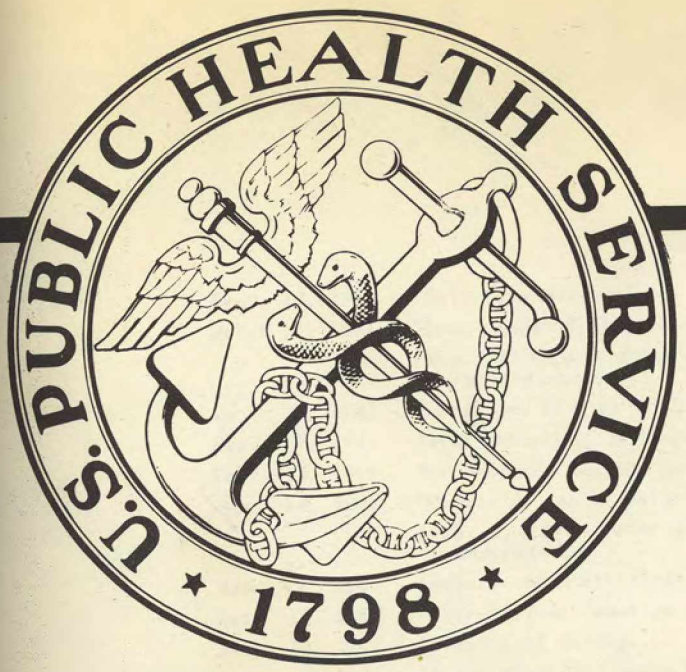
MALARIA CONTROL IN WAR AREAS



FEDERAL SECURITY AGENCY
U.S. PUBLIC HEALTH SERVICE

Courtesy of the David J. Sencer CDC Museum



MALARIA CONTROL IN WAR AREAS 1945-46

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
ATLANTA, GEORGIA

Courtesy of the David J. Sencer CDC Museum

6-17-1187. BU-COS-WP

Sept. 16, 1940 - "Selective Service" Act passed....

March 11, 1941 - "Lend-Lease" Bill passed by Congress....

(May 1941 - USPHS Mosquito Control in Defense Areas organized.)

May 22, 1941 - German and Italian consulates closed....

Dec. 7, 1941 - Japan attacks U. S. at Pearl Harbor....

Dec. 11, 1941 - War declared against Germany and Italy....

Jan. 14, 1942 - "Battle of the Atlantic" begun...,

(Feb. 9, 1942 - Malaria Control in War Areas inaugurated.)

Nov. 8, 1942 - Invasion of North Africa....

May 12, 1943 - North African campaign concluded....

July 10, 1943 - Invasion of Sicily....

Sept. 8, 1943 - Italy surrenders unconditionally....

June 6, 1944 - Invasion of Normandy....

Jan. 7, 1945 - Invasion of the Philippines....

(Feb. 1945 - Extended Malaria Control operations begun.)

May 6, 1945 - Germany surrenders unconditionally....

(July 1, 1945 - Typhus Control dusting begun.)

Aug. 6, 1945 - Atomic bomb dropped on Hiroshima....

Aug. 8, 1945 - Atomic bomb dropped on Nagasaki....

Aug. 10, 1945 - Japan sues for peace....

(Aug. 28, 1945 - War Area Program ordered curtailed.)

Sept. 2, 1945 - Japan surrenders unconditionally....

(July 1, 1946 - MCWA terminated. Communicable Disease Center inaugurated.)

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APPENDIX. ix

Material in this report is not for publication.

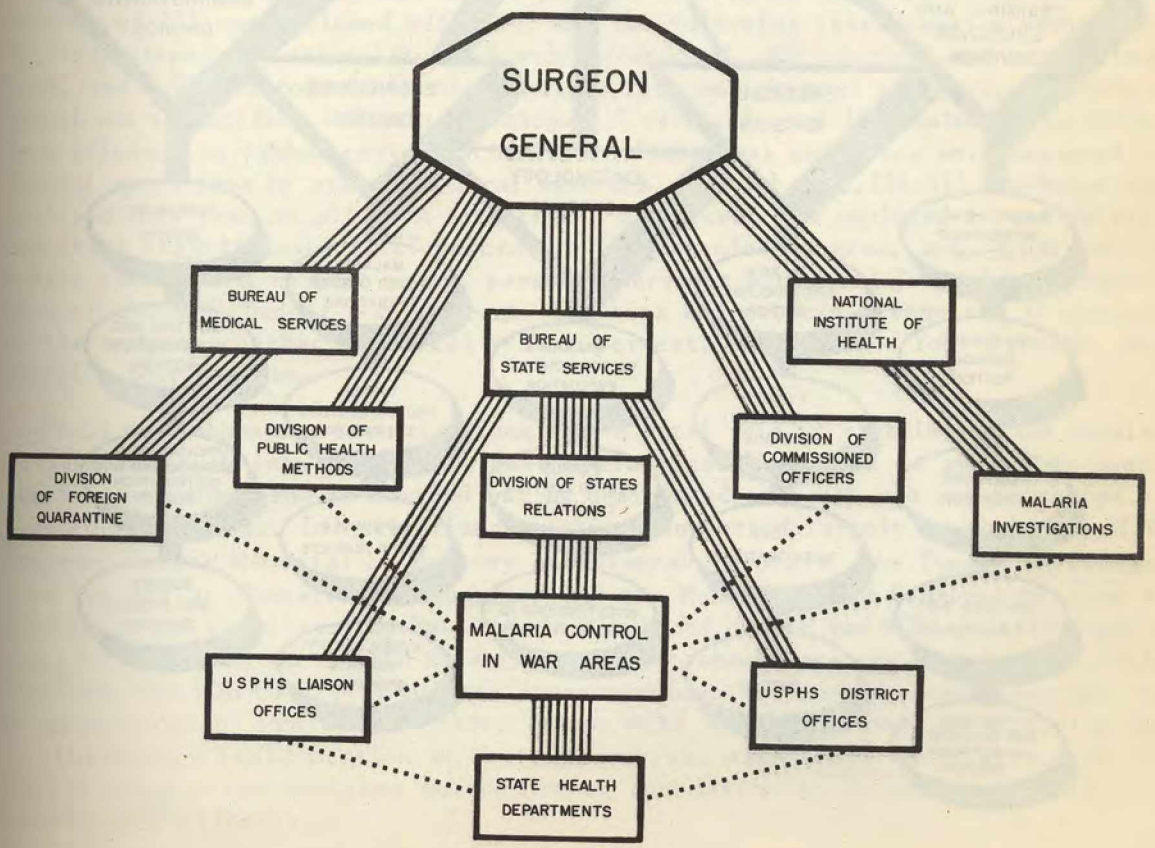
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MALARIA CONTROL IN WAR AREAS

ORGANIZATION

Malaria Control in War Areas is an office of the States Relations Division, with lines of authority stemming from the Surgeon General through the Bureau of States Services. Functional interrelations exist with other USPHS divisions such as Foreign Quarantine, Public Health Methods, Sanitary Engineering, Commissioned Officers, and the National Institute of Health. Liaison is maintained with military authorities in the various service commands of the Army and districts of the Navy through USPHS liaison officers, and with state and territorial health departments through USPHS district offices.

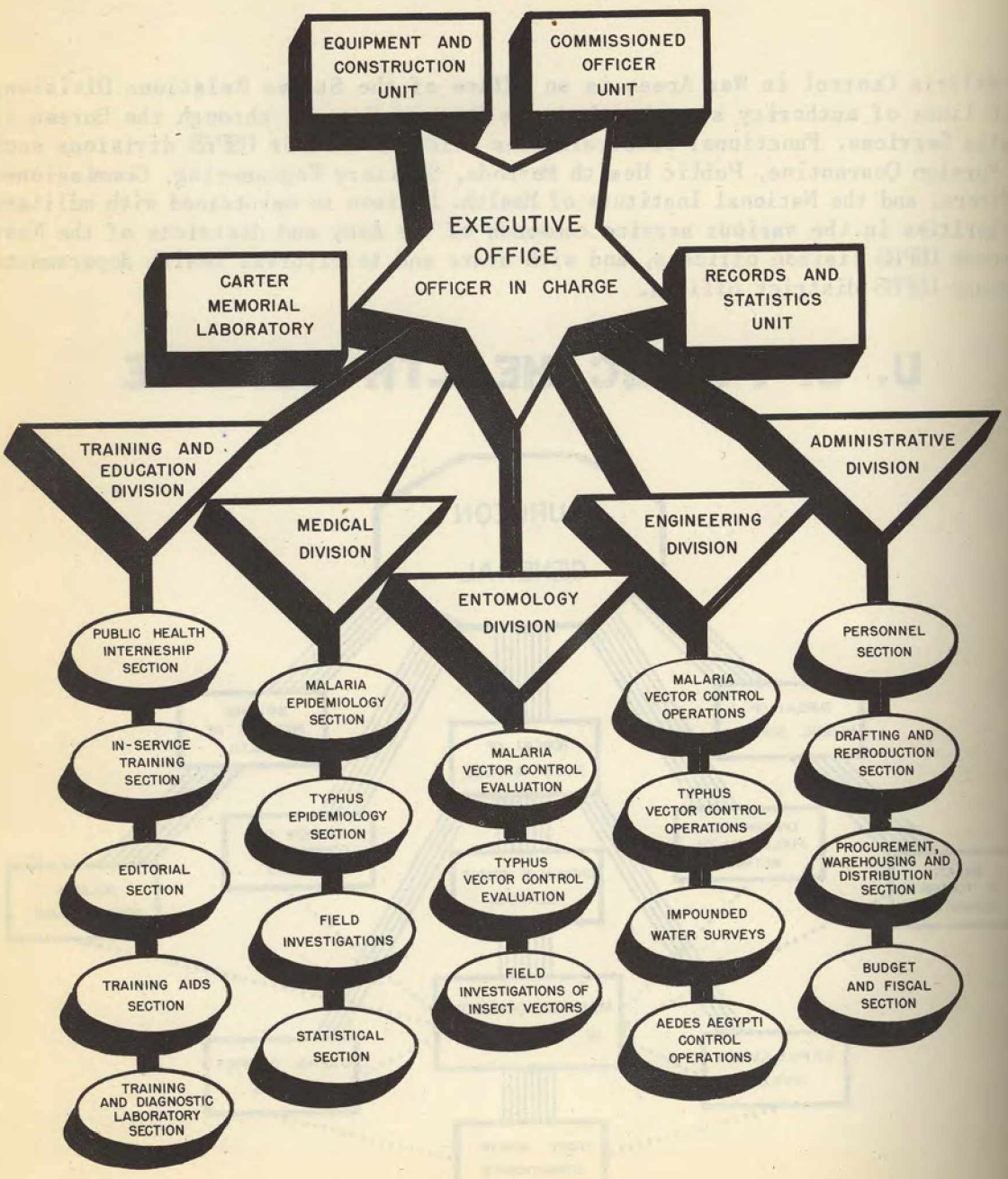
U. S. PUBLIC HEALTH SERVICE



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MALARIA CONTROL IN WAR AREAS

ORGANIZATION



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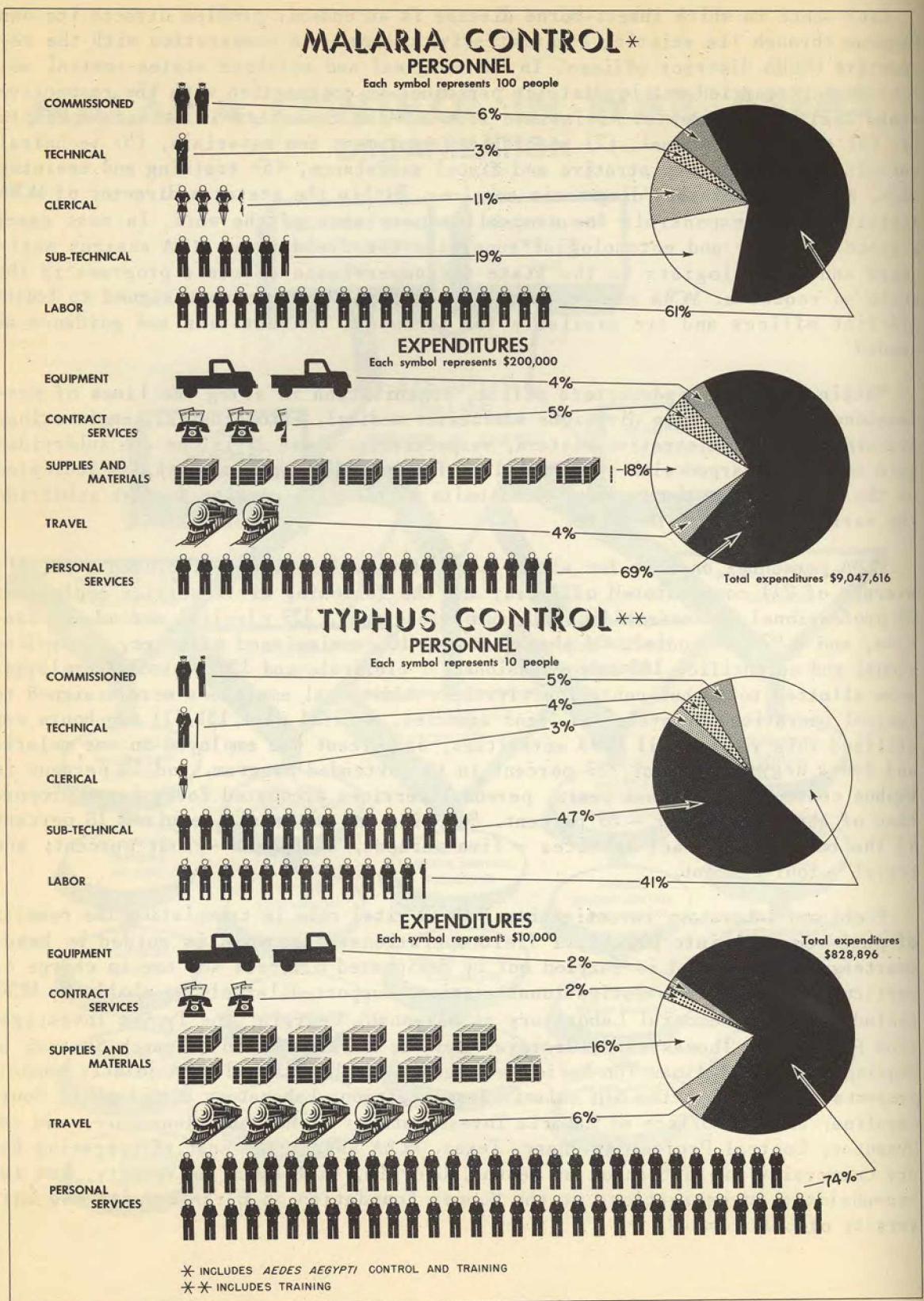
Each state in which insect-borne disease is an endemic problem directs its own program through its existing administrative channels in cooperation with the respective USPHS district offices. In the marginal and northern states control activities are carried out by district personnel in cooperation with the respective state health departments. Assistance from MCWA headquarters in Atlanta consists of: (1) trained personnel, (2) specialized equipment and materials, (3) technical consultation, (4) administrative and fiscal assistance, (5) training and training aids, and (6) laboratory diagnostic services. Within the states a director of MCWA activities is responsible for over-all supervision of the work. In most cases a state engineer and entomologist supervise the field work; MCWA assigns engineers and entomologists to the state for supervision of state programs if the state so requests. MCWA engineers and entomologists are also assigned to USPHS district offices and are available for technical consultation and guidance as needed.

