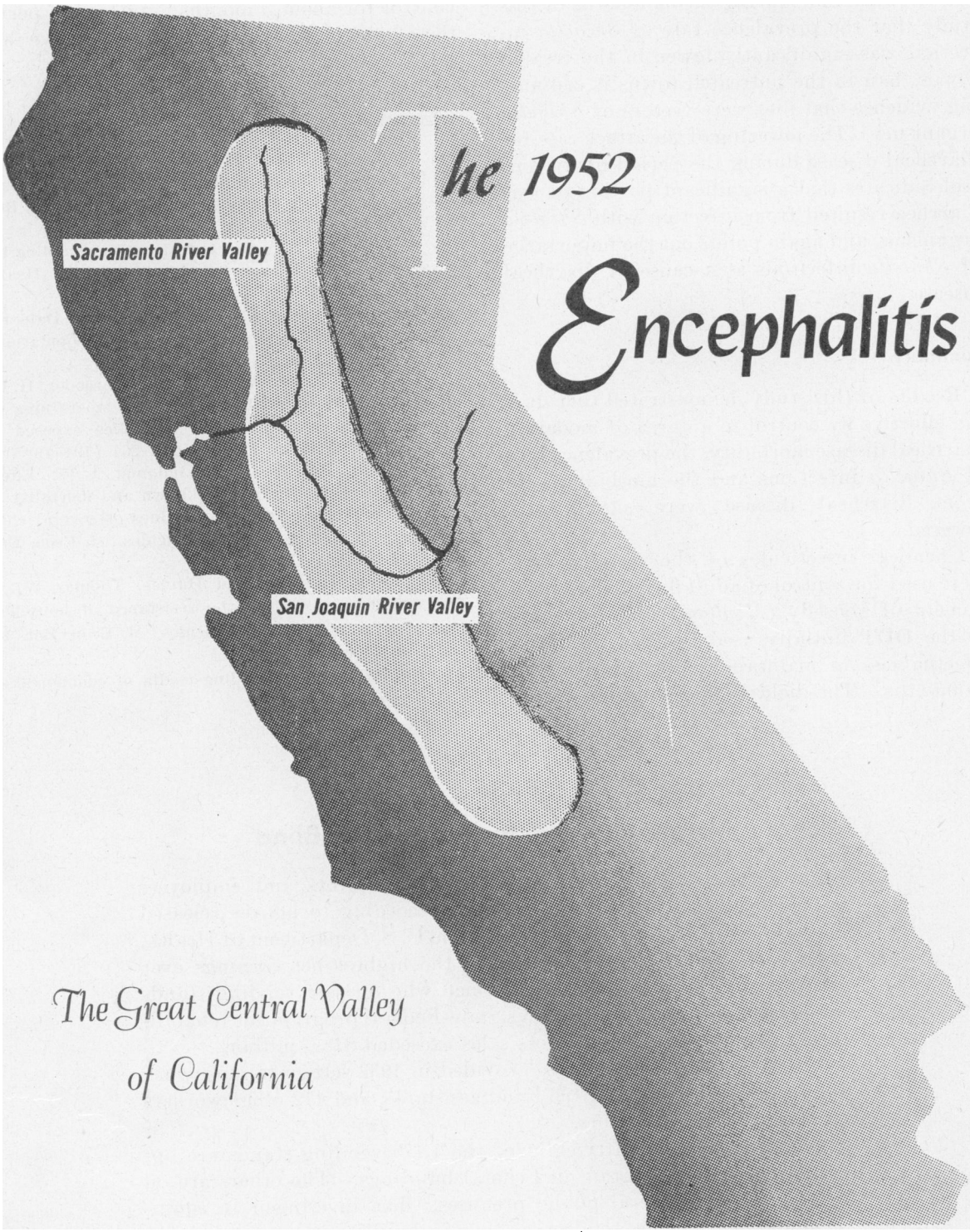

The 1952
Encephalitis
Sacramento River Valley
San Joaquin River Valley
The Great Central Valley
of California

OUTBREAK in California

By WILTON L. HALVERSON, M.D., Dr.P.H., WILLIAM ALLEN LONGSHORE, Jr., M.D., M.P.H., and RICHARD F. PETERS, B.S.

DURING THE PAST summer California experienced the highest incidence of infectious encephalitis thus far recorded in this State. A total of 729 human cases was reported from 37 counties during the June to October encephalitis season. Ninety-four percent (689) of the cases occurred in the 20 Central Valley counties. Over half of the cases were confirmed by laboratory tests. Fifty-one deaths were listed as having resulted from this disease. Four hundred cases of encephalitis in horses were reported during the season.

The present account is concerned primarily with the emergency plan worked out to cope with the 1952 outbreak of infectious encephalitis caused by one or the other of two viral agents, namely, viruses of western equine encephalomyelitis and of St. Louis encephalitis. Special studies were undertaken along with emergency control activities to gain as much additional epidemiological information as possible regarding infectious encephalitis, which is endemic in various parts of the country and which becomes epidemic under conditions which are not well understood.

