irst stage larval population was usual ıfter 18 hours; a second stage population ıfter 24 hours; a third after 48 hours; a ourth after 96 hours; pupation reached a eak at 120 hours; adult emergence after 44 hours; with blood feeding beginning everal hours thereafter. A graphic account of development is given for the omposite population and for each of the our species and shows exceptions to the ısual.

Eight sandbox-type framed plots, 96 quare feet each, represented habitat and contour differences within the pool. Four of these plots were screened to prevent oviposition. From this it was learned that six successive floodings did not deplete the overwintering egg population of the previous winter.

Insectary results, presented in Table 2, show longevity, blood feeding, and oviposition records of 150 isolated females representing the four dominant species of the study. An interpretation of these results is given in the text, above.

ENTOMOLOGICAL EVALUATION OF A PROPOSED MOSQUITO SOURCE REDUCTION PILOT OPERATION

EMBREE G. MEZGER [1]

During the past decade there has been ı steady increase in the number of acres ınder irrigation in the Solano County Mosquito Abatement District. As a result here has been a gradual change in emhasis within the District from salt-marsh nosquito control to the control of mosquitoes associated with irrigated forage and ow crops. This change in program diection called for greater effort on the part of the District to get farmers to adopt nore efficient land and water management ractices. It soon became apparent that he rate of progress toward this goal was ıot keeping pace with the increase in mosquito production potential. In order to neet this need, a carefully-organized and ıighly-controlled mosquito source reducion pilot study was undertaken in the Tremont area of Solano County (Pangurn *et al.*, 1961).

This report is concerned with the entomological aspects of the Tremont Township Source Reduction Project, and is an integral part of the information-gathering phase of the study, preliminary to instituting an intensive source reduction program (Dunphy *et al.*, 1962).

Tremont Township is in the Dixon area, which is located in the southwestern part of the Sacramento Valley in California, lying at the eastern base of the Coast Range. This area includes 75,950 acres of irrigated agricultural land; of this, approximately 21,700 acres are in pasture, 13,250 acres in alfalfa, and 41,000 acres in row crops (sugar beets, milo, field corn, tomatoes, and beans).

The climate is characterized by hot, dry summers and cool, moist winters. The greater part of the annual precipitation falls during the winter and early spring, with little or none during the summer and early autumn. Approximately 75 percent of the total annual rainfall occurs between December and March, with less than 2 percent between June and September.

There are three principal soil types in the area under investigation—Zamora

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clay loam, Yolo silty clay loam, and Capay clay. Cosby and Carpenter (1931) report that Capay soils have a high clay content and a very high water-holding capacity. The pasture lands in the study area consist primarily of this type of soil. The Yolo silty clay loam, classed by many farmers as the best agricultural soil in the area, is adapted to a wide range of crops. The Zamora clay loam, like Capay clay, also has a high water-holding capacity, but has been adapted to more varied agricultural use.

During the 1954–1960 period, according to State of California Department of Public Health Morbidity Records, there were 9 laboratory-confirmed human cases of encephalitis reported from Solano County, 3 St. Louis and 6 western equine. The study area (Dixon) is recognized as one of the more important endemic foci in the County.

Procedure and Observations. Sixty farms, comprising 5,898 acres, were selected at random in the study area. Of this area, 256 acres (4.35 percent) were found to be productive of mosquitoes. Of the 60 farms selected, 52 (86.6 percent) were producing mosquitoes. There were 17 farms in pasture, ranging in size from 0.5–137 acres, containing 222 acres (86.7 percent) which were producing mosquitoes. There were 17 farms in alfalfa, ranging in size from 0.5–33 acres, containing 19 acres (7.39 percent) which were producing mosquitoes. There were 18 farms in row crops, ranging in size from 0.125-157 acres, containing 14.5 acres (5.6 per cent) which were producing mosquitoes These data indicate that the highest mos quito production was in irrigated pasture land, followed by alfalfa and row crops

The most significant mosquito produc tion sources were found in seepage an overflow water from irrigation ditche canals and drain ditches, tail water, an field drainage (Table 1). The high mos quito production in seepage and overflo water and field drainage was due to fault land preparation and inadequate mainte nance. Tail water sources were primaril a product of excessive irrigation.

As a result of these practices the wor load of the Mosquito Abatement Distric including necessary routine entomologica inspections and repeated insecticidal ap plications throughout the mosquito sea son, was increased greatly.

It is significant that all sources produce the three most troublesome species occur ring in this area: *Culex tarsalis* Coquil lett, *Aedes nigromaculis* (Ludlow), an *Aedes melanimon* Dyar.

C. tarsalis was especially abundant i the following sources: drainage slough railroad borrow pits, road drains, tail wa ter, and field drains. This mosquito, th principal vector of encephalitis in Cal fornia, is the most common and wide spread species in the state, being found i all 58 counties. It is a strong flyer an bites man readily, although showing

Table 1.—Types of mosquito production sources and crops grown, June–September, 1960.