Within the MCWA headquarters office, organization is along the lines of professional services. Five divisions administer medical, entomological, engineering, training, and administrative matters, respectively. These divisions are subdivided into sections charged with responsibility for specific types of work, as indicated on the accompanying chart. Functional units within each section further subdivide the various phases of the work.

MCWA personnel on duty for all or part of this fiscal year included a monthly average of 211 commissioned officers, and the following civil service employees: 89 professional and scientific, 708 subprofessional, 339 clerical and administrative, and 1,976 custodial. Of these totals, 16 commissioned officers, 12 professional and scientific, 142 subprofessional, 7 clerical, and 123 custodial employees were allotted to typhus control activities. Additional employees were assigned to control operations by state and local agencies. A total of 4,131,511 man-hours was utilized this year on all MCWA activities; 55 percent was employed in war malaria and *Aedes aegypti* control, 27 percent in the extended program, and 18 percent in typhus control. As in past years, personal services accounted for a large proportion of the MCWA budget — 69 percent. Supplies and materials required 18 percent of the budget; contract services — five percent; equipment — four percent; and travel — four percent.

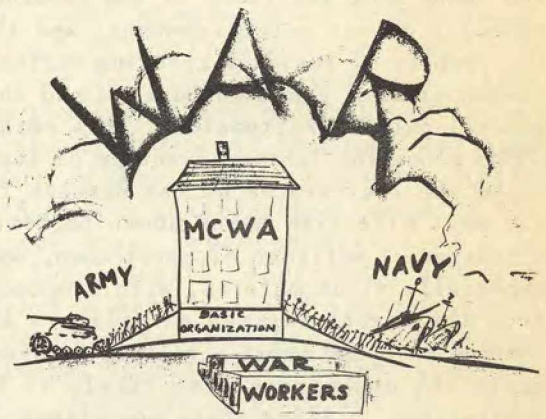
Field and laboratory investigations play a vital role in translating the results of pure research into practical field operations. This work is guided by headquarters personnel and is carried out by designated officers who are in charge of particular projects. Investigational stations supported largely or wholly by MCWA include: Carter Memorial Laboratory at Savannah, Georgia; the Typhus Investigation Project at Thomasville, Georgia; and the Malaria Field Research Station at Manning, South Carolina. The National Institute of Health and MCWA jointly support projects conducted at the NIH Malaria Investigations Laboratory at Columbia, South Carolina; the NIH Office of Malaria Investigations at Memphis, Tennessee; and the Dysentary Control Project at Pharr, Texas. MCWA shares the cost of operating Emory University Field Station at Newton, Georgia, with Emory University, and the encephalitis investigations at the Hooper Foundation in Berkeley with the University of California.

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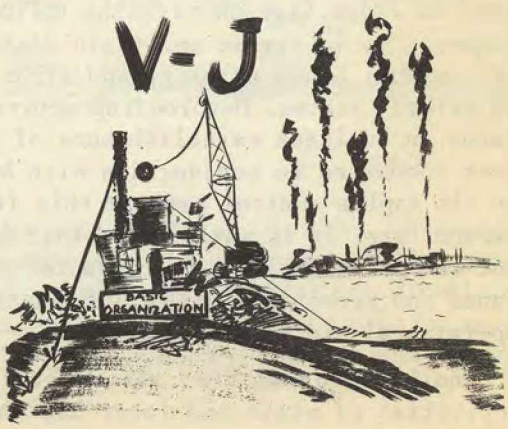
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an END and a BEGINNING



During 1945 the war malaria and extended malaria control programs operated concomitently for the protection of the military and civilian populations respectively. Although the war in Europe had ended approximately two months before the start of this fiscal year, World War II appeared to be far from over. The foe in the Pacific was firmly entrenched in far-flung positions and was prepared to wage what he termed a "Hundred Years War." When this fiscal year began, official policy did not contemplate any significant changes in the Malaria Control in War Areas program. Hospitals were receiving increasing numbers of casualties, including tropical disease cases; prisoner of war camps were filled, training camps and other military installations were still operating at maximum capacity, and thousands of troops from malarious areas were being shuttled through this country on their way to Pacific theaters.

AN END. Suddenly the war was ended by the birth-pangs of the "atomic age." The Japanese sued for peace on August 10, 1945. On August 28, MCWA Headquarters issued Field Memorandum No. 59, entitled "Curtailment of War Establishment Malaria Control Operations." This memorandum stated that the appropriation for war malaria control had been reduced approximately 50 percent for the remainder of fiscal year 1946 as a result of post "V-J Day" review. During the calendar 1946 malaria season, war establishment anti-malaria protection was to be confined to separation and debarkation centers, permanent posts and large camps containing substantial numbers of troops, military hospitals and associated rehabilitation and recuperation centers, and active arsenals and service of supply depots containing large numbers of troops. Establishments dropped from the MCWA program included prisoner of war main and branch camps, civilian housing areas, war industries, recreational areas, access roads, arsenals, ordnance works, navy yards, and service of supply depots not containing large numbers of troops, and most tem-



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porary camps, posts, and airfields. No reduction was made or anticipated in extended malaria control. In fact, emphasis was placed on the necessity for prompt termination of as many war malaria zones as possible by the end of October, since the financing of residual spray operations through the end of the fiscal year was contingent upon major reduction in war malaria activities. Personnel employed in the war malaria program were to be released to the extended malaria and typhus control programs.

The extended malaria control program expanded greatly in 1946 as a result of the funds made available by the termination of anti-malarial protection around the majority of war establishments, and the increased amount of local participation. The results of residual spraying during the beginning of the 1945 mosquito-breeding season aroused great enthusiasm and the desire for cooperation on the part of the general public. Fortunately, this enthusiasm for residual spraying coincided with USPHS plans for taking advantage of the lowest level of malaria in history to eradicate the last traces of the disease from this country. DDT residual spraying was the most effective means known to control the potential hazard introduced by the discharge of millions of servicemen, some of whom had subclinical cases of malaria, especially *vivax* malaria, with symptoms suppressed by atabrine treatment. Release from the strict regimen of military life coupled with a change of climate could combine to bring about a relapse or even a primary attack which had remained latent. Since the mosquitoes most likely to become infective were those found in human habitations, killing these mosquitoes would break the chain of transmission at its most vulnerable point.

The organizational setup for extended malaria control was ideally suited for the control of endemic typhus fever, which was recognized as an increasing health problem in southern and southeastern United States. In the past, in those states in which typhus was a problem, ratproofing and rat poisoning programs were operated with state and local funds under state and local ordinances; USPHS participation was limited to the operation of a Typhus Control Unit, primarily for demonstrating ratproofing methods to local municipalities. On July 1, 1945 typhus control activities of the USPHS were transferred to MCWA and federal funds were made available to the states for a program of DDT dusting for the control of rat ectoparasites, which were implicated in the transfer of the typhus fever rickettsiae from rats to man. The various state activities were integrated into an over-all MCWA Typhus Control Program, with operations conducted under state health department jurisdiction in close liaison with the USPHS. MCWA personnel were loaned to states, upon request, to supervise and train state and local personnel on the job. Supervision of residual house spraying and typhus dusting activities was effectively combined in several states. Ratproofing activities continued with state and local funds and labor in business establishments of cities and towns, and rat poisoning campaigns were conducted in conjunction with both dusting and proofing. Local participation in the typhus control program this fiscal year amounted to 62 percent of the total expenditure. It is anticipated that eventually typhus control dusting, ratproofing, and rat poisoning will be conducted entirely with state and local health department funds and personnel, with USPHS participation limited to consultative services and operational aid in emergencies.

Another program that was effectively integrated into the general sanitation activities of state and local health departments in several states this year was

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Aedes aegypti mosquito inspection and control. This combining of inspection work resulted in a more complete public health program with a minimum number of field personnel and a large savings in cost. MCWA participation in *aegypti* control has been decreasing each year, aiming at the eventuality of complete state and local health department operation of the respective state programs.

The returning overseas veterans were potential carriers not only of malaria but also of numerous other tropical infections, many of which were unknown in all or certain parts of this country. Since physicians and local health department technicians were the first line of defense against the introduction of these foreign diseases, and since millions of servicemen were being discharged and returned to their homes in every part of this country, the program of training physicians and medical technicians in the diagnosis of tropical and parasitic diseases and in public health methods was considerably expanded this fiscal year. Representatives of state and local health departments and other agencies were offered instruction in effective control practices against malaria, typhus, yellow fever, dengue, etc., including instruction in the laboratory diagnosis of parasitic infections. Special seminars and courses were offered to malaria control consultants, typhus control personnel, members of the War Department Corps of Engineers concerned with malaria control on impounded water, and to trainees from foreign countries. The production and distribution of audio-visual training aids were increased to keep pace with the expanding training program. Special investigations of operational significance were carried on in association with other governmental agencies, various universities, and state health departments. Research subjects included studies of foreign malarias, epidemiological and entomological evaluation of DDT residual sprays, the design and testing of spray equipment, the durability of DDT residuum under various conditions, evaluation of DDT as a larvicide, anopheline host-preference studies, DDT dusting in relation to human typhus prevalence, the significance of flies in the transmission of diarrheal diseases, and encephalitis investigations.

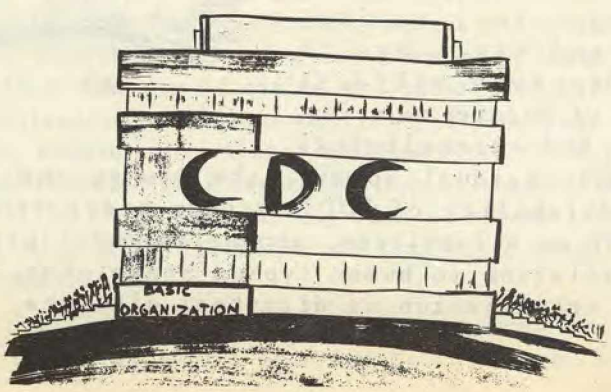




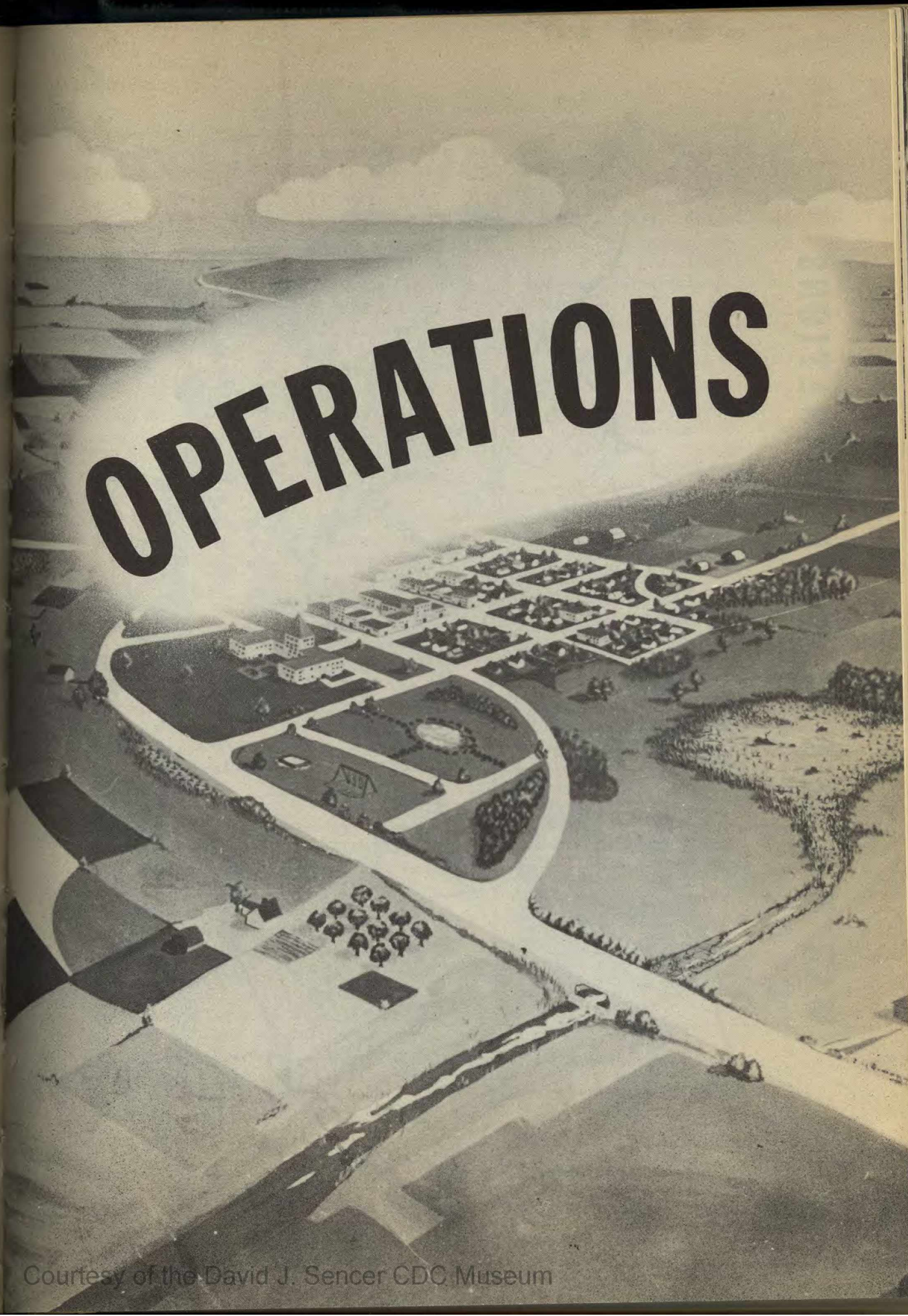
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A BEGINNING. By the very nature of its original purpose and plan of operation, MCWA was destined to pass into oblivion at the conclusion of the war. The extra-cantonment program of malaria control was rapidly liquidated with the inactivation of the great majority of military establishments in 1945 and 1946, and the rapid demobilization of the armed forces. However, during the more than four years of its existence, it became increasingly apparent that MCWA programs fulfilled a public health need that went far beyond the war emergency. Experience had shown the wisdom of coordinated attack upon such problems as insect-borne diseases with a single, coordinated unit specially trained and equipped to deal effectively with such public health problems. No such agency had existed before the institution of MCWA, and it appeared to be a progressive step to maintain the basic organization of physicians, engineers, and biologists, skilled and experienced in the control of insect- and rodent-borne disease, which could: (1) combat certain endemic diseases, notably murine typhus, sylvatic plague, and insect-borne virus infections which are progressively infiltrating and entrenching themselves in new sections of the United States; (2) prevent the establishment of exotic infections in this country by returning veterans and constantly increasing global air traffic; and (3) serve as a safeguard against the recurrence of that unfortunate state of affairs which prevailed in 1942 when this nation could not find enough competent malaria control teams to service the Army and Navy overseas and at the same time protect the health of its civilian and military personnel at home. It was therefore logical that, with the termination of the Malaria Control in War Areas program, the highly developed basic organization and skills should be utilized for public benefit by some permanent unit of the U. S. Public Health Service. Such a step was to be taken on July 1, 1946 with the inauguration of the Communicable Disease Center.