Dr. Halverson is the director of the California State Department of Public Health. He has recently been to South America as a consultant on public health affairs. Dr. Longshore is assistant chief, bureau of acute communicable diseases, and Mr. Peters is chief of the bureau of vector control of the department. Another member of the staff of the department, Arthur C. Smith, took the photographs used in this article.

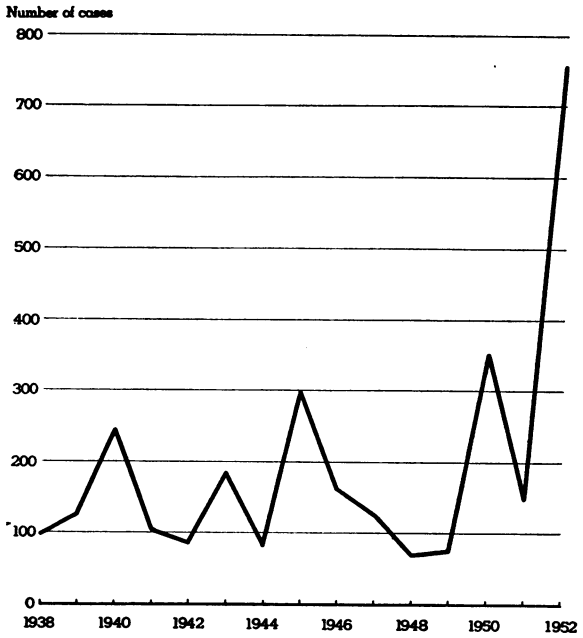
California History, 1938–51

Infection of man with western equine encephalomyelitis virus in California was first suggested by pathological specimens in 1932 but was not confirmed by isolation of the virus until 1938. Prior to that time the virus was considered to produce a disease only in horses. Human infection with the St. Louis virus was first recognized in California in 1939. In the years following the recognition that these agents could cause infection in man, human illness attributable to these viruses in California has been found to be relatively common in the Central Valley areas (see map). Since 1938, certain observations have been recorded concerning the epidemiological and clinical aspects of enceph-

alitis caused by these two specific agents as they have occurred in California.

There has been a wide variation from year to year in the number of cases of infectious encephalitis reported. Incidence of the disease in California was highest in 1945 and 1950, when

Human cases of acute infectious encephalitis reported in California, 1938–52.



320 and 357 human cases, respectively, were reported. The lowest number of cases reported was 71 in 1948. Laboratory studies have been carried out on a good percentage of these cases, particularly since 1945, when the State viral and rickettsial disease laboratory began to perform serologic tests as a routine procedure.

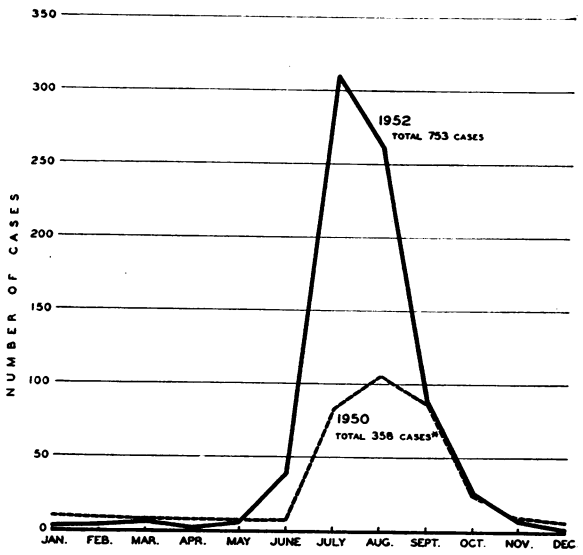
Cases of infectious encephalitis have been reported from 46 of the 58 counties in California. The preponderance of cases, however, has been reported from the Central Valley areas (see map), with the largest number in Kern, Fresno, San Joaquin, and Tulare Counties. Moreover, it is considered significant that the laboratory confirmed human cases of western equine encephalomyelitis and St. Louis encephalitis have been confined almost exclusively to the Central and Imperial Valleys, leaving the coastal areas relatively unaffected.

Laboratory confirmed cases have been reported from only 23 counties of the State, and distribution within the State is limited essentially to the hot, irrigated agricultural sections of the Central and Imperial Valleys. This geographic distribution appears to reflect to some degree the distribution and density pattern of the principal mosquito vector, *Culex tarsalis*. Also, laboratory confirmed cases have occurred only during the months of June through October.

Experience gained over a period of some 12 years, with the seasonal occurrence of endemic arthropod-borne encephalitides in the Central and Imperial Valleys of California, proved valuable in carrying out the emergency encephalitis program in 1952. The following factors also contributed in an important way to the success of the emergency program:

1. The excellent diagnostic facilities provided by the California State Health Department's viral and rickettsial disease laboratory.

