all species population index did not drop proportionately. Significantly at this time, there was a percentage increase of *Culiseta melanura* compared to the total mosquito collection.

Table 1 compares, by months, the average number of selected species collected per trap/week at Fort Dix from 1955 through 1959. The *Culiseta melanura* population is shown to be unusually high in 1959 as compared to previous years. The general mosquito population index was also higher during 1959. During 1955 and 1959, the general mosquito population peak occurred in September, while in 1956 through 1958 it occurred in July or August. There were no *Culiseta melanura* trapped during the latter years.

After an intense search for the breeding source, *Culiseta melanura* larvae were finally discovered in a cedar-type swamp located within the Post Ordnance Impact Area which was approximately three-quarters of a mile from the Officers' Open Mess Annex where the highest adult *C. melanura* counts were recorded.

C. melanura larvae were located in ground level tree holes which were too small for the regular larval dipper (5 in. dia.), and under the extensive root systems of the cedars. Often dead leaves and other debris covered the root systems so that one may not have ascertained that water was beneath. The swamp was dense with second growth cedar and other larger trees that provided constant shade throughout the day. The water was cool, tea colored, with a pH range of 4.4 to 5.5. All larval instars were present and collections averaged approximately 3–8 larvae per dip. *Culex territans* (Walker) were commonly found breeding in association with *C. melanura*. Occasionally, *Culex pipiens* (Coq.) *Culex salinarius* (Coq.) and *Anopheles punctipennis* (Say) were present.

Routine weekly larval collections from common breeding sources within the cantonment and bivouac-training areas were often negative throughout the season, perhaps due to routine larval control efforts. The few positive collections always confirmed the qualitative adult mosquito light trap counts, but not the quantitative counts, perhaps due to adult infiltration from "off post." Larval counts were never sufficient to account for the local adult mosquito population as indicated by the light trap counts.

Few mosquitoes were collected from the artificial resting containers. The number was insufficient for virus studies.

TABLE 1.—Fort Dix mosquito light trap collection averages per trap/week for selected and other species 1955–1959, July through October

Species	1955				1956				1957				1958				1959			
	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.	July	Aug.	Sept.	Oct.
Aedes sollicitans	10	36	4	1	163	11	3	1	3	10	11	0	27	19	1	1	8	8	19	0
Aedes vexans	12	93	54	5	2	18	20	7	42	14	17	2	55	147	56	7	5	35	168	17
Culex spp. (total)	64	54	132	75	289	305	174	3	42	243	173	33	265	239	249	36	150	285	363	57
Culiseta melanura	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	78	11
Other species	2	8	12	1	1	8	1	1	5	1	2	0	4	8	3	2	2	16	36	2

Temperature and relative humidity ran substantially the same pattern each year, 1955–59. Temperature more or less leveled between 70 and 80 degrees Fahrenheit during July and August, dropping gradually each month thereafter. Relative humidity averaged approximately 73 percent.

Precipitation records of the Ft. Dix Area for 1955 and 1959, the years of EEE outbreaks in Massachusetts and New Jersey respectively, indicated heavy rainfalls followed by relatively long dry periods. The year preceding the New Jersey outbreak, heavy rainfalls occurred in October, which may have substantially contributed to an abnormally high overwintering population of *C. melanura*. This in turn would have provided a large initial population for the mosquito season of 1959.

SUMMARY

A special mosquito surveillance and abatement program was initiated at Ft. Dix, N. J., immediately after confirmation of eastern equine encephalitis in a local pheasant flock. Thirty-four recorded human EEE cases later occurred in several counties of New Jersey. Ft. Dix was located partly in one of the affected counties.

In addition to routine mosquito surveillance operations, a special survey was made to determine the breeding source of *Culiseta melanura* (Coq.). Breeding was found only in cedar-type swamps with typical ecological environs.

Routine mosquito abatement measures were intensified and augmented by mist blown operations in sensitive areas. Outlying areas which were inaccessible to ground equipment were treated by late aerial spraying.

Weekly misting operations successfully reduced the general adult mosquito population throughout the post. The aerial spray was only initially effective for 2–4 days. Routine fogging and larval control did not satisfactorily reduce the adult population index; however, fogging gave temporary relief to local personnel.

Mosquito light trap records of Ft. Dix for the past five years suggest that a correlation may have existed between the unusually high 1959 *C. melanura* population and the EEE outbreak which occurred in the State of New Jersey. Numerous *C. melanura* were encountered in 1959 compared to a few in 1955 and none in 1956 through 1958.

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