ADDITIONAL STUDIES ON THE DISTRIBUTION OF MOSQUITO LARVAE AND PUPAE WITHIN A RICE FIELD CHECK

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The data presented in this paper are a continuation of studies conducted in the San Joaquin Valley (Stanislaus County), California in 1947 (Markos, 1951). In order to corroborate the 1947 findings, similar studies were conducted in 1949 in the rice field areas of the Sacramento Valley, which is the foremost rice growing area in the state.

For this study a large rectangular rice check was selected at the Biggs Rice Experiment Station, Butte County. The field was of a Stockton clay adobe soil, well suited for a study of this type. This study was one of several undertaken in the various rice checks located at the Biggs Rice Station.

METHODS. The procedures followed in this investigation were essentially the same as those used in the previous study and have been described in detail (Markos, 1951).

When completely flooded, the Biggs rice check comprised an area of 38,564 square feet, its dimensions being 124 x 311 feet.

In order to compare the relative density of mosquito larvae across the middle of the check with that occurring along the levees an equal number of dips, 104 across the middle and 104 along the levees, were taken. The mid-field of the study check was defined as the area directly across the bridge, excluding the first twelve feet which was the length of the first plank at either end. The numbered levee stations were in turn subdivided into so-called A, B, and C sections of the stations, as in the previous study.

The study check was inspected three times each week (Monday-Wednesday-Friday) from the time of flooding to the end of the season.

OBSERVATIONS. The algal growth in the study check consisted of *Oedogonium* spp. and *Nostoc* along with *Calothrix, Scenedesmus, Anabaena* and *Zygnema.*

Among the more common weeds which appeared in the check were the following: barnyard grasses (*Echinochloa crusgalli* and varieties), cattails (*Typha latifolia*), water plantain (*Alisma plantago-aquatica*), arrowhead (*Sagittaria latifolia*), spike rush (*Eleocharis palustris*), redstem (*Ammannia coccinea*), slim aster (*Aster exilis*), water hyssop (*Bacopa rotundifolia*), bulrush (*Scirpus fluviatilis*), umbrella plants (*Cyperus*), and *Najas*, a very prevalent waterweed found below the water surface. The check contained an excellent

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growth of rice, and the weeds which were present were scattered in small numbers throughout the check.

The rice was in seed during the fourth week of April. Observations on May 18, after the rice plant had emerged from the water, showed a mean density of 8.35 plants per square foot along the center, and 7.89 plants per square foot along the levees.

Water flowed in and out of the check during most of the season. The fluctuation is shown in Figure 1.

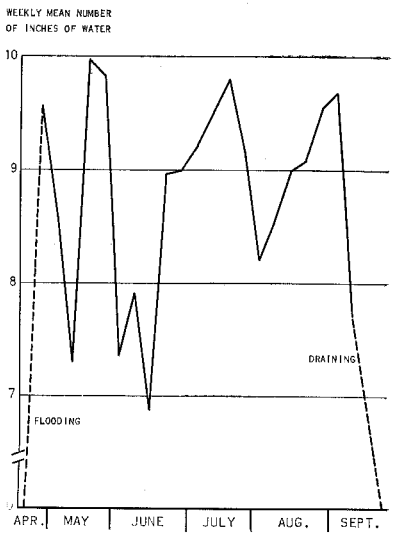
The mean height of the vegetation (principally rice plants) is indicated in Table 1.

A total of 12,197 dips were taken during the season from April to September from the entire check. Of these, 6,136 dips were from the center and 6,061 were from the levees. This discrepancy was due to the lowering of the water in the study check, which caused a few of the levee stations to become dry.

After the check had undergone the usual preliminary land preparation including plowing and disking it was irrigated on April 25 and completely flooded April 26. Observations on April 26 and 29 revealed no mosquito larvae. On May 2, however, a few *Aedes* larvae were noted for the first time. Subsequent observations showed a steady increase, reaching a peak in density on May 6. By May 11 *Aedes* larvae and pupae could no longer be found in the check.

FIGURE 1

FLUCTUATION OF WATER IN BIGGS RICE CHECK APRIL - SEPTEMBER, 1949



Aedes larvae appeared to be much more prevalent along the levees or margins. This was at least in part due to the

TABLE 1.—Mean height of vegetation (in inches) along center and levees of Biggs rice check April–September, 1949

Week of Observation	Total Number of Stations	Mean Height of Vegetation (in inches) Center[1]	Total Number of Stations[2]	Mean Height of Vegetation (in inches) Levees[1]
April				
24–30	104	Seed	104	Seed
May				
15–21	104	13.82	104	11.44
June				
12–18	104	17.49	104	17.41
July				
17–23	104	26.24	104	28.60
August				
14–20	104	34.26	104	38.17
September				
11–17	104	38.82	104	42.93

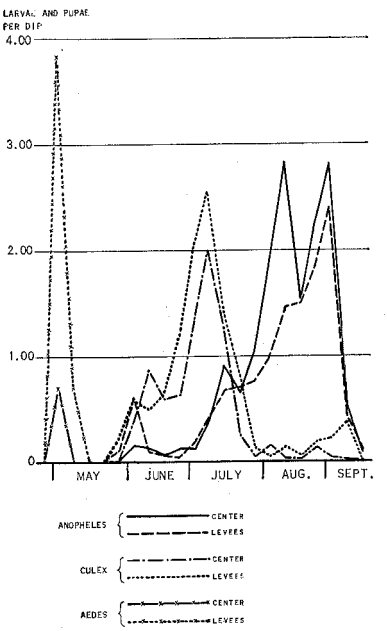
[1] Vegetation principally rice.