Human cases of infectious encephalitis reported in California, by month of onset, 1952 and 1950.



*Total for 1950 includes 6 cases with date of onset not stated.

2. The alertness of the private practicing physician to this particular illness.

3. The awareness of the problem on the part of local health departments.

4. The intensified activity of the mosquito abatement districts.

5. The good working relationships between

the State health department, local health departments, and mosquito abatement districts.

Mosquito-Breeding Factors

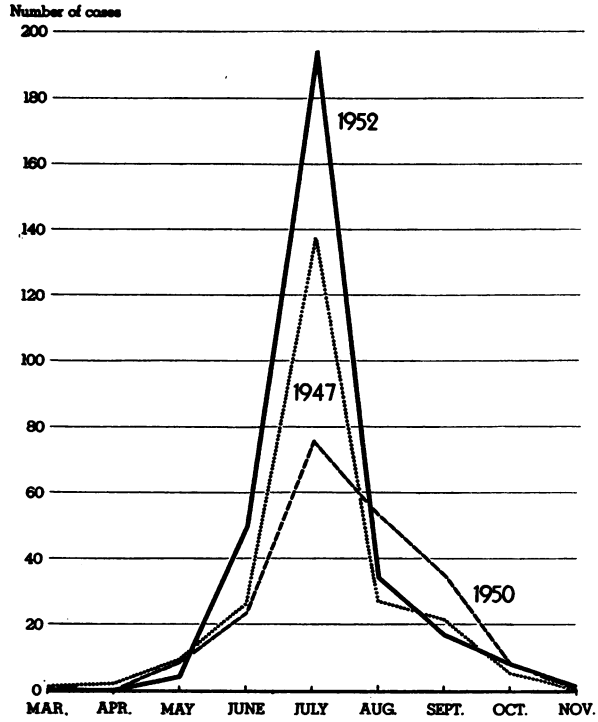
During the winter of 1951–52 one of the heaviest snow packs ever recorded was deposited upon the mountain ranges of California, and rainfall throughout the State was extraordinarily heavy. Winter and springtime average temperatures were relatively moderate, with only a few short periods of critically low temperature to work adversely upon the overwintering mosquito population. These conditions apparently proved optimum for the rapid development and biotic potential of the *C. tarsalis* population during the early spring. Not only was the distribution of this mosquito more general in 1952, but extensive water in the river-bottom lands and various low flooded areas were observed to produce the insect in extraordinary numbers. As is characteristic in California, mosquito population peaks were first reached in the lower San Joaquin Valley and progressed northward through the spring and summer.

Within the 21 mosquito abatement districts comprising the area under organized mosquito control in the Central Valley, intensive control operations were directed against *C. tarsalis*. The breadth of the breeding area, however, exceeded the physical resources available and it was not possible to prevent emergence of a large portion of the adult mosquitoes.

The resistance of *C. tarsalis* to DDT and other chlorinated hydrocarbon insecticides, which had been demonstrated conclusively the previous season, appears to have played a significant part in reducing the effectiveness of chemical control measures used.

Mild spring climatic conditions, aside from greatly favoring the reproduction of *C. tarsalis*, apparently increased its longevity. Moreover, the 1952 flights of this mosquito are believed to have greatly exceeded the range earlier attributed to it. Earlier scientific measurement of the flight pattern of *C. tarsalis* had shown it capable of flights of approximately 2 miles; indications this year were that it flew 5 to 10 miles or more.

Equine encephalomyelitis cases reported in California, by month, 1947, 1950, and 1952.



By June most of the mosquito abatement districts in the San Joaquin Valley had felt the impact of the *C. tarsalis* problem and every emergency measure available was put to work against this mosquito. A further factor of significance was that the production of this mosquito in such large numbers led to its invading homes and biting man in a manner not previously observed. Ordinarily, this mosquito seeks and prefers the blood of either domestic or wild fowl.

By July the important aquatic sources of *C. tarsalis* had largely changed from characteristic natural sources to places incidental to the use of irrigation water in agriculture. This change, and the apparently decreasing adult mosquito populations, gave promise that *C. tarsalis* populations would also subside. In addition, the Central Valley experienced several days of maximum temperatures exceeding 100° F., a condition unfavorable to adult mosquito survival. This provided additional hope that the mosquito population would decrease to a level approaching normal for that time of the year. However, such optimism proved to have been ill-advised.

Beginning of the Outbreak

Since 1943 it had been the practice of the Hooper Foundation of the University of California and the State health department to assign medical personnel to the Kern General Hospital at Bakersfield, during the summer months, to observe all cases admitted to the communicable disease ward. Histories and adequate diagnostic specimens, with thought for the encephalitides, were taken routinely. When a visit was made to the Kern County area in early July for the purpose of placing a student, an unusual increase in the number of encephalitis cases was noted. Some 25 suspect admissions to the Kern General Hospital during June had been recorded.