Mosquito Sources	Number of sources							
	Pasture	Alfalfa	Sugar Beets	Milo	Beans	Tomatoes	Total	Percent
Tail water	6	15	8	1	1	0	31	12.2
Field drainage	12	9	3	2	1	1	28	10.8
Seepage and overflow from irrigation ditches and canals, and drain ditches	8	11	10	3	1	0	33	12.9
Depressions in fields	11	2	5	0	0	2	20	7.81
Road drains	1	0	1	4	0	3	9	3.51
Drainage sloughs	3	2	1	1	0	0	7	2.73
Contour checks (pasture)	3	0	0	0	0	0	3	1.17
Railroad borrow pits	0	0	1	0	0	0	1	0.38

preference for avian blood. Because it readily enters houses it is the chief cause of complaints referred to the District.

A. nigromaculis was found in greater numbers in the following sources: contour check (pasture), depressions in fields, seepage and overflow areas, tail water, field drains, and road drains. Adults of this species are aggressive biters of man and domestic animals during the day and early evening. While unknown in California prior to 1937, *A. nigromaculis* is now widespread throughout the State. This species is also the cause of many complaints referred to the District.

A. melanimon occurred in greatest numbers in the following sources: field drains, railroad borrow pits, tail water, road drains, seepage and overflow areas and depressions in fields. Like *A. nigromaculis*, the adults of *A. melanimon* are aggressive biters, attacking man and livestock during the day and early evenings. This species is believed to be capable of flying several miles. It is also widespread in California.

The data in Figure 1 show weekly collections of female mosquitoes taken nightly in three standard light traps. The traps were in operation every night; trap collections were made and recorded every 7 days. *A. nigromaculis* was the dominant mosquito species during the period June–September 1960, followed by *A. melanimon* and *C. tarsalis*. These adult mosquito collections are compatible with observations on occurrence of immature stages.

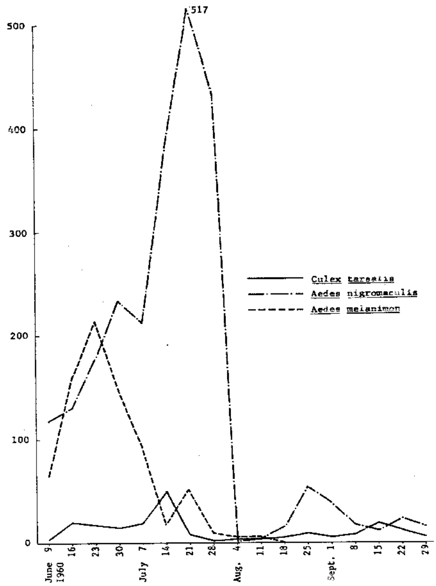

FIG. 1.—Weekly collections of female mosquitoes from three American model light traps operated in the Tremont Township, 1960.

TABLE 2.—Mosquito production sources and mosquito species June–September, 1960[a, b]

Mosquito sources	Total larvae and Pupae	Larval occurrence as percent of total collection		
		C. tarsalis	*A. nigromaculis*	*A. melanimon*
Tail water	30,990	28.7	38.9	32.4
Field drains	26,800	27.3	29.7	43.0
Seepage and overflow from irrigation ditches and canals and drain ditches	33,000	19.7	52.5	27.8
Depressions in fields	9,790	15.7	67.8	20.5
Road drains	8,600	41.2	27.9	30.9
Drainage sloughs	7,614	69.3	17.2	13.5
Contour check (pasture)	3,000	18.2	73.9	7.9
Railroad borrow pit	1,000	47.3	12.9	39.8

[a] Average based on 10 dips per station per source per week.

[b] The techniques and procedures developed by Davis and Husbands (1954) were used throughout this study for the purpose of determining larval densities.

Summary and Conclusions. Of the total number of acres devoted to farming in the source reduction project area, 75,950 acres (20 percent) were under irrigation during 1960. Local agricultural records revealed that 21,700 acres were in pasture, and, based on our sampling, an estimated 63 percent of this acreage was productive of mosquitoes. A total of 13,250 acres were in alfalfa, 7.8 percent of which were in like manner assumed to be productive of mosquitoes. Row crops comprised 41,000 acres, of which an estimated 2.8 percent were productive of mosquitoes. The most intensive mosquito production occurred in irrigated pasture, and to a lesser extent in alfalfa and row crops.

The most significant mosquito production resulted from (1) seepage and overflow, and (2) tail water. Field drainage and depressions in fields were also highly productive of mosquitoes. Sources such as road drains, drainage sloughs, contour pasture checks and railroad borrow pits contributed to the problem to a lesser extent. *Culex tarsalis* was the predominant species in drainage sloughs, railroad borrow pits, and county road drains. *Aedes nigromaculis* was the predominant species in the contour checks, depressions in fields, and seepage and overflow from irrigation ditches and irrigation canals, and drain ditches. On the other hand, *Aedes melanimon* was abundant in field drains, railroad borrow pits, tail water, and road drains. All three major species occurred in all of the sources as noted above.

Entomological evaluation of the source reduction project area indicated that mosquito production sources were due almost exclusively to faulty land preparation, inadequate drainage maintenance, and excessive irrigation, and that these deficiencies greatly increased the need for routine inspections and insecticide applications throughout the mosquito season. Defining the problem in this manner has provided a solid basis for the third phase of the project—working with farmers toward the progressive elimination of mosquito sources. This third phase will also require close liaison with numerous state and county agencies which share interest and responsibility for improving agricultural production, conserving land and water resources, and reducing the hazards of mosquito-borne diseases.

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