The Communicable Disease Center would continue certain training and research functions of the present MCWA and, in addition, deal with special phases of communicable disease prevention not heretofore provided as a federal service. This would include field investigation and control of diseases of protozoan and helminthic origin, such as malaria, amoebiasis, schistosomiasis, ancylostomiasis, and filariasis, and also certain bacterial or virus infections transmitted by insects, such as yellow fever, dengue, certain neuro-virological disorders, the various forms of typhus and plague, sand-fly fever, and diarrhea-dysenteries. The functions undertaken by the Communicable Disease Center would exceed the resources and facilities of individual states. They would be concerned to a large extent with interstate and extra-continental health hazards. The scope and magnitude of this enterprise remains to be defined by future events.

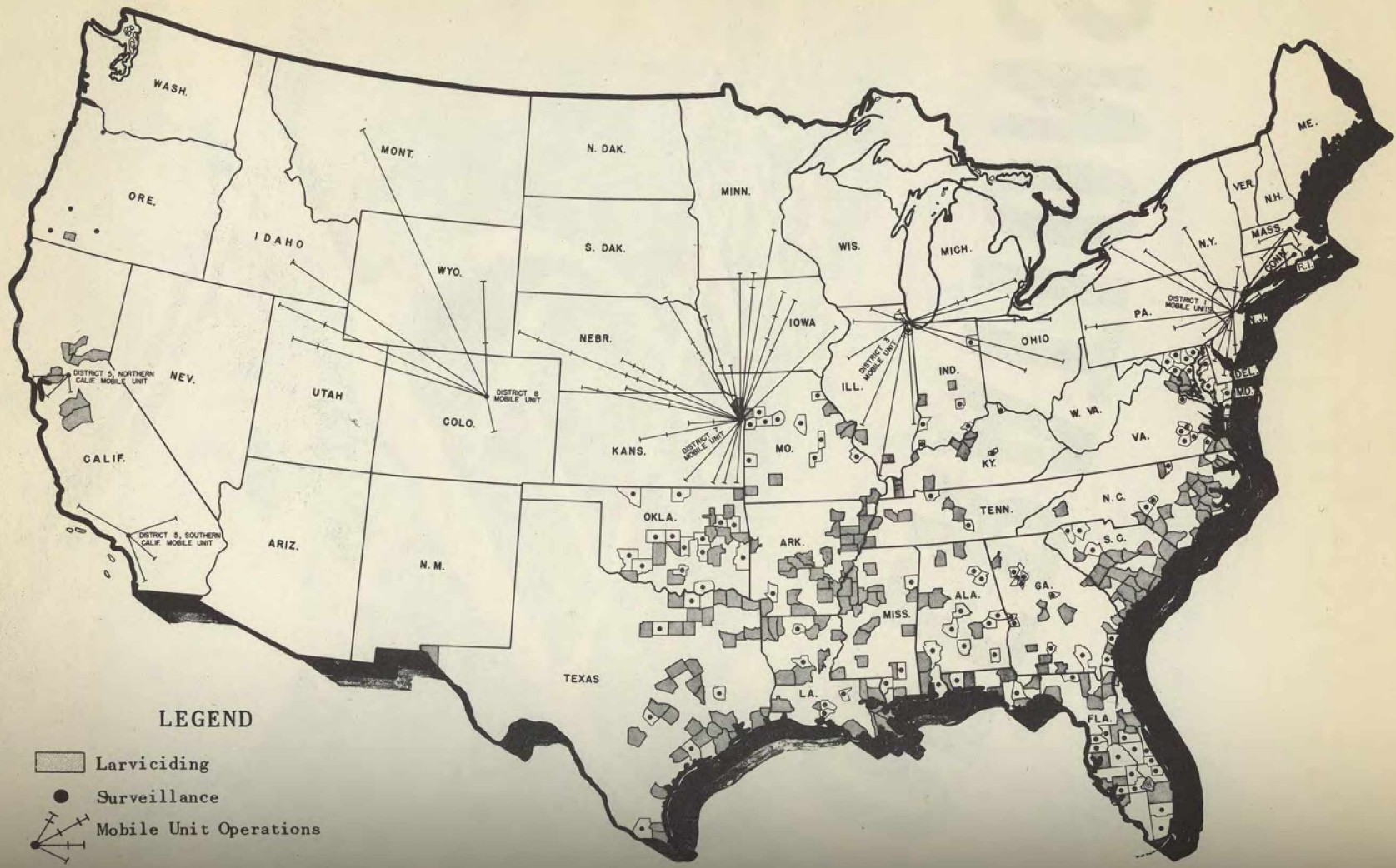


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WAR MALARIA CONTROL OPERATIONS



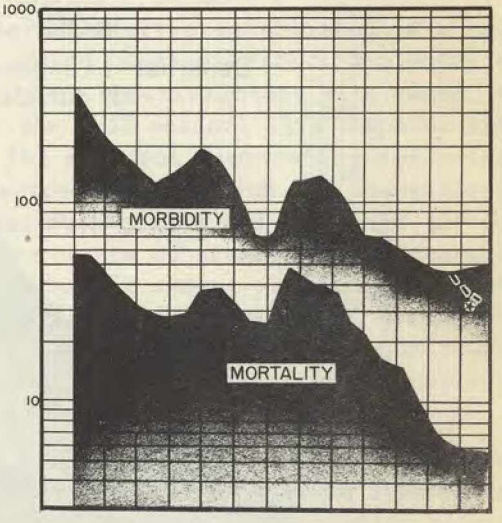
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War Malaria Control

With the cessation of hostilities in August 1945, the war malaria control program underwent a rapid reduction in a relatively short time. Operations from July through December 1945 were planned on the same scale as in the preceeding three years, with the exception that almost all permanent and semi-permanent drainage, most of which had already been accomplished in previous years, was discontinued. After "V-J Day" the malaria control program in the vicinity of war establishments was rapidly reduced and operations included only those military installations which remained active after the end of the war and had a significant malaria hazard. The liquidation of war malaria control projects closely paralleled the rapid military demobilization. During the year operations were suspended in 245 of the 307 war areas, and many of the areas still in operation in 1946 were reduced in scope from seven zones down to one or two. In the first half of the fiscal year war malaria control projects were protecting 819 zones, while on June 30, 1946 this had decreased to 118 zones.

During the course of the year war malaria control around critical war establishments followed much the same pattern as in the previous years in regard to species sanitation in extra-cantonment areas. Control measures were, however, limited to larviciding and minor drainage as the means of combating larval production of the three malaria vector species in this country — *Anopheles quadrimaculatus* in the east, *A. freeborni* in the west, and *A. albimanus* in the lower Rio Grande Valley. The presence of malaria vectors and recent malaria history as prima facie evidence of a potential hazard, even though a large number of actual malaria cases were not reported, continued to be the basic premise for control and the success of the program was judged in terms of mosquito reduction rather than on the decrease of malaria mortality and morbidity.

MALARIA TREND. In 1944 and 1945 malaria at first glance appeared to have reversed its previous downward course in the United States. From 1935 until 1944 there was a consistent, decreasing mortality and morbidity rate. In both 1944 and 1945 there were reported respectively more cases than the preceding year. However, when those cases which were known to have been acquired outside of the continental limits of the United States were subtracted from the total figures reported, there still was an actual decrease in the mortality and morbidity rates. To date no known outbreaks of any size can be attributed



Malaria morbidity and mortality rates per 100,000 population in all states reporting cases and deaths during 1920-1945 inclusive.

*Excluding extra - continentally acquired cases.

Courtesy of the David J. Sencer CDC Museum

to the return of servicemen from malaria-infested areas. Undoubtedly anti-malarial efforts have contributed toward the maintenance of this continued downward trend.

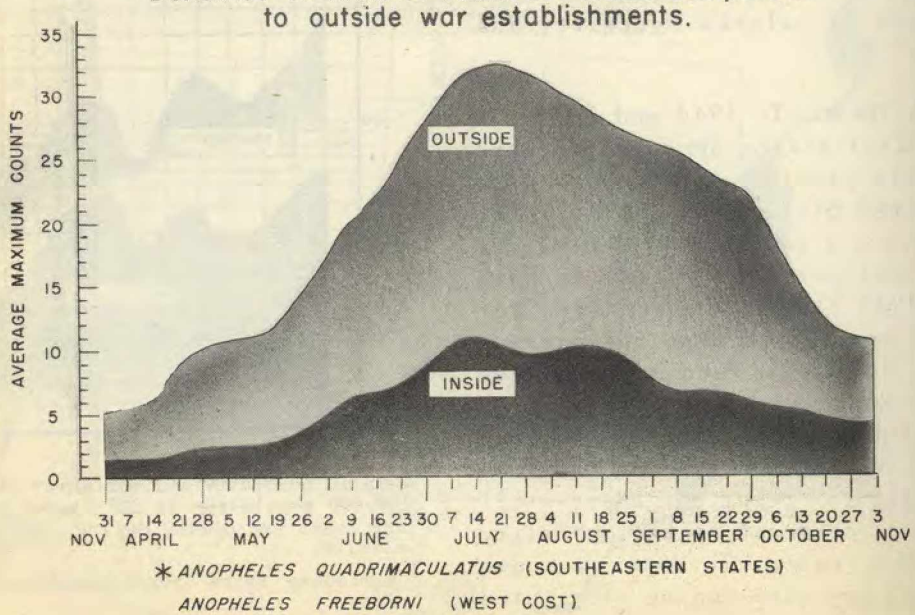
ENTOMOLOGICAL FACTORS

From January through December 1945 larvicidal operations for the control of malaria-carrying mosquitoes were carried on in 874 zones which were grouped into 192 areas. The over-all effectiveness of these operations during 1945 is shown graphically in Figure I. Here the densities of malaria vectors as measured by the numbers occurring in index stations inside the protected zones are compared to those encountered outside but adjacent to the protected zones. It will be noted that the average of the maximum densities in the protected zones was one-third or less of that occurring at outside locations throughout the season; also that the averages of the inside densities, with the exception of one week during July, were less than ten mosquitoes per resting place. In presenting these data it is necessary to point out that these averages are those of the highest single anopheline count each week in each control zone rather than the averages of all index stations. This procedure rates the zones on their worst conditions with respect to vector densities. It has been adopted for evaluations because anophelines frequently are a menace in only one section of a camp or community. Under such conditions if all index station counts for an area were averaged, any unsatisfactory condition would be effectively masked.

On the MCWA program the occurrence of ten or more *Anopheles* mosquitoes in any

FIG. I. RESULTS OF CONTROL WORK IN WAR AREAS

Densities of malaria vectors* inside compared to outside war establishments.

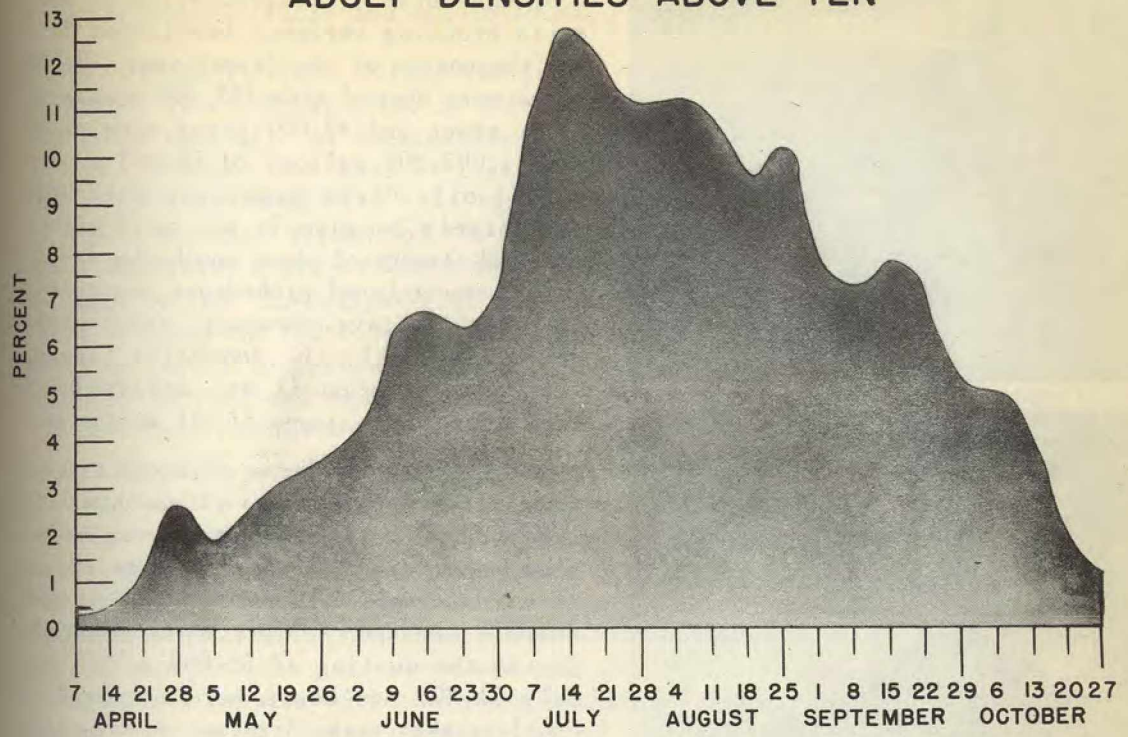


*ANOPHELES QUADRIMACULATUS (SOUTHEASTERN STATES)

*ANOPHELES FREEBORNI (WEST COST)

Courtesy of the David J. Sencer CDC Museum

FIG. 2. PERCENTAGE OF ZONES HAVING INSIDE ADULT DENSITIES ABOVE TEN



resting place for three consecutive weeks was arbitrarily established as a criterion of unsatisfactory control operations. Based on this criterion a total of nearly 16 percent of 136 of the control zones were unsatisfactory with regard to adult densities at one time or another during the 1945 season. This compares with 14 percent in 1944 and ten percent in 1943. The apparent diminishing percentage of satisfactory work was caused by several factors, among which may be mentioned the more favorable mosquito breeding conditions during 1944 and 1945, and the addition to the program during the active breeding season of zones in which mosquito densities already were high and in which a considerable amount of preliminary work was necessary to prepare the areas for efficient larvicidal work. Also, during the 1945 season, the inauguration of the extended program and the necessity for transferring to that program some of the more capable, trained supervisors undoubtedly adversely affected larvicidal programs in some cases.