As July progressed, an increased number of cases of encephalitis was noted from the lower San Joaquin Valley area, where the disease ordinarily makes its first appearance, and two human cases were reported by the health officer of Madera County. Also, the virus laboratory was beginning to receive increased numbers of diagnostic specimens from patients suspected of having encephalitis.

Initial State Planning

In view of these developments, a meeting was held on July 14, 1952, in the office of the director of public health to review the situation with the mosquito abatement officials and the advisory committee of the bureau of vector control. Following this conference a press release was issued stating that a potential epidemic of encephalitis was at hand. A previous telephone conference had been held with the 20 health officers of the endemic areas explaining the plan of action and pointing out that a news release was to be made. Advance copies of the State release were sent to the local health officers so that simultaneous statements could be made in the local press. A second meeting with the vector control advisory committee was held on July 28, 1952, to which all of the health officers of the counties in the endemic areas of the State were invited.

Out of this and a later series of meetings came plans for an intensified program directed specifically toward the suppression of the *C. tarsalis*. This program, "Operation *Culex tarsalis*," was created to augment resources of the 21 existing mosquito abatement districts in the Central Valley and to assist local areas outside these districts in planning emergency control operations.

Administrative Problems

Upon declaration of the emergency, the director of the State department of public health designated the chief of the division of environmental sanitation to coordinate the overall program. The bureau of acute communicable diseases was assigned full responsibility for conducting the epidemiology, and the bureau of vector control was likewise charged with accomplishing the necessary mosquito control. The division of administration provided direct assistance in facilitating the procurement and delivery of needed equipment, materials, and supplies. The viral and rickettsial disease laboratory organized its facilities to perform all the necessary laboratory functions.

At the same time epidemiological followup of cases of encephalitis occurring in the Valley areas was intensified. All indications pointed to the likelihood that the number of cases would increase. It was forecast at that time that there would be between 500 and 700 cases for the disease year. Close followup was thought to be desirable to obtain complete epidemiological data on all cases of central nervous system disease with fever admitted to the hospitals in the 20 counties involved. It was thus necessary to arrange for increased activity on the part of the virus laboratory to process the additional specimens which would be secured through the intensified diagnostic effort.

State and Federal Aid

As State and local agencies moved into action, the Governor, on August 1, 1952, made $250,000 in emergency State funds available. This grant of funds enabled the State health department to provide the financial assistance necessary to marshal materials and manpower for the intensified operation. Many of the Central Valley counties also made funds available for the control program.

At the request of the State director of public

health, the Federal Public Health Service dispatched to California, from stations in various parts of the country, 22 technical personnel from its epidemic intelligence service and other branches to aid both the mosquito control work and epidemiological investigations.

Knowing that professional and technical assistance was forthcoming, the emergency program was planned so that the project would operate in two major fields: a field epidemiological program under the guidance and supervision of the bureau of acute communicable diseases, and an emergency mosquito control program to be carried out under the guidance and supervision of the bureau of vector control.

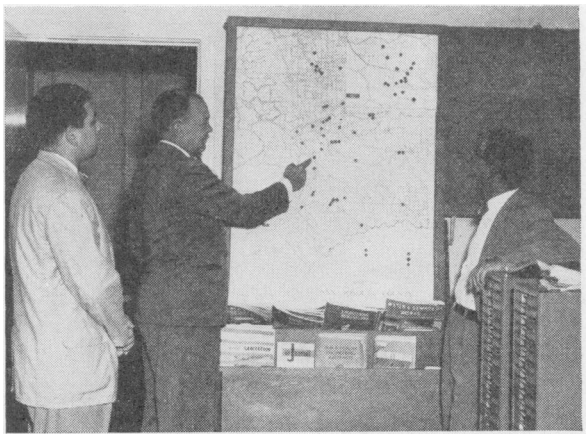
Epidemiology Program

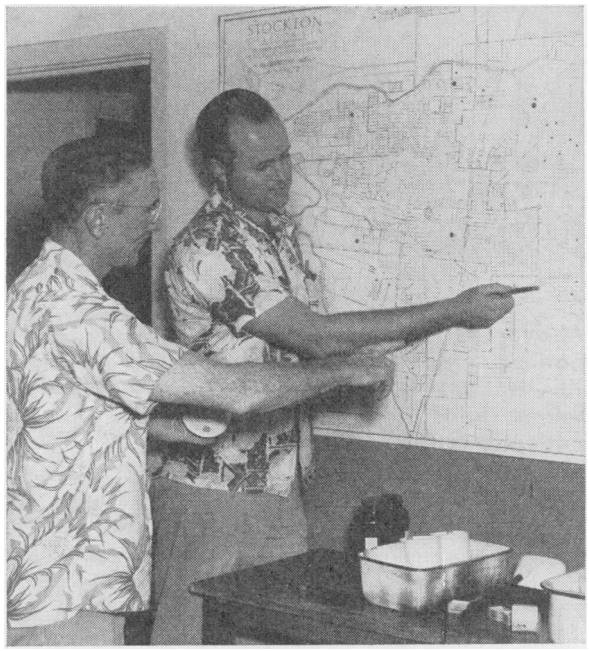
The emergency epidemiological planning embraced two areas: central office activities, which included the modification of reporting procedures and the issuing of laboratory diagnostic notifications, and emergency field epidemiology, which made use of the services of personnel from the Federal Public Health Service.