[2] Actually the mean of all dipping stations (104A, B and C stations) along the levees.

strong winds which prevailed in the area at this time. Adults reared from numerous larval and pupal collections consisted of *Aedes melanimon* Dyar.[3] This heavy breeding of the *Aedes* phase lasted for only two weeks. No *Aedes* specimens were found in the check during the remainder of the season. The seasonal prevalence of the *Aedes* phase is indicated in Figure 2. There was no vegetation in the check at this time.

FIGURE 2

ANOPHELES, CULEX AND AEDES FROM CENTER AND LEVEES OF RICE EXPERIMENT STATION CHECK APRIL - SEPTEMBER, 1949



The weekly mean number of *Culex* larvae and pupae from the center and levees is indicated in Figure 2. It is apparent that *Culex* mosquitoes were well distributed within the check. *Culex* species reached their peak during the second week of July and then quickly diminished to very small numbers during the remainder of the season. The dominant *Culex*, as determined by reared adults and larval identifications, was *Culex tarsalis* (Coquillett).

In the late summer *Anopheles* species dominated the rice check. The weekly mean number of *Anopheles* larvae and pupae from the center and levees is shown in Figure 2. From their first appearance early in the season *Anopheles* slowly increased in numbers to attain a maximum density during August and early September. The dominant representative of this genus was *Anopheles freeborni* Aitken.

Only two additional species of mosquitoes were found in the rice check during the season. On June 24 and July 6 a few *Culex erythrothorax* Dyar were taken from bridge stations in the check. A few adults of *Anopheles franciscanus* McCracken were reared from collections taken from levee stations on August 1.

DISCUSSION. It is of significance to compare the seasonal incidence of the mosquito larvae in the rice check to the south in the San Joaquin Valley (Stanislaus County), with that in the north in the Sacramento Valley (Butte County). These two similar studies were carried out in 1947 and 1949, respectively, in areas widely separated in California. Rice is grown in California principally in the Sacramento Valley and to a much lesser extent in the San Joaquin Valley.

The *Aedes* phase occurred between April 14–28, 1947, in the rice fields in the San Joaquin Valley, and between April 26–May 9, 1949, in the check in the Sacramento Valley. It is logical to expect that the *Aedes* phase would occur at approximately the same time even in rather widely separated areas, inasmuch as its appearance is closely related to the time of flooding of the rice fields.

There appeared to be only a slight variation in the seasonal prevalence of the *Culex* phase. In the San Joaquin Valley the *C. tarsalis* reached its peak between the last week of June and first week of July; in the Sacramento Valley

[3] Identified at the time as *Aedes dorsalis* (Meigen) in keeping with the then current taxonomic understandings.

check it reached its peak during the second week of July.

There also appears to be only a slight variation with *Anopheles* in the two areas. In San Joaquin Valley rice fields *A. freeborni* reached its peak during the first week of August and second week of September; in the Sacramento Valley it reached its peak between the third week of August and first week of September.

The seasonal incidence of *A. freeborni* in the interior valleys of California has been discussed by Freeborn (1932) who, basing his study on a correlation of adult and larval population, found that in the Sacramento Valley there are six generations a year. Larval collections were made at the same time from aquatic habitats adjacent to the collection points for adults. These habitats consisted of pools of water adjacent to rice field areas. Freeborn showed the seasonal abundance of adults and larvae of *A. freeborni* to increase steadily from May to October, with apparent peaks during the third week of May, fourth week of June, fifth week of July, third week of September, and the first week of October.

In the San Joaquin Valley rice fields we found a steady increase of *A. freeborni* in the checks from May to September, with apparent peaks during the first and fourth week of June, first week of July, first and third week of August, and the second week of September. In the Sacramento Valley it was also observed that there was a steady increase from June to September, with well-defined peaks occurring during the second week of June, the third week of July, the third week of August and finally during the first week of September.

SUMMARY. Observations in a rice field check at the Biggs Rice Station in Butte County, California during the summer of 1949, revealed that:

1. The rice check was productive of considerable numbers of mosquitoes which appeared in three "phases." The *Aedes,* represented by *A. melanimon,* appeared immediately after flooding and then disappeared to be followed by *C. tarsalis* and *A. freeborni.*

2. The *A. melanimon* population reached its maximum during the first week of May, *C. tarsalis* during the second week of July, and *A. freeborni* during late August and the first week of September.

3. In addition to the above species, small numbers of *C. erythrothorax* were taken from the check center during the fourth week of June and first week of July. *A. franciscanus* was taken during the first week of August along the levee.

4. The center of the rice check was found to be as productive of mosquito larvae as were the areas adjacent to the levees. Larvae of the above-mentioned species were found to be well distributed throughout the check, except for the *Aedes* which were found in greater abundance along the levees.

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