Figure II shows for each week during the 1945 season the percent of control zones in which the densities of malaria vectors were considered to be high enough over a sufficient period of time to present a possible malaria transmission hazard. In this connection it should be pointed out that in many of these so-called "unsatisfactory zones" the percentage of *Anopheles quadrimaculatus* reduction achieved was excellent and undoubtedly the malaria hazard was greatly reduced. In all larvicidal zones facilities for intensifying anopheline control were available if reports of malaria transmission were received.

Courtesy of the David J. Sencer CDC Museum







LARVICIDES

Of the total of 130,000 acres of mosquito-breeding surfaces larvicided during the course of the fiscal year, 81,000 acres were dusted with 132,300 pounds of paris green and 49,000 acres were oiled with 1,003,500 gallons of Diesel or No. 2 fuel oil. Paris green was used more extensively because it was more effective and economical where anopheline breeding was associated with dense vegetation or heavy floatage. However, since paris green kills only the *Anopheles* larvae, oil was used when it was desirable to kill all aquatic stages of all mosquitoes.

APPLICATION. In terms of acres treated as well as expenditure of man-hours of labor, hand dusting of paris green rather than power dusting was the more extensive method used this year, requiring some 166,000 man-hours. Power application effected the dusting of 36,000 acres, but only 11,400 man-hours were required to complete this task. Airplane dusting this year was confined mostly to experimental projects. The application of oil was accomplished almost entirely by hand-operated sprayers; 44,500 acres were hand-oiled at an expenditure of 412,000 man-

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LARVICIDING: (upper left) hand spraying oil; (middle left) power spraying oil; (lower left) hand dusting paris green; (below) power dusting.



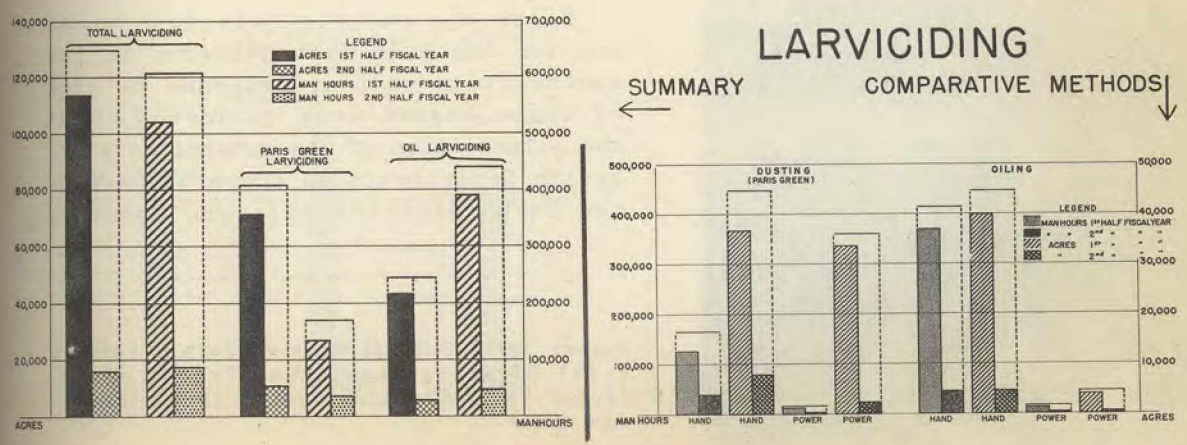
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hours, while 4,500 acres were power-sprayed at the expense of 15,600 man-hours. The cost of larviciding was increased this year by a 20 percent rise in the price of labor, bringing the average operational cost per acre-treatment of paris green to approximately $2.33 and oil to $6.84.

DDT OIL-MIST SPRAY. During the year a technic was developed for the hand-application of a DDT larvicide in a No. 2 Diesel oil-mist spray. While it is almost axiomatic that all new insecticides making their initial appearance are heralded by the statement that here at last is "an insecticide to end all insecticides," the results obtained with this spray seemed to surpass by far any previous larvicide. A detailed account of the method of application of this oil-mist spray and the comparative costs of larviciding with DDT-oil, paris green, and fuel oil may be found in the "Investigations" section, under "Technical Developments." It was found in using the DDT oil-mist larvicide that 0.05 pound of DDT per acre was adequate to insure 90 percent control of all instars of anopheline larvae and most culicine larvae, and was reasonably safe from the standpoint of damage to fish and fish-food organisms.

In Tennessee a solution of DDT in oil applied at the rate of 6.5 gallons per acre at ten-day intervals gave successful control of mosquito production and affected a reduction of 40 percent in over-all costs as compared to oil alone. Kentucky reported a one-third decrease in costs and Arkansas recorded a saving of from 63 to 90 percent in material and from 20 to 80 percent in labor. California used this new larvicide for the control of *Culex tarsalus* in connection with Japanese "B" encephalitis prevention and also reported very favorable results. The new larvicide was popular with the crews because of greater ease of application, increased spray swath, greater penetration of vegetation, and less frequent refilling of the spray cans.

CLEARING. In order to render more easily accessible the places to be larvicided and to eliminate favorable anopheline breeding conditions, extensive clearing of brush and aquatic vegetation was carried on. In all a total of 2,000 acres of aquatic vegetation and 1,900 acres of terrestrial vegetation was cleared. Water chestnut and hyacinth did not present much of a problem this year since wide-spread cutting during the previous year had eradicated most of the troublesome areas. Experimental airplane herbiciding proved very efficient in control-



Courtesy of the David J. Sencer CDC Museum







ling the growths of water-hyacinth in Florida. In those areas still infested with these prolific aquatic plants, paris green dusting was sufficient to control malaria mosquito breeding.

DRAINAGE

At the close of the 1945 fiscal year little major drainage remained to be done on the war area program in the continental United States. Most permanent or semi-permanent drainage projects were discontinued except where local or state funds were made available to continue projects beneficial to civilian populations. Prime emphasis was placed on the cleaning and maintenance of previously constructed ditches and additional temporary ditching was utilized wherever necessary as a supplement to larviciding operations. A total of 9,550,000 feet of previously constructed ditches was cleaned and otherwise maintained during the year. Hand ditching amounted to 636,000 feet, as compared to 48,000 feet of machine ditching and 58,500 feet of dynamite ditching. Only nominal amounts of ditch linings - 31,000 feet - and underground drains - 2,700 feet - were installed and the fill totalled 77,000 cubic yards. In all some 1,000 acres of water surface were eliminated by combined drainage operations.

DISTRICT-OPERATED PROGRAMS

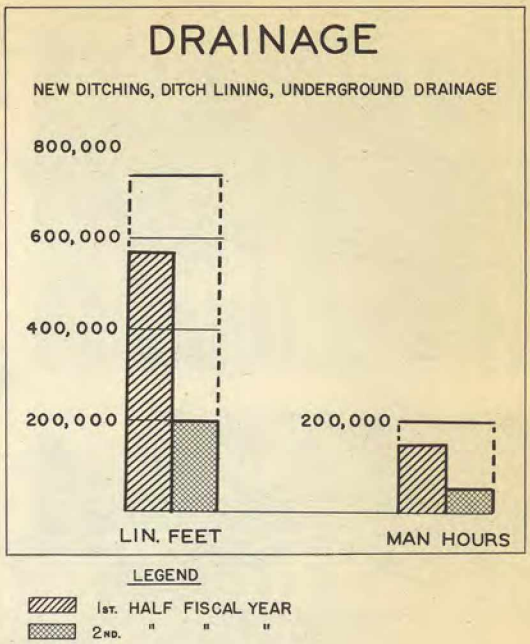
Since the endemic malarious areas are for the most part centered in the southeastern states, programs in each of these states were conducted under the jurisdiction of the respective state health departments in cooperation with the USPHS district offices. However,

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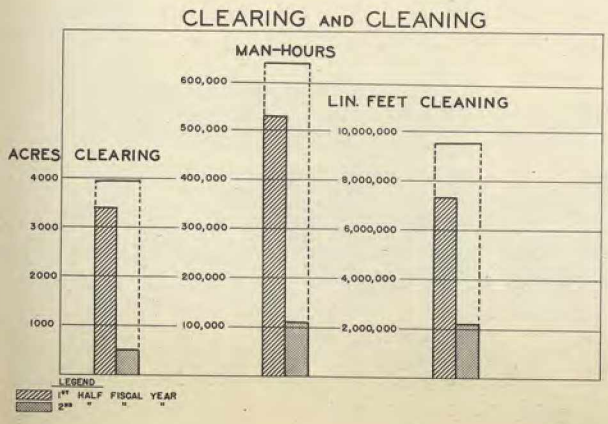
(upper left) DDT oil-mist spraying. (middle left) Clearing vegetation from a ditch. (lower left) Cleaning debris from a drainage ditch.

Courtesy of the David J. Sencer CDC Museum

certain marginal and northern states are well within the distribution range of malaria vectors, and during the war years a potential malaria hazard was introduced into almost all parts of the United States by the establishment of prisoner of war camps, military hospitals, and cantonment zones, in which were housed many cases of malaria contracted in endemic and epidemic regions throughout the world. MCWA programs were begun in these states to forestall the possibility of malaria gaining a foothold in presently non-malarious areas. Since the problem was essentially one of prevention it was not considered necessary to carry on an extensive program in each of these marginal and northern states with actual operations around each war establishment. Instead activities were conducted under the general supervision of the various district offices in cooperation with the respective state health departments and military authorities. Major reliance was placed on the entomological phases of the work and the data so obtained were used as a guide to control operations. District entomologists conducted reconnaissance surveys and the necessary larviciding and drainage was carried on by district mobile units and "fixed" resident projects.



MOBILE UNITS. Two types of mobile units were operated out of the district offices during this fiscal year. One type, initiated in the early summer of 1946, served to demonstrate insect control measures to federal institutions and state health departments. Such units contained the different kinds of larviciding and residual spray equipment and chemicals, and the personnel were trained to carry on exhibitions of the various methods currently in practice. One demonstration unit was maintained in District 7; District 3 had completed plans for a unit; and District 8 had one which was loaned to District 9 for use in Indian Territory in New Mexico. Another such unit is being completed in District 8. These demonstration units were available to the states for control of insects in case of an outbreak on insect-borne diseases.



The other type of mobile unit

Courtesy of the David J. Sencer CDC Museum





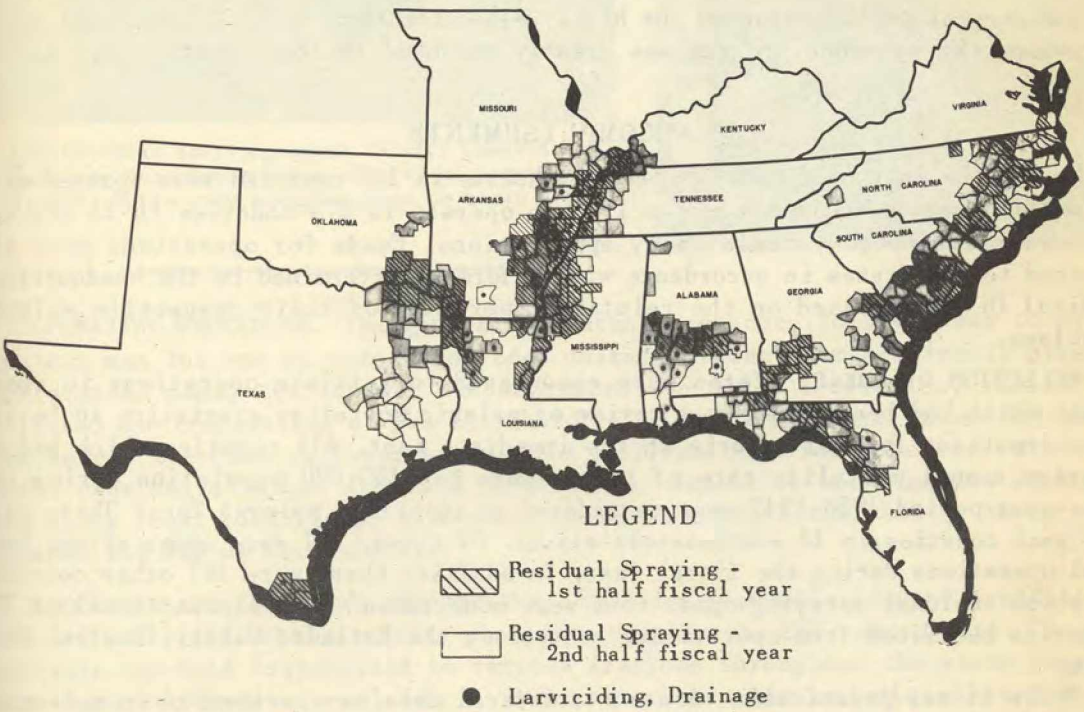
was used to carry on mosquito control measures in war areas around installations where resident control was not considered necessary. California had two such units operating under state supervision. Three units under District 1 supervision operated throughout ten northeastern states, accomplishing 1,000 acres sprayed with 13,000 gallons of oil, 9,200 acres dusted with 18,500 pounds of paris green, 46,000 feet of hand-dug ditches, 8,200 feet of machine ditching, and 700 cubic yards of fill. The District 3 unit used 850 pounds of paris green to larvicide 270 mosquito-breeding acres and cleared four acres of aquatic vegetation to create unfavorable anopheline breeding conditions. The District 8 operational unit sprayed 54 acres of water surface with 250 gallons of oil, dusted 570 acres with 200 pounds of paris green, and completed 700 feet of hand ditching. Since the basis of district-operated programs was essentially one of prevention, each mobile unit spent considerable time on entomological inspection in those zones requiring surveillance.

MOBILE UNITS IN OPERATION: (upper left) entomological inspection; (center) oiling; (below) paris green dusting.



Courtesy of the David J. Sencer CDC Museum

Extended Malaria Control



The inauguration of the Extended Malaria Control Program was predicated on the assumption that there was a possibility of malaria spreading from malaria carriers returning from foreign countries to the civilian population of this country unless adequate preventive measures were instituted. Investigation had shown that foreign malarias adapted themselves readily to our insect vectors, and that successive transfers through our vectors did not result in a decrease in virulence. Previous infections with native malarias conferred little immunity against these foreign malarias, some of which seemed to be separate strains. Also, since mosquitoes can be infected as long as relapses occur, some carriers might be sources of infection for several years.

It was believed that malaria could be introduced most easily in the areas where the disease had last been prevalent. Efforts were therefore directed toward eliminating the residuum of malaria in endemic foci and preventing its reintroduction in sections with a history of significant malaria morbidity. The principle involved in the DDT residual spray method was that those anophelines which enter houses to bite humans, and thus are most likely to become infected with malaria, will rest on the treated surface before or after feeding and be killed by the residual insecticidal action of the DDT-crystal coating.

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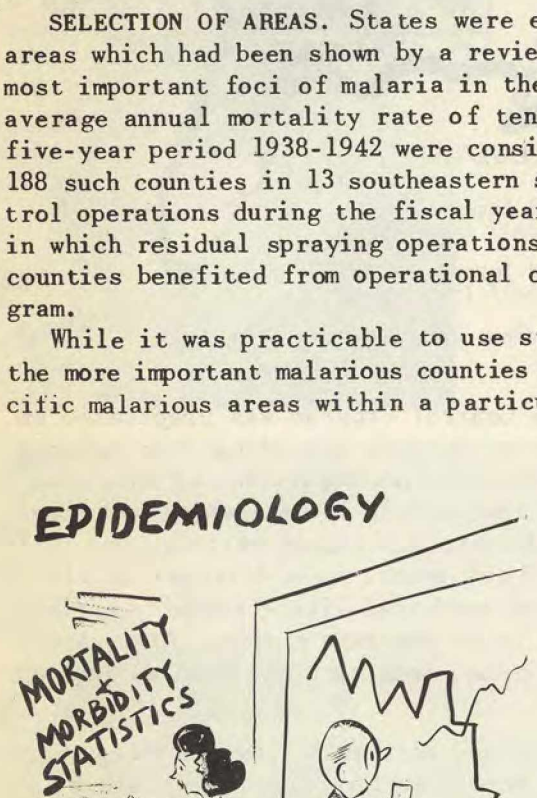
The shift in emphasis to the extended program for the protection of the civilian population against imported malaria was completed by 1945. When the war ended, military demobilization was rapid and millions of men from malarious areas overseas returned to their homes throughout this country. Among these men were former malaria patients who might later have relapses of the disease. Also, possible subclinical cases whose symptoms had been suppressed by atabrine could suffer a primary attack when released from the strict regimen of chemical prophylaxis. For these reasons, and because of the enthusiastic reception on the part of the general public accorded the highly effective results of DDT residual house spraying, the extended program was greatly expanded in scope during this fiscal year.

ACCOMPLISHMENTS

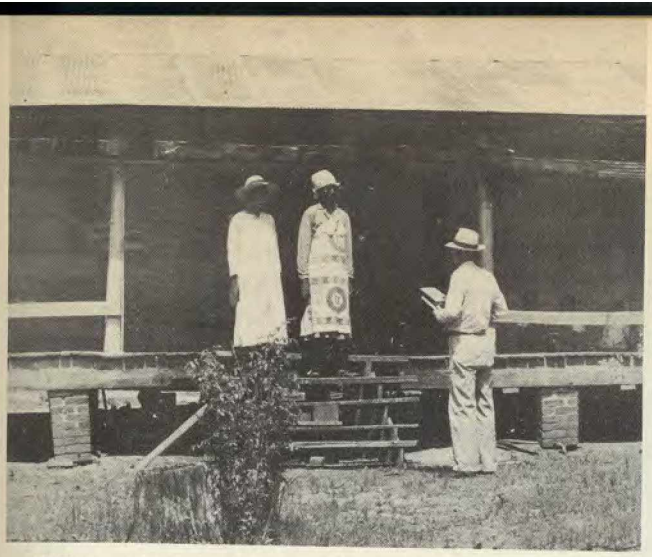
During the last half of 1945, 413,500 houses in 123 counties were sprayed with DDT. This program was expanded in 1946 to operate in 274 counties in 13 states, accomplishing 650,000 house spray applications. Funds for operations were allocated to the states in accordance with a formula determined by the headquarters Medical Division based on the relative importance of their respective malaria problems.

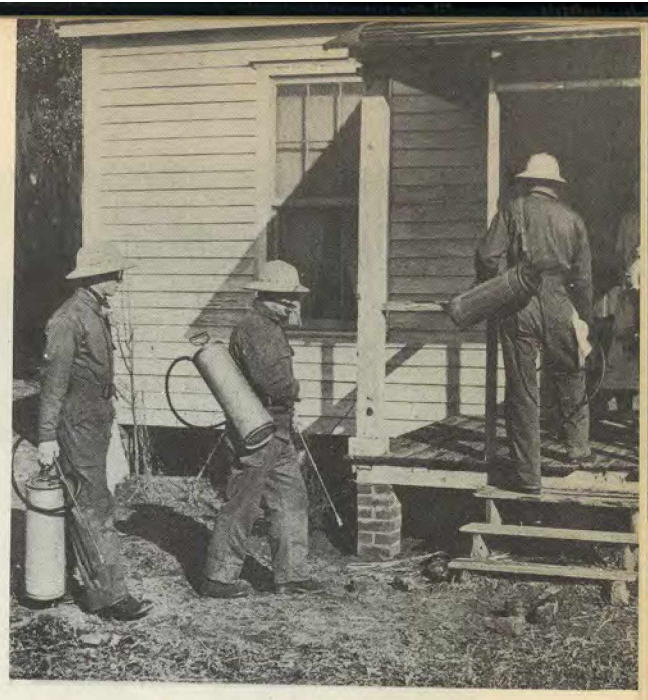
SELECTION OF AREAS. States were encouraged to initiate operations in those areas which had been shown by a review of malaria mortality statistics to be the most important foci of malaria in the immediate past. All counties which had an average annual mortality rate of ten or more per 100,000 population during the five-year period 1938-1942 were considered as important malaria foci. There were 188 such counties in 13 southeastern states. Of these, 167 were under actual control operations during the fiscal year. In addition there were 107 other counties in which residual spraying operations were undertaken. Thus a grand total of 274 counties benefited from operational control on the Extended Malaria Control Program.

While it was practicable to use statistical data as a criterion in selecting the more important malarious counties in a state, it was difficult to select specific malarious areas within a particular county. Several of the states on their own initiative undertook to determine on an entomological basis those portions of a county where control operations should be conducted. This proved to be a means of expending materials and supplies where most needed and served the purpose of making a budget cover more territory than would have been possible if county-wide operations had been the rule. Some states approached the problem from another viewpoint, giving top priority to homes of veterans with malaria histories, followed by homes in which positive blood smears occurred, and lastly, communities with a high incidence of malaria.



Courtesy of the David J. Sencer CDC Museum

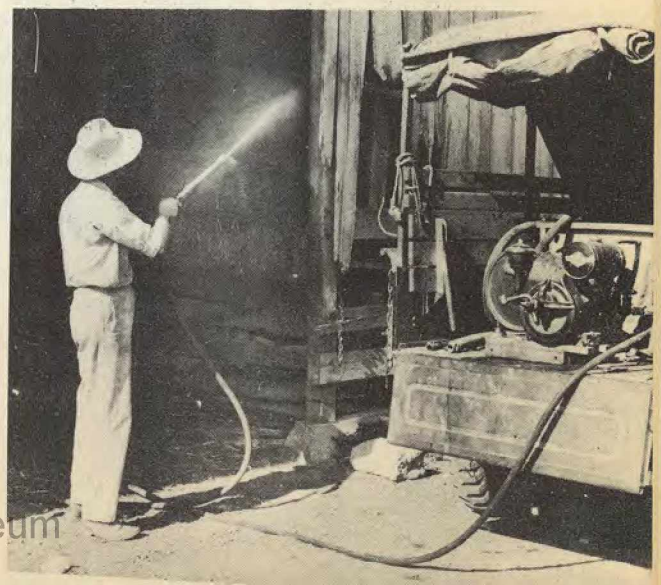




DDT residual house spraying. (left) Contact man prepares householders for arrival of spray crew (right) Spray crew entering home to begin work.

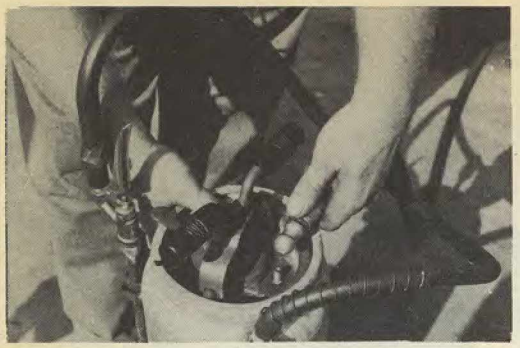
OPERATING PROCEDURE. The general operating procedure followed was to have a contact man for one or more spray crew units. Working from previously prepared operational maps, the contact man scheduled the day's activities, visited and enlisted the cooperation of the householders in preparing their homes for spraying before the crew arrived, and solved problems concerning public relations. Spray crew units varied from one to four men, depending upon density of houses and other local conditions, with most states favoring either two or three men - foreman and one or two laborers.

PROCEDURE AND EQUIPMENT INNOVATIONS. The most generally adopted practice was that of utilizing central mixing plants to prepare the DDT concentrate. The concentrate was then transported to various stations throughout the state where it was converted into an emulsion by dilution with water and distributed to the spraying crews in 55-gallon drums equipped with lock-type faucets. Various provisions were made for clarifying the mixture to prevent clogging of spray nozzles. Continuous agitation of the emulsion in the drum was provided by the jostling of the truck over the road. These procedures eliminated handling of DDT, xylene, and other toxic chemicals and also did away with the necessity for careful measuring of concentrate and water each time a spray can required filling. A more versatile spray can was produced by installing a valve stem on the filler cap or cover plates of hand sprayers so that air pressure could be provided by a compressor unit mounted on the truck. This method proved more satisfactory than the old hand pumping method not only in saving time and energy but also in saving spray can maintenance. Some states used power sprayer units in the more populated areas and hand sprayers in sparsely settled districts. A note-



(right) Power spraying unit on ¾ ton truck.

Courtesy of the David J. Sencer CDC Museum





(top) Spray can with valve stem on cover plate. Pressure is applied from a compressor on the truck. (lower) Filling spray can with emulsion from 55 gallon drum.

worthy modification of automotive equipment was the jeep-trailer combination. The jeep transported personnel and the trailer carried the equipment. In the spray area the crew used the trailer while the contact man used the jeep in his visits to prepare houses for spraying.

PERFORMANCE. With the experience gained from one year's operation and the increased development of equipment and materials it proved possible to reduce the average man-hours required for residual spraying from 1.15 man-hours per house application at the beginning of the 1945 spraying season to 0.96 man-hour at the end of the year. The rate of DDT application varied from state to state but the program average was 0.68 pound per house, or approximately 135 mg. per square foot for the average size home. This rate of application has been found to be effective for three and a half to four months. DDT applied during the spring did not last the entire season; however, all homes sprayed after July 15 did not require respraying during the same mosquito breeding season. The cost of residual spraying of homes was gradually reduced as the program developed. At the end of this fiscal year the average gross cost per house application was $3.75, which included all field supervision, state office overhead costs, and local contributions. Federal cost varied among the several states from $2.35 per house to as much as $5.50 per house, depending on the average size of homes, the equipment used, crew organization, and the efficiency of the personnel assigned.

The residual spraying program was primarily limited to spraying of rural homes and small communities. Towns within any given extended program area which required protection were usually provided for by larviciding projects. In communities where the population was more than 2,500, control of anopheline mosquitoes was provided by larviciding, unless the necessary materials and personnel for spraying were furnished locally.



Interior DDT spraying with pressure equipment.

Courtesy of the David J. Sencer CDC Museum

Precipitin testing of blood-engorged mosquitoes to determine the percentage which have fed on humans.



Marginal states having limited or scattered malaria problems were given assistance with mobile malaria control units attached to the district offices of the U. S. Public Health Service. These units were also available for control of any sudden outbreaks of malaria that might have occurred in these states.

EVALUATIONS

Entomological measurements of the effectiveness of this work in decreasing the likelihood of malaria transmission were made in two ways: (1) Inspections of a small percentage of treated houses selected at random were made at intervals after spraying to determine results of the spray in keeping houses free of *A. quadrimaculatus*. At the time each of these house inspections was made, an adjacent unsprayed resting place was inspected to determine the general abundance of *quadrimaculatus* in the vicinity so that efficiency of the spray in the presence of various anopheline densities could be approximated. (2) Collections of engorged specimens of *quadrimaculatus* were made routinely from resting places on premises having sprayed houses and also on premises where houses were not sprayed. Precipitin tests were made of blood from the stomachs of these mosquitoes to determine the percentage on each type of premise that had fed on man, and comparisons were made. This method of checking the effects of DDT residual deposits was used because, if *quadrimaculatus* feeds principally on humans while indoors, as is commonly supposed, and these human feeders are being killed by resting on the sprayed surfaces, the general *quadrimaculatus* population about the sprayed premises should then show a low human feeding rate in comparison to that of the population about unsprayed premises.

Table I

HOUSE INSPECTIONS ON RESIDUAL SPRAY PROGRAM

Total houses inspected and per cent in which *A. quadrimaculatus* was found during afternoon inspections.

MONTHS FOLLOWING SPRAYING	NUMBER OF HOUSES INSPECTED	HOUSES WITH *A. QUADRIMACULATUS*	
		NUMBER	PER CENT
Less than 1	3916	42	1.1
1 - 2	4558	79	1.7
2 - 3	3557	154	4.3
3 - 4	1375	73	5.3
4 - 5	723	42	5.8
Totals	14129	390	
Per cent			2.8

The records of house inspections for the season are summarized in Table I. These data show that a total of 14,129 inspections was reported and that the inspections were made at intervals following spraying varying from less than one month to a maximum of over four months. Three hundred and ninety sprayed houses, or an over-all percentage of only 2.8 percent of those houses inspected, contained *quadrimaculatus* during the afternoon. It will be noted that there was a gradual decrease in the effectiveness of the DDT deposits at successive monthly intervals after application. Inspections

Courtesy of the David J. Sencer CDC Museum

made up to one month after spraying indicated that 1.1 percent of the treated houses were positive for *quadrimaculatus*. This percentage increased to 1.7, 4.3, and 5.8 after intervals of two, three, and four months, respectively. The smaller number of house inspections made three and four months after spraying was due to the spraying schedule established, which called for respraying at three-month intervals.

In Table II the inspection records are grouped to show the effect of age of DDT deposits and numbers of *quadrimaculatus* in outbuildings on the percent of houses harboring mosquitoes. Only those houses which contained mosquitoes in the afternoon were considered as positive. These data show in general that for all spray ages the greater the density of *quadrimaculatus* around the premises the greater is the percentage of sprayed houses positive for mosquitoes. This is probably due in some measure to the likelihood that greater numbers of mosquitoes enter houses in areas of high densities and therefore there is a better chance that some will find non-lethal resting places. It will be noted however that there is a general decrease in effectiveness of DDT deposits with age in each density group except the first. Here the number of zero densities accounted for apparent uniformity.

In order to fit the inspection routines into usual working hours, inspections were made throughout the day. Since DDT acts slowly, each house in which live *quadrimaculatus* mosquitoes were found during morning inspections was reinspected during the afternoon, and only afternoon positive houses were considered in making evaluations. Sufficient data have not been accumulated to determine if there is a normally occurring reduction in the percentage of houses positive for *quadrimaculatus* from morning to afternoon among unsprayed houses. It is assumed that day-long survival of *quadrimaculatus* may be expected in resting places of this type.