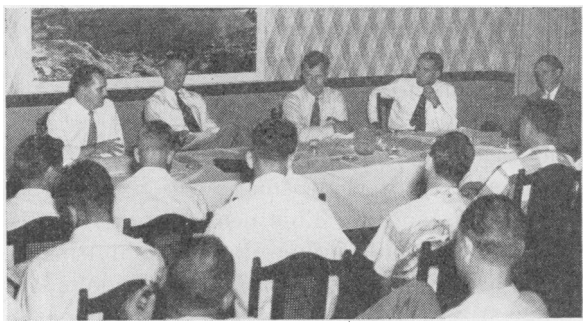
The virus laboratory reported to the bureau of acute communicable diseases the results of blood tests and the receipt of first bloods (the first blood specimen of paired series required for diagnosis) submitted for diagnostic encephalitis studies. This information, together with the information obtained in the routine processing of morbidity cards sent in by local health departments, was used to alert the field teams to possible diagnostic cases so that master lists of suspected cases could be prepared for the field personnel.

The field epidemiology program was set up on the basis of four zones, covering the endemic areas of the State. The epidemiology teams—2 physicians and 1 veterinarian—had headquarters in the cities of Sacramento, Stockton, Fresno, and Bakersfield. Each operated through the local health departments and their respective county hospitals, which receive the majority of cases. The epidemiology teams also covered the counties adjacent to headquarters. The zones and their headquarters were:

Zone 1. Headquarters at Sacramento—included the counties of Sutter, Yuba, Yolo, Placer, Sacramento, and Butte.

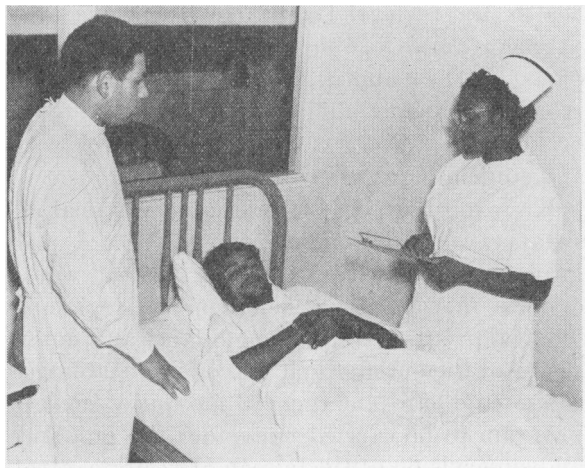


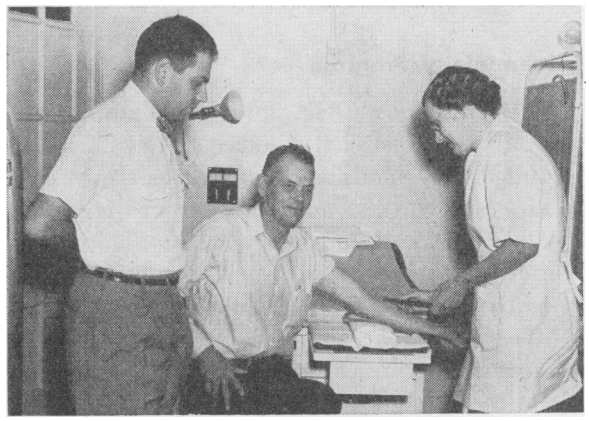




PLANNING AND ADMINISTRATION

Top: Discussing distribution of encephalitis cases with the San Joaquin County health officer. Center: Planning residual spray program in Stockton. Bottom: Emergency encephalitis control staff meets at Fresno.





EPIDEMIOLOGY

Above: An interview with the family of a patient. Top right: Interviewing an encephalitis patient in the Stockton County Hospital. Lower right: Taking a blood sample from a patient's father.

Zone 2. Headquarters at Stockton—included the counties of San Joaquin, Stanislaus, and Merced.

Zone 3. Headquarters at Fresno—included the counties of Madera, Fresno, Kings, and Tulare.

Zone 4. Headquarters at Bakersfield—included the county of Kern.

The personnel from the Public Health Service's Communicable Disease Center, augmented by members of the State staff, were detailed to the zones. Two physicians were assigned to each zone and a veterinarian to each two zones. The majority of these emergency assignments were for 1 month. This necessitated replacements from time to time due to commitments of the assignees to return to their previous stations. While these replacements could not be avoided, the lack of continuity in the conduct of the epidemiological work was marked, and there was continuing need for orientation of new assignees.

The objective of the field epidemiological studies was to obtain laboratory confirmation of cases of encephalitis and to secure as early and completely as possible the detailed epidemiological information concerning the disease in both humans and horses. The epidemiology teams were so placed that they would be able to undertake studies immediately upon receipt in the field of reports of suspected cases. Briefly, the field operations included these three elements:

Human Cases. In the four epidemiology zones, all known central nervous system encephalitis cases with fever were followed closely. Attempt was made to collect blood from these individuals in the acute and in the convalescent stages of the disease and to obtain complete epidemiological data. Autopsy specimens were secured on fatal cases whenever possible. The great majority of the blood specimens were taken by the hospital staffs, but collection of blood from discharged convalescent patients was the responsibility of the epidemiology teams. Specimens were tested in

the State laboratory by complement fixation or animal neutralization.

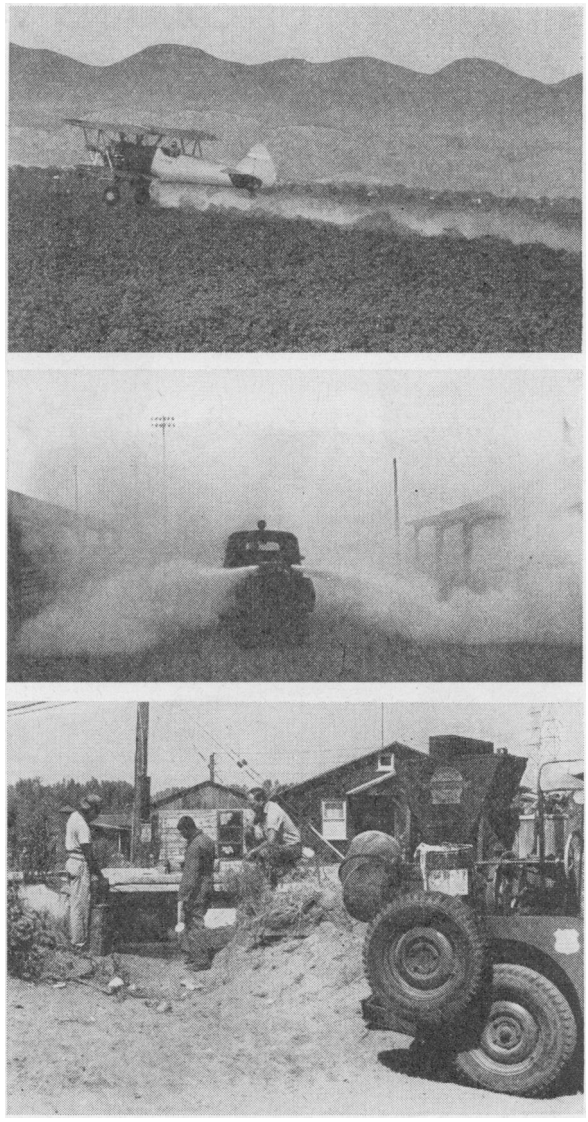
Two auxiliary studies were undertaken in special areas. In zones 1 and 2 an associate survey was attempted in which all household associates of known cases were bled once to determine their immunity status. The second special program, carried out in the Fresno County and Stanislaus County Hospitals, included a serologic survey of all febrile hospital admissions, in an attempt to broaden the clinical basis for the diagnosis of encephalitis. When possible, blood specimens were taken both during the acute and convalescent stages of the disease on all febrile admissions to the hospital, regardless of admission diagnosis.

Horse Cases. The State department of agriculture furnished reports on all known cases in horses. Veterinarians on the epidemiology teams collected and submitted to the virus laboratory as many paired bloods as could be obtained from clinical cases in horses and, when possible, secured post-mortem brain specimens for virus recovery and identification.

Special Studies in Outlying Areas. Epidemiological studies were made in selected areas outside of the Central Valley where cases in humans or a large number of cases in horses had been reported. The studies were particularly concerned with the fringe areas outside of the valley counties in order to determine the geographic distribution of the disease. Verification of *C. tarsalis* prevalence was sought and, when possible, mosquito pools were collected for virus recovery studies. These special studies were performed by teams of physicians, veterinarians, and entomologists operating from headquarters on special assignment.

Mosquito Control Program

With *C. tarsalis* mosquitoes already numerous, practical decisions had to be made with respect to control measures which would reduce the hazard to the majority of the residents of the valley. This logically resulted in a plan which gave priority consideration to towns and cities and adjacent suburban areas. Any effort to cover the entire valley would have diluted the control resources to such an extent that the prospect for accomplishment would have been generally negated.

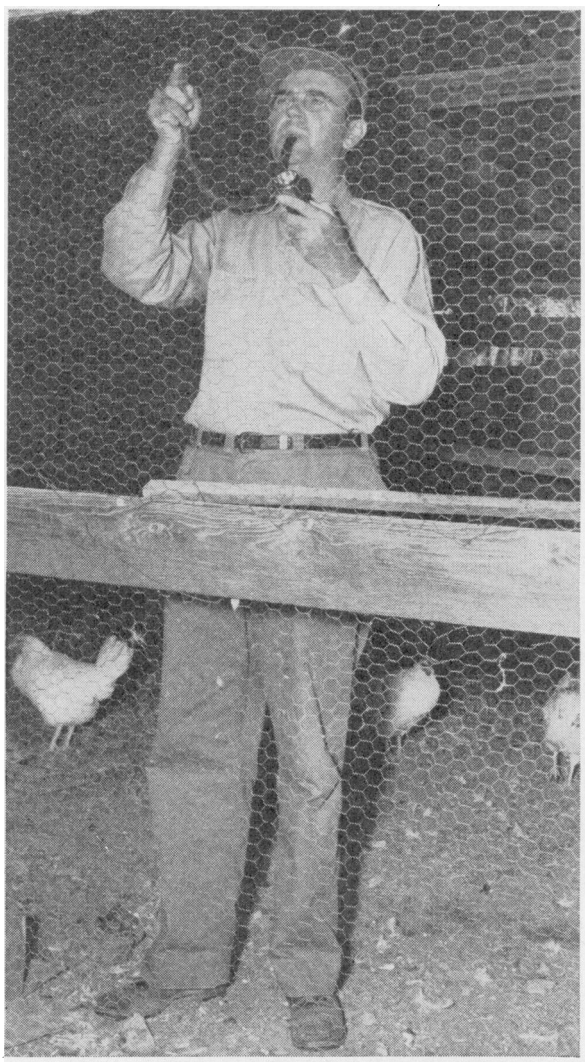


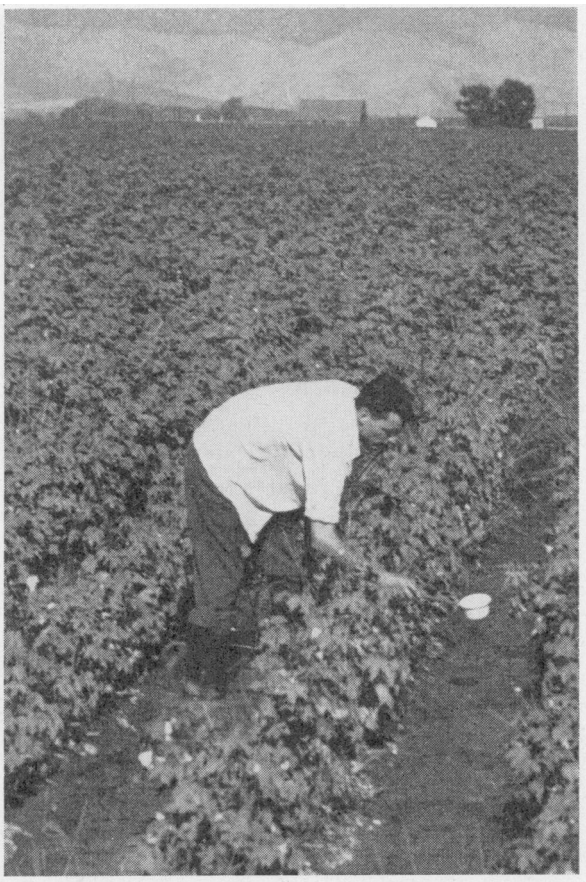
VECTOR CONTROL OPERATIONS

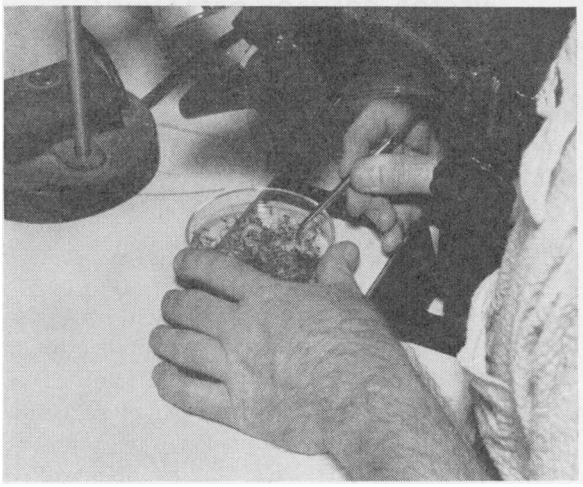
Top: Spraying a cotton field for *Culex tarsalis* larvae near Porterville. Center: Laying down an aerosol fog at a fairgrounds near Colusa. Bottom: Larvaciding at home of an encephalitis patient near Stockton.

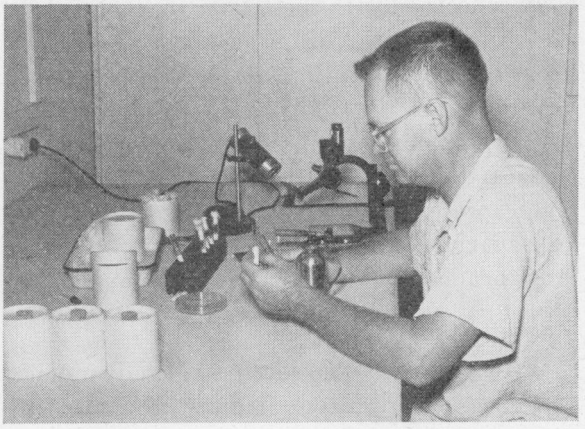
Since the 21 mosquito abatement districts in the valley had been conducting expanded activities against *C. tarsalis* for a month or more, their principal need was for additional funds with which to expand and further intensify their emergency activities. The uncontrolled

ENTOMOLOGICAL AND VIRUS RECOVERY OPERATIONS









Top left: Collecting *Culex tarsalis* adults in chicken shed at Willows. Top right: Dipping for mosquito larvae in a cotton field at Porterville. Lower left: Sorting mosquitoes. Lower right: Sealing in tubes for shipment to the Virus and Rickettsial Disease Laboratory.

portion of the valley, however, required a complete plan to develop local participation and to provide technical personnel who could direct operations and get control work under way immediately. The same general plan of controlling mosquitoes was recommended for both the mosquito abatement districts and the uncontrolled territory. This consisted of methods designed to reduce an existing adult mosquito population and, if possible, to maintain it at a low level for the period of the emergency.

Essentially, the mosquito control program had three parts: (*a*) space (aerosol) spraying at frequent intervals; (*b*) barrier spraying of a quarter mile band on the periphery of each city and town; and (*c*) intensive larviciding or correction of mosquito sources within cities and towns and outward to a radius of 2 miles.

Control teams were organized combining Communicable Disease Center personnel with members of the staff of the bureau of vector control. Six such teams were established and dispatched to the six major uncontrolled areas of the Sacramento and San Joaquin Valleys, which include all or parts of Tehama, Glenn, Colusa, Placer, San Joaquin, Fresno, Tulare, and Kings Counties. Each team consisted of an engineer, an entomologist, and at least one vector control officer.

Since State funds were largely consumed in the purchase of spray equipment and insecticides, the teams were obliged to stimulate local participation in each individual mosquito control effort. Wherever local health departments were available they were used as the nucleus for conducting and encouraging the mosquito control operations. In some localities the office of the agricultural commissioner served this function in lieu of the health department. As a whole, the response by local officials to the emergency was very good. Local funds were made available in many localities to employ operators. In some cases local workers were loaned to the cause. Each team was provided 1 aerosol machine, 8 exhaust aerosol generators for installation on local vehicles, and 33 cylindrical-type hand sprayers, plus all of the spray equipment which could be recruited in each zone. DDT and diesel oil were provided wherever needed. Airspray operations were conducted in certain areas where this method of operation was indicated.

The bureau of sanitary engineering assisted by inspecting and obtaining rapid treatment or correction of mosquito sources associated with community sewage disposal lands. The bureau of health education provided two health educators to assist the local health departments and other agencies participating in the emergency program and otherwise to facilitate the securing of local support and participation. A leaflet, "Kill Mosquitoes, Protect Your Family From Encephalitis," which contained helpful suggestions to the individual householder, was distributed liberally by local health departments and mosquito abatement districts throughout the Central Valley.

Entomologists, in addition to sampling mosquito prevalence and guiding control operations, collected and submitted over 1,100 pools of mosquitoes to the viral and rickettsial disease laboratory for virus recovery studies.

A Note in Summary

This brief account outlines the organization and plan used in conducting the emergency epidemiology and mosquito control programs in California during the summer of 1952. As is characteristic of any emergency, administrative problems were encountered in the course of this antiencephalitis effort. There was, for example, the lack of a previously conceived specific plan, the problem of how to utilize most effectively the personnel unfamiliar with California conditions, the matter of forced rotation of personnel, communications, fiscal arrangements for participating personnel, and procurement lag. These problems will be covered in detail in a later report.

At this writing it is premature to attempt to evaluate the epidemiology of the outbreak or to comment on the effect of the mosquito control effort in arresting or altering the course of events. Upon completion of the analysis of the multitudinous data collected on both aspects of the subject, such conclusions will be duly reported.