Of 508 sprayed houses which contained *quadrimaculatus* in the morning, survival to afternoon was found in only 30.5 percent. Table III summarizes the records of these reinspections. The gradual lessening of toxicity of the deposits with age, as previously mentioned, is indicated by the decreasing percentage of houses which became mosquito-free by afternoon at successive monthly intervals after spraying. When inspections were made less than one month following spraying, 93 percent of the morning-positive houses were found to be free of live mosquitoes

Table II

HOUSE INSPECTIONS ON RESIDUAL SPRAY PROGRAM

Effect of premise densities and age of spray on percentage of *quadrimaculatus* positive houses (afternoon inspections).

MONTHS FOLLOWING SPRAYING	NATURAL RESTING PLACE *QUADRIMACULATUS* DENSITIES						
	0-10	11-50	51-100	101-200	201-400	400 +	All
	Percent of Positive Inside House Inspections (afternoon).						
Less than 1	0.6	1.5	2.3	2.8	1.0	6.0	1.1
1 - 2	0.9	2.9	5.3	3.3	5.0	5.3	1.7
2 - 3	1.6	5.4	7.2	12.5	14.2	32.9	4.4
3 - 4	0.6	12.4	11.1	22.4	17.2	50.0	5.4
4 - 5	1.5	12.5	14.8	15.0	63.6	66.7	5.7

Table III

HOUSE INSPECTIONS ON RESIDUAL SPRAY PROGRAM

Reduction in houses positive for *A. quadrimaculatus* from morning to afternoon.

MONTHS FOLLOWING SPRAYING	NUMBER OF HOUSES WITH *A. QUADRIMACULATUS*		PERCENT REDUCTION
	MORNING	AFTERNOON	
Less than 1	59	4	93.2
1 - 2	123	13	89.4
2 - 3	206	66	68.0
3 - 4	79	43	45.6
4 - 5	41	29	29.3
Totals	508	155	
Percent			69.5

Courtesy of the David J. Sencer CDC Museum

in the afternoon. This percentage decreased to 89, 69, 45, and 29 for inspections made one, two, three, and four months, respectively, after spraying. Table IV shows, for those houses found positive at morning inspections, the decrease in total *numbers* of *quadrimaculatus* which occurred between morning and afternoon at successive monthly intervals. As in Table III the lessening of effectiveness of the deposits with age is indicated.

Concerning the results of the precipitin tests, less than half the samples of *quadrimaculatus* bloods taken for determination of human feedings have as yet been tested. However, of 21,913 specimens collected on premises where the houses have been sprayed (Table V), only 0.6 percent gave human reactions, while of 9,565 specimens from premises where no spraying had been done the human feeding rate was 3.1 percent. It is believed that these data, which show 80 percent fewer *quadrimaculatus* with human feedings to be present about premises having sprayed houses, are highly significant as indicating that chances for malaria transmission were greatly reduced.

TRAINING AND EDUCATION

There was no great need for training supervisory personnel in operational procedure this year since most of them had been adequately trained last year and had had at least one season's spraying experience. Spray crews were trained by these experienced supervisors, and new recruits occasioned by normal labor turnover were trained on the job by old crew members. Similarly, there was no great need for an extensive program of public education in most states this year in light of the phenomenal success of the previous season's spraying program in terms of public enthusiasm and cooperation. The amount of local monetary and labor contributions to the extended program attested to this. Several of the states conducted health education programs in the schools and instituted workshops on malaria sanitation in colleges. Health instruction was given to persons and families affected with malaria, and special concessions, such as offers to spray their homes, were made to those infected if malaria was diagnosed by a physician. This induced many persons to visit physicians. Field educators held meetings with civic organizations and the general public to ex-

Table IV

HOUSE INSPECTIONS ON RESIDUAL SPRAY PROGRAM

Reduction in numbers of *A. quadrimaculatus* in houses from morning to afternoon.

MONTHS FOLLOWING SPRAYING	TOTAL *A. QUADRIMACULATUS* IN HOUSES		PERCENT REDUCTION
	MORNING	AFTERNOON	
Less than 1	172	6	96.5
1 - 2	290	22	92.4
2 - 3	598	182	69.6
3 - 4	190	74	61.1
4 - 5	106	60	43.4
Totals	1356	344	
Percent			74.6

Table V

RESULTS OF PRECIPITIN TESTS - 1945
(APR. - AUG.) COMPARISON OF SPRAYED VS. UNSPRAYED AREAS.

	NUMBER SPECIMENS TESTED	NUMBER POSITIVE FOR HUMAN BLOOD	PERCENT
Sprayed	21913	142	0.6
Not sprayed	9565	293	3.1
Difference	-	-	80.7

Courtesy of the David J. Sencer CDC Museum



Spray crews were trained by experienced supervisors.

plain the use of DDT in household sanitation, and demonstrations were carried on as part of the county health program. Some states conducted state-wide residual spraying projects in which public buildings of various kinds were treated for purposes of demonstration. Considerable effort was made in several states to locate discharged servicemen with malaria histories and to instruct them in malaria sanitation.

INVESTIGATIONS AND TECHNICAL DEVELOPMENTS

Detailed field tests of dosage and type of spray coverage showed that over-all spraying of a room was preferable to spot spraying of corners, undersides and backs of furniture and pictures, and other resting places of mosquitoes. Also, it was concluded that the extra expense of applying 200 mg. of DDT per square foot in place of 100 mg. was justified by a better percentage of mosquito mortality three to four months after treatment. Laboratory tests showed that the nature of the sprayed surface greatly affected the length of residual effectiveness and that temperature definitely affected the deterioration of DDT on sprayed surfaces.

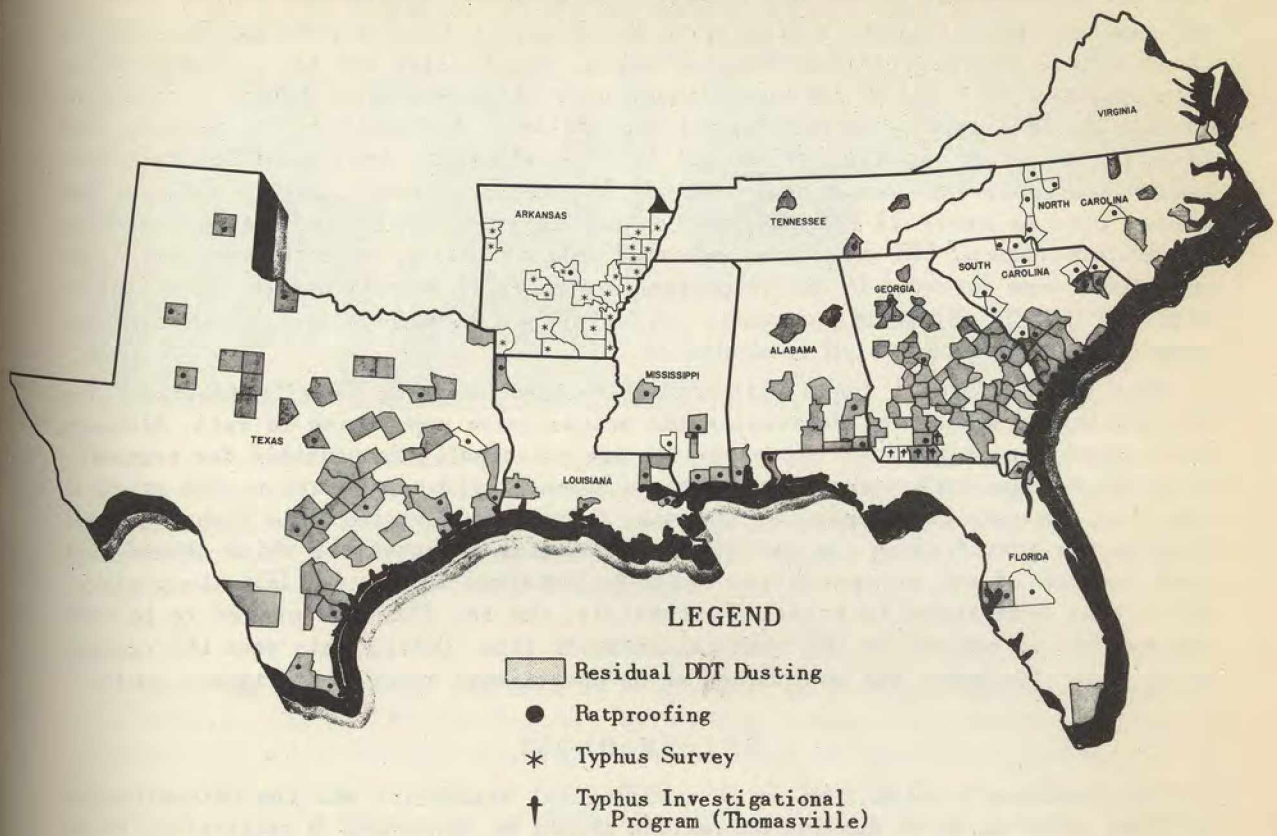
The use of DDT for the control of other insects affecting public health was investigated in detail this year and there were indications that some of the more recently discovered insecticides had advantages over DDT in specialized usage. In Hawaii a DDT-smoke aerosol generator attached to a truck motor exhaust was developed for control of adult mosquitoes. Several investigations centered around studies to determine the efficacy of DDT residual spray in preventing transmission of human malaria and observations were made on the epidemiology of malaria in endemic areas. In Puerto Rico results of a "controlled" residual spray study showed that the malaria rate in one town dropped from 6.3 to 0.91 percent after three sprayings, while the rates in the check, unsprayed area changed only from 4.7 to 3.8 percent in the same period.

FUTURE TREND

In all but a few states, federal allocations were augmented by local contributions which ranged from about two percent to over 60 percent of the federal allocation. In addition to augmenting federal allocations by local contributions, there were also other ways in which the various states supplemented extended program spraying. In one instance county-paid crews were put at the disposal of area supervisors to spray border-line counties that would not otherwise have been included in extended program operations. In one state, a proposition was put before civic leaders and county health commissioners outlining the possibility of greatly extending the residual spraying program with locally contributed funds and labor. Of the 19 communities approached, 16 subscribed to the first spray period and guaranteed the second on the same basis. Supplementary residual spraying was carried on in another of the states as a private enterprise by individuals trained by working with spray crews on the extended program. As the public interest and demand for DDT residual spraying increased, the local contributions increased and it is anticipated that the contributions of many more states may approach 50 percent of the total expenditure by the end of the next fiscal year.

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Typhus Control



Murine, or endemic, typhus fever is a disease of increasing public health significance. Rats are the natural reservoirs of infection and fleas are the probable vectors transmitting the disease from rat to rat, and from rat to man. Other closely related diseases of the typhus group of fevers include the louse-borne or epidemic type, sometimes called "Old World" typhus, and scrub or mite-borne typhus, sometimes called "field" typhus. Since 1940 there has been so rapid an increase in the number of cases of the murine type reported in this country that typhus fever is now recognized as a major health problem in southern and southeastern United States.

More than 5,300 cases were reported to public health departments during 1944. This was the greatest number recorded for any one year, but probably represented only a part of the total number of cases occurring because the reporting of actual cases has been far from complete. The fatality rate of endemic typhus is only two to five percent, but the debilitating effect is great. Climatic conditions most favorable for the widespread occurrence of murine typhus fever in this country appear to lie south of 33 degrees north latitude, which crosses the country at about the northern boundary of Louisiana. In areas north of this line the occasional transmission of the disease can be traced almost invariably to foci that are business establishments, especially where food is handled. South of the 33 degree north latitude line typhus appears to be contracted about as extensively in residential and rural sections as in business areas of cities and towns. The peak in seasonal inci-

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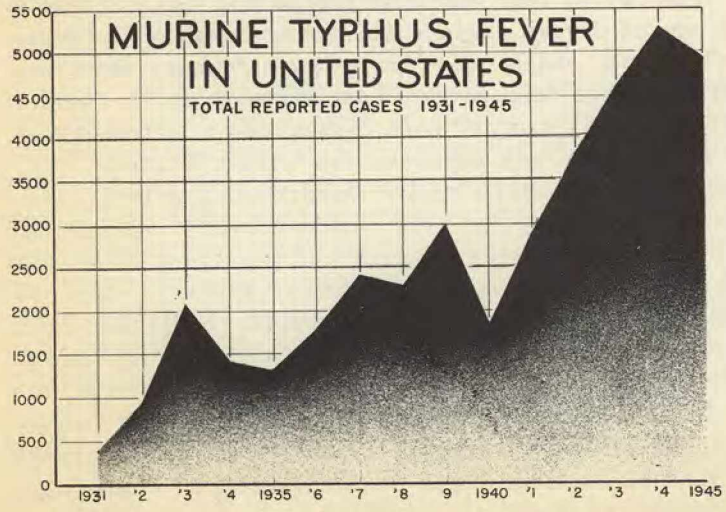
dence of typhus cases varies in different localities; in many regions it is reached during November or December, but in most places the greatest number of cases are reported during July or August.

In July 1942 the Typhus Control Unit of the U. S. Public Health Service was formed. This was an outgrowth of limited federal typhus control activities started earlier, and was used primarily as a field unit for demonstrating ratproofing methods. In those states in which typhus was a problem, ratproofing and poisoning programs were operated with state and local funds under state and local health ordinances. On July 1, 1945 typhus control activities of the U. S. Public Health Service were transferred from the Typhus Control Unit to MCWA and increased federal funds became available for operational control. The various state activities were integrated into an over-all MCWA Typhus Control Program, which was characterized by the introduction of DDT dusting as a method of controlling rat ectoparasites. State operations were directed by the respective state health departments in close liaison with the USPHS, and MCWA personnel were assigned to direct typhus control programs in those states which requested it.

Most of the federal funds allocated for typhus control were "ear-marked" for DDT dusting as a means of decreasing the ectoparasite population on rats. Although it is uncertain as to which ectoparasites are principally responsible for transmitting the endemic typhus fever organism to humans, evidence points to the oriental rat flea, *Xenopsylla cheopis,* as the most incriminated vector. The Typhus Control Program was justified on the basis of experimental observations which showed that good control of rat ectoparasites could be obtained by dusting DDT along places where rats were known to travel. Fortunately, the rat flea has proved to be more susceptible to control by DDT than rat mites or lice. During this year DDT dusting on an area-wide basis was introduced as an operational measure for typhus control.

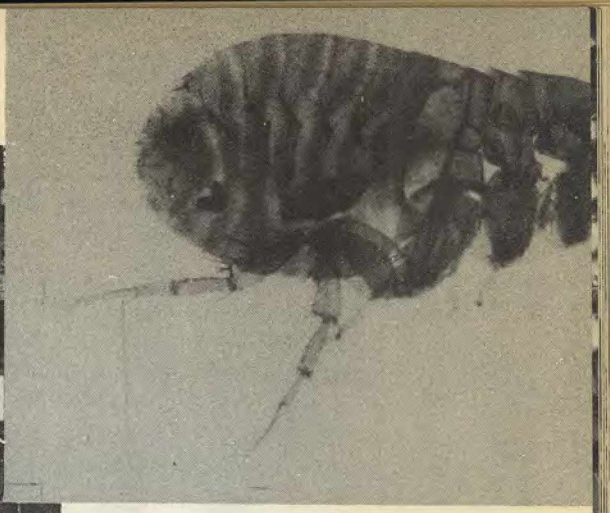
EPIDEMIOLOGY

The immediate problem from an epidemiological standpoint was the determination of those areas in which dusting operations should be conducted. A statistical study undertaken for this purpose indicated in general the following facts: (1) Approximately 5,000 cases of typhus fever are reported in the United States each year; 4,987 cases were reported for the calendar year 1945. Since the death rate is low (two to five percent), morbidity statistics are more practical than mortality statistics in determining the extent of the problem. (2) Of these 5,000 cases, over 98 percent are currently being reported from nine southeastern states. (3) There were 100 counties in these nine states which reported an annual average of



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(above) *Xenopsylla cheopis* —rat flea. (left) Mobile typhus control unit.

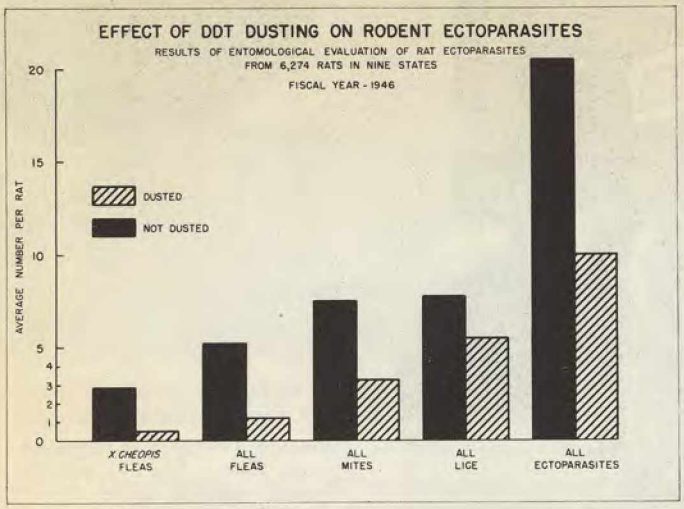
ten or more cases for the five-year period, 1940-1945. (4) There were an additional 40 counties, not included in the 100 above, which reported ten or more cases in 1944 and 1945. (5) Thus, a total of 140 counties in nine southeastern states constituted what was considered to be the nucleus for typhus dusting operations, which could be covered with the funds available.

OPERATIONS

During the fiscal year projects were operated in 11 state health departments, Puerto Rico, and the Virgin Islands with USPHS assistance. These involved 167 counties, in which residual dusting was undertaken in 150 and ratproofing in 57. Rat poisoning was also added to these projects if financed by state or local contributions. Of the total cost of typhus control during this fiscal year, state and local participation accounted for 62 percent and federal funds for the remainder. In general, three types of operational typhus control programs were conducted. The area-wide dusting program was carried on by the respective state health departments. Organization was similar to malaria control programs. Critical supplies and equipment were secured by MCWA. Labor was provided by the counties in which operations were conducted, although the Public Health Service supplied experienced foremen and laborers to work with and train local crews. As soon as the local crews were able to carry on alone, USPHS labor was withdrawn. A similar arrangement was made for supervisory personnel. The second type of program was ratproofing, which included trapping and poisoning to eradicate the rats inside the proofed premises. Besides some federal supervision and a limited amount of federal equipment, ratproofing was supported entirely with state and local funds and labor. The third type of program was rat poisoning on an area-wide basis, usually carried on in conjunction with dusting. Poisoning was conducted only in those areas where state or local contributions financed it.

RESIDUAL DUSTING. A total of 336,200 premise dustings were completed during the fiscal year, representing an approximate average of two treatments per premise. On the basis of programs proposed by the respective states, the ratio of residences

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to business establishments treated in the areas in which operations were carried on was 11:14. Each premise treatment required an average of 0.68 labor and foreman man-hour to spread 2.4 pounds of ten percent DDT in pyrophyllite. In light of examinations of more than 6,000 rats from both undusted and dusted premises, the DDT dusting was found to reduce the oriental rat flea population by 85 percent. A 77 percent reduction was found among all the rat fleas, the somewhat lower figure resulting from difficulty in controlling the "stick-tight" poultry flea. Rat mites were reduced 66 percent in spite of the fact that mites constitute a group of arthropods generally found to be difficult to control with DDT. Only a seven percent reduction was indicated in the case of rat lice. An over-all reduction of 43 percent was found among all rat ectoparasites. More than 3,000 blood samples from rats taken from both dusted and undusted premises were submitted for complement-fixation tests. These tests indicated that the number of typhus infections among rats in dusted premises was 40 percent less than those in undusted premises.

Dusting programs in the respective states followed similar patterns, with a few variations. Several states combined rodent extermination with practically all of the DDT dusting done, and operated residential and farm programs of typhus control, as well as treating urban and business establishments. In one state supervision of residual house spraying and typhus dusting was combined, although each of these operations constituted a separate program. Due to the intermittent and scattered

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(below) Dusting an overhead rat run with a small hand duster. (right) Setting traps along rat runs. Trapped rats are bled for complement-fixation tests.





Courtesy of the David J. Sencer CDC Museum

nature of operations in sections of several states, dusting and other control measures in these sections were carried on by mobile units, each of which circulated in an area of several counties. Another state carried on county-wide dusting in some areas and spot dusting wherever typhus cases occurred in other counties. Other state innovations included a program of dusting and poisoning carried out by local health units in all motion picture theaters each quarter, and mixing DDT dust with flour which was placed in suitable locations in restaurants to kill roaches as well as rat ectoparasites. Typhus control was made an integral part of the routine sanitation program in one of the states in accordance with the policy of the state health department to embody some permanency of organization in each county health unit where typhus was of public health importance. In several of the states where control of *Aedes aegypti* and typhus fever were coincident problems, dusting and premise sanitation were combined from the operational standpoint since it required little additional effort to search for rat runs while inspecting for *aegypti* breeding places, and most *aegypti*-infested premises also required dusting. It is still too early to evaluate the effect of residual dusting in controlling human typhus cases.

RATPROOFING AND POISONING. Approximately 4,000 urban business establishments in 57 counties were ratproofed during the year. Each proofing treatment required an average of 36.9 labor and foreman man-hours. Both trapping and poisoning were carried on as a supplement to ratproofing to eliminate those rodents already within the premises. In one state, rat poisoning in connection with ratproofing was made the responsibility of local project personnel. This state also effected the ratproofing of temporary structures by using treated metal lathes as a sub-



(above) Dusting a feed store with a hand pump dust gun. (below) Dusting a rat burrow with a Cyano A foot duster.



(below) Rat dying after drinking "1080" water from paper cup.



Courtesy of the David J. Sencer CDC Museum

stitute for concrete chain walls. For each establishment ratproofed in another of the states, metal or concrete garbage stands were constructed and the cost of new garbage cans, if required, was computed as part of the over-all cost of ratproofing.

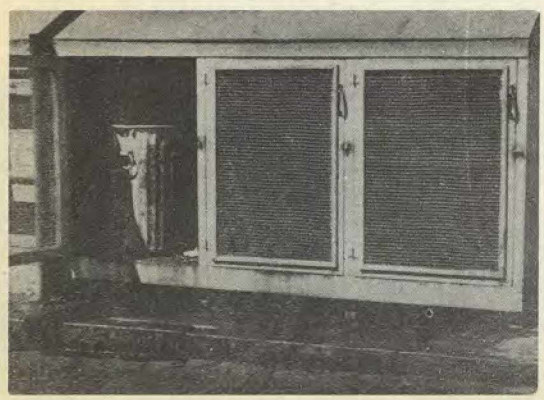
A total of 115,100 premise poisonings was completed during the year, both on an area-wide basis and in connection with ratproofing. Each treatment required 0.56 labor and foreman man-hour to spread 0.63 pound of bait. Most of the area-wide poisoning was carried on in connection with dusting, since the fact that ectoparasites tend to leave dead rats in search of other hosts may temporarily increase the transmission of typhus fever unless control of ectoparasites is combined with rat poisoning measures. Red squill was the poison used most because it is slow-acting and allows the rat to carry DDT back to the burrow and other inaccessible places before it dies. Other poisons used included ANTU (alpha napthylthiourea), 1080 (sodium fluoroacetate) water, and cyanogas "A" dust. A central squill-bait mixing plant was put into operation in one state to furnish mixed bulk and wrapped bait to the state projects. This plant was able to furnish materials to the cities and counties more cheaply than the cost of their buying ingredients and mixing bait themselves. In some areas rat poisoning was combined with premise sanitation for the control of *Aedes aegypti* mosquitoes.

INVESTIGATIONS

To determine the effectiveness of typhus fever control methods, particularly DDT dusting, as they effect the incidence and prevalence of the disease in the human and rodent populations, an investigational project was undertaken in an area in southern Georgia. The incidence of human typhus cases in the study area was determined by a census survey, principally designed to locate mild and unreported cases. The other major aspect of the program involved reservoir and vector studies. Typhus surveys were also made in 21 cities in Arkansas to obtain data on typhus fever cases, ectoparasite populations, and rat blood samples. Technical developments included the combination of ten percent DDT, 50 percent ANTU, and 40 percent pyrophyllite to serve both as a rodenticide and for ectoparasite control. After initial field testing, the mixture was recommended for more extensive field testing on an area-wide basis by selected states. Preliminary technics were also established for testing panels of various construction materials to determine their value in ratproofing.

FUTURE TRENDS

As more of the respective state and local health department personnel gain experience in the application of typhus control methods, it is anticipated that USPHS participation will be limited to epidemiological and technical developmental investigations, furnishing specialized equipment and materials, and providing technical supervision when requested. Activities in the 11 states concerned with typhus control are now largely being conducted with state and local funds and labor. As time goes on it is expected that this trend will be carried to its logical conclusion — complete state and local financing and operation of typhus control field activities.



Ratproofed garbage stand.

Courtesy of the David J. Sencer CDC Museum

Aedes Aegypti Control



As a continuance of the previous year's trend, all of the *Aedes aegypti* control activities this year were integrated into the general sanitation programs of local health departments. It was found that the regular activities of *Aedes aegypti* inspectors could be combined with inspection of other sanitary facilities and conditions to make a comprehensive sanitation inspection at a great saving in cost. This combining of inspection work also tended to assure continuance of *aegypti* control as a regular activity of the local health departments. On a number of projects it was found possible to incorporate DDT typhus dusting and some rat poisoning with sanitation inspection, which resulted in an even more complete public health service with a minimum number of field personnel. Public relations were considerably improved since the public preferred to know and deal with one inspector rather than many, and efficiency was increased. Correction of sanitary violations was obtained primarily by giving the householder a notice at the time of inspection, listing violations and required corrections. In most cases this was sufficient to effect the necessary results.

OPERATIONS

MCWA participation continued through this fiscal year on a diminishing scale, with the local health departments furnishing at least 50 percent of the personnel. In most cases MCWA supplied the field supervision, together with a few inspectors, and the local municipalities provided the personnel to make up the remainder of

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the crews. As shown in the accompanying table, a total of 754,300 premise inspections was made in the continental United States during the year and 31,400 premises were found to be harboring *Aedes aegypti* breeding places. The average breeding index, or the percentage of total premises inspected where breeding was found, was 4.2 for all inspections, each of which required 0.12 man-hour of labor. Activities this year were continued in all of the cities inspected last year, with the exception of Jacksonville, Florida.

Although the over-all index of breeding was almost exactly the same as in the preceding fiscal year, several instances of greatly increased breeding indices were noted. In one city in Florida, inspection and control of breeding places was drastically reduced for reasons of economy during this fiscal year, resulting in a rise of more than five percent in infested habitations among those premises inspected. The marked rise in percentage of infested premises among those inspected in another Florida city during this year was due mostly to the fact that there was no real control program in effect to follow up the inspections made. In one locality in Texas there was no *aegypti* program in operation during the last part of 1945 because of the negligible amount of infestation the year before. As a result of this over-optimistic let-down, the breeding index in this area rose precipitously, necessitating renewed control in 1946. The inspection program throughout Texas was expanded this year to include the surburban towns in the environs of the larger cities regularly inspected. This expansion represented an increase in surveillance rather than an aggravated *aegypti* problem. The value of inspection and control on a modified county-wide basis may be inferred from the material reduction in the breeding index over the preceding year in Hidalgo County, Texas.

AEDES AEGYPTI SUMMARY

PROJECT	PREMISES INSPECTED		INDEX	
	1944-45	1945-46	1944-45	1945-46
Mobile, Alabama	69,946	51,846	10.3	4.3
Jacksonville, Florida	17,682	---	2.0	---
Key West, Florida	29,218	10,052	10.1	15.2
Miami, Florida	383,344	240,165	3.7	4.9
Tampa, Florida	22,606	19,440	2.2	15.7
Savannah, Georgia	76,201	28,609	3.1	2.4
New Orleans, Louisiana	92,409	21,059	6.0	8.5
Charleston, South Carolina	66,834	26,281	2.5	3.7
Brownsville, Texas	75,908	68,531	1.4	1.3
Corpus Christi, Texas	86,936	29,026	0.9	1.2
Galveston, Texas	48,880	21,380	1.3	1.6
Hildago County, Texas	54,937	24,283	2.0	0.9
Houston, Texas	147,136	150,164	2.8	2.6
Laredo, Texas	3,971	22,220	0.2	5.4
San Antonio, Texas	55,837	34,549	5.4	5.8
Norfolk, Virginia	---	3,673	---	6.2
Portsmouth, Virginia	---	3,034	---	3.9
Total	1,231,246	754,312	4.3	4.2
Hawaiian Islands (*A. aegypti* and *albopictus*)	222,788	335,295	5.0	2.2

Courtesy of the David J. Sencer CDC Museum





Aedes aegypti mosquitoes may be found breeding in a variety of containers, such as tin cans in the backyard or in ornamental ponds.

In the cities of Norfolk and Portsmouth, Virginia, MCWA carried on a combination survey and control program during the first half of this fiscal year in those sections of the cities where *aegypti* breeding was most prolific. Local control activities were included in the over-all mosquito-abatement program of the municipal health departments. MCWA participation in control activities in New Orleans, Louisiana, was considered unnecessary in 1946 because the local health unit had the situation under effective control. The program in Savannah, Georgia was terminated at the end of March 1946.

DENGUE CONTROL IN THE HAWAIIAN ISLANDS

The control of *Aedes aegypti* and *albopictus* in the Territory of Hawaii continued during this year according to the basic plan of operation established in the fall of 1943 to cope with the outbreak of dengue fever. This plan stressed *inspection* of premises, *correction* of breeding, and *education* of the householder. One positive case of dengue fever was recorded in July 1945, although a number of suspected cases during the year were investigated and anti-mosquito precautions taken. Because of reductions in staff it was impossible to maintain continuous inspection of all zones within cities as previously practiced. Although each zone was inspected, only those zones of high human population density and demonstrated hazard from the standpoint of



Water barrels should be covered with screening to prevent *aegypti* breeding.

Courtesy of the David J. Sencer CDC Museum

reintroduction of dengue fever received treatment that approached the desired optimum of control.

Routine inspections were made of 335,300 premises, of which 7,300 were found to be breeding *Aedes* mosquitoes. Special emphasis was placed on permanent correction wherever possible. In the course of the year 7,500 catch basins and storm drains, 200 ground pools, 60 cesspools, 90 ditches and streams, and 13 swamps were oiled to eliminate mosquito breeding. In addition, 134 fish ponds were stocked with surface minnows, which feed on mosquito larvae. Phenothiazine strips became increasingly important as a means of controlling interior breeding because they were readily acceptible to the householder. An important phase of this year's program was the development of an alcoholic suspension of DDT in water, which could be used in all breeding containers and served to replace the variety of larvicides previously carried by each inspector. Tests were conducted on the effectiveness of various DDT concentrations in ape plants, lily plants, bamboo stumps, tree holes, and a variety of artificial containers.

Close liaison was maintained with agencies concerned with insect quarantine and inspection of airplanes and other forms of transportation in order to prevent the introduction of medically or economically important insects into the Territory of Hawaii. Also, an extensive program of publicity and education concerned with mosquito control activities was conducted during the year, including news releases, health programs in the schools, numerous public lectures, films, and demonstrations of control technics. The success of the program in the Hawaiian Islands may be judged from the fact that only one positive case of dengue fever was reported this year and the breeding index was decreased from 5.0 in the 1945 fiscal year to 2.2 this year.

Inspectors check flower vases in homes and urns in cemeteries for *aegypti* breeding places.





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Impounded Water Survey

In March 1945 the Impounded Water section of the MCWA Engineering Division was established to conduct malaria surveys of existing and proposed impoundments under the jurisdiction of the War Department Corps of Engineers. This was brought about by an agreement between the Office of the Chief of Engineers and the U. S. Public Health Service for the utilization of the trained malaria control personnel of MCWA to assist the engineers in planning for malaria control on the impoundments which they were constructing or planning to construct. Official requests were made by the Corps of Engineers to the U. S. Public Health Service office of Water and Sanitation Investigations in Cincinnati, Ohio, who in turn requested MCWA to make field studies and prepare reports and recommendations.

The survey reports were prepared after detailed field study of existing conditions. Consideration was given to topography, climate, location, population, and entomological, epidemiological, and other related factors. Impoundments located in the southern states where malaria is endemic were given more complete and intensive surveys. Detailed malaria control methods and procedures were recommended for each reservoir if a malaria problem was present. Estimates of the cost of mosquito control were also furnished so that the engineers could consider this factor as an integral part of the proposed project. The surveys and reports were made with the cooperation of the state health departments. During this fiscal year requests were received from 30 district or division offices of the Corps of Engineers for malaria surveys on 188 existing and proposed impoundments located in 34 states. As of June 30, 1946, 94 reports had been completed and field surveys had been made on 40 additional impoundments.

In the spring of 1946 a training course was held in Atlanta, Georgia, and at Wilson Dam, Alabama, for the personnel of the Corps of Engineers. Plans for this course were made by the MCWA In-service Training Section of the Training Division and the Impounded Water Section of the Engineering Division. The course was attended by 38 engineers representing 31 districts and divisions in 24 states. The first week was devoted to classroom lectures in Atlanta and the last two weeks were spent observing Tennessee Valley Authority field demonstrations, during which time lectures were given by personnel of the Health and Safety Department of the Tennessee Valley Authority.



Impoundment to create a pond for wild life refuge in Santee-Cooper Reservoir.

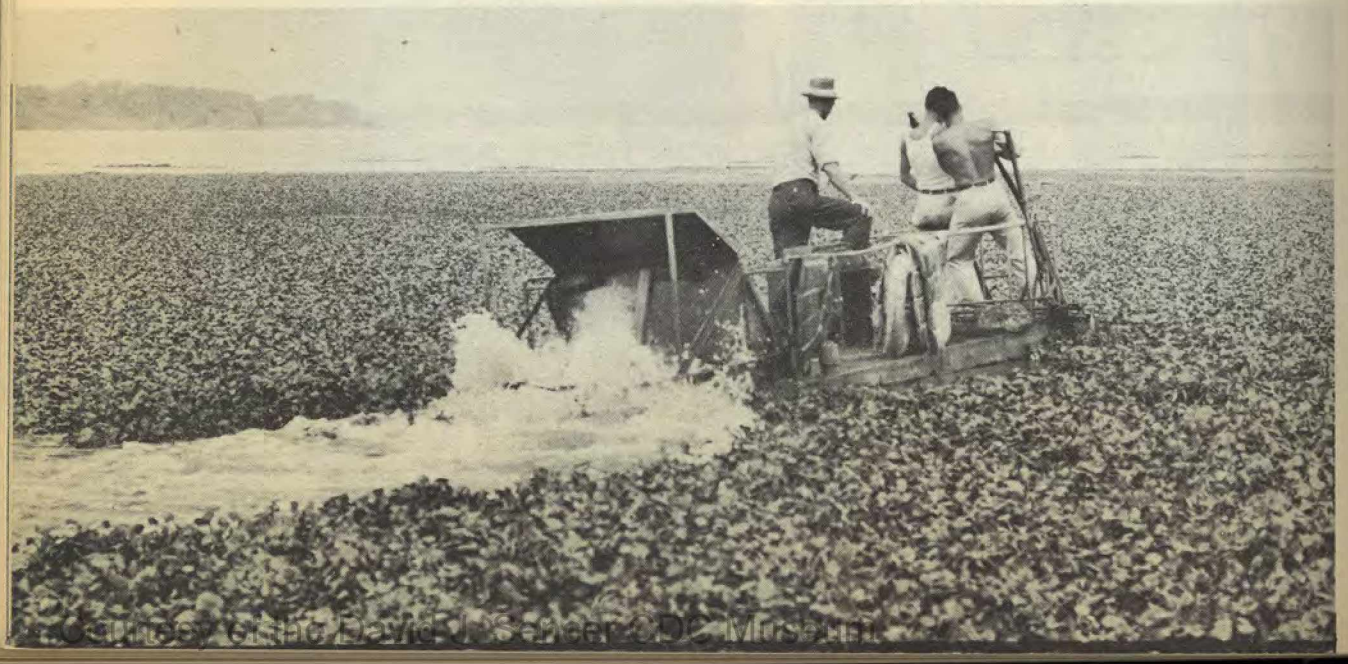
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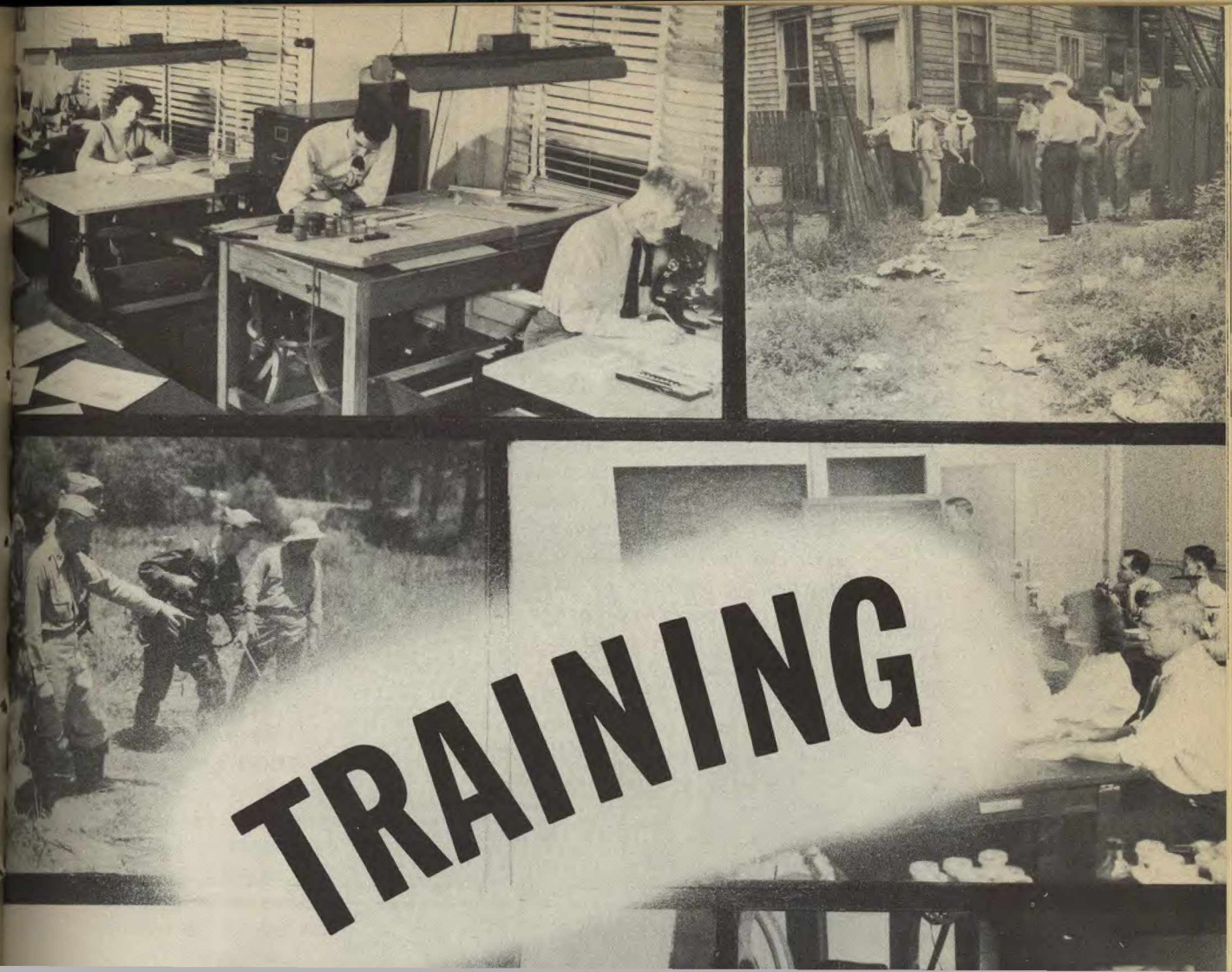
Water-Hyacinth Survey

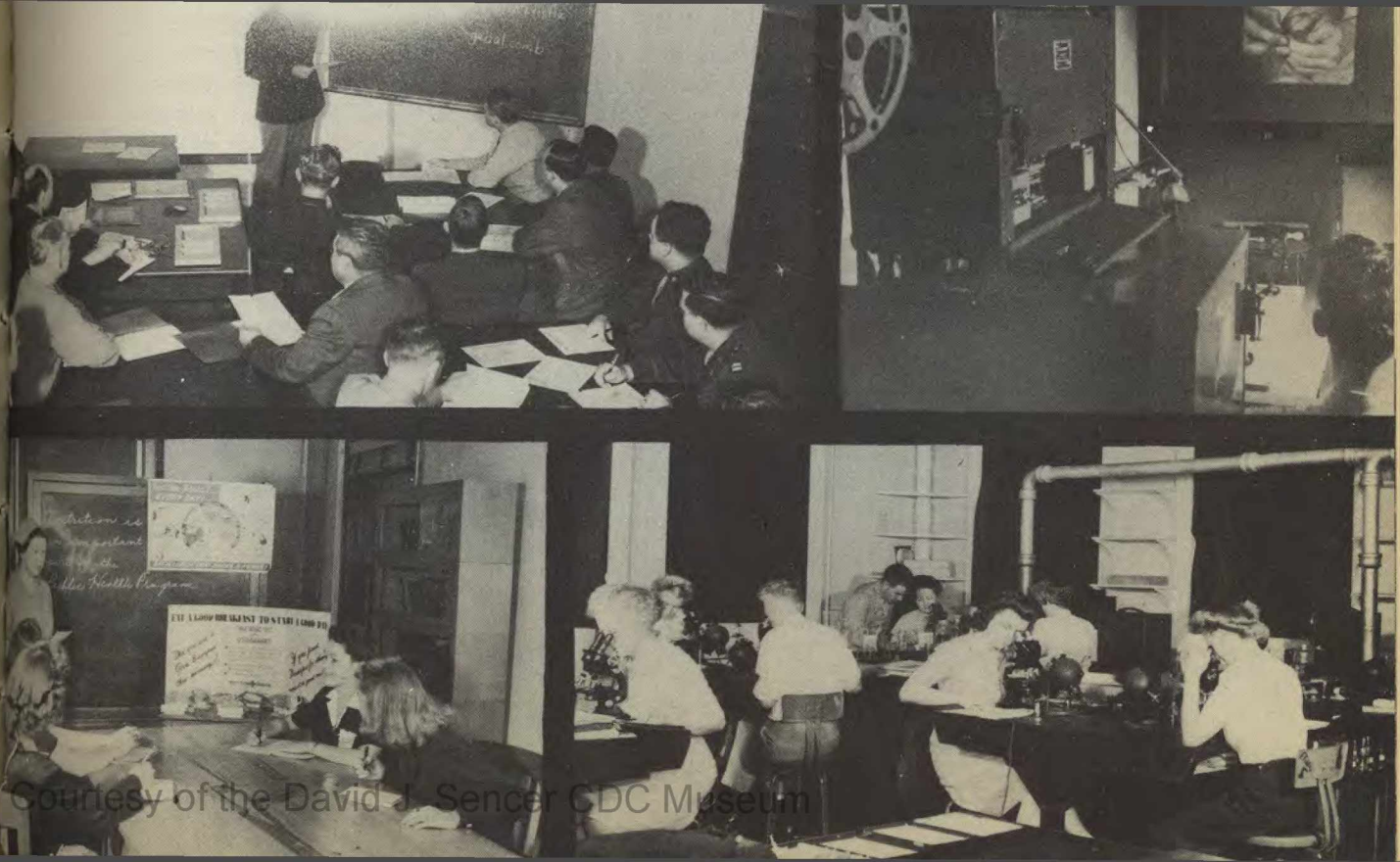
The Committee on Rivers and Harbors of the U. S. House of Representatives passed a resolution on February 6, 1945 requesting the Board of Engineers for Rivers and Harbors to review the water-hyacinth problem with a view to determining: (1) whether any expansion of the scope of operations or any change in the method now employed for exterminating and removing the hyacinth plants and other marine vegetation from the waters of such states as are affected is advisable at this time; (2) the nature and extent of the various public benefits that would accrue from such extermination and removal; and (3) the amount of local cooperation that may be warranted by reason of the local benefits. The Fish and Wildlife Service of the U. S. Department of the Interior, the U. S. Department of Agriculture, and the U. S. Public Health Service were to be solicited for cooperation in this study since obstruction of streams by hyacinth growths affects the fishing industry, agriculture, and health conditions.

In connection with this work the U. S. Public Health Service was invited by the Secretary of War to send a representative to a conference held at Washington, D. C., on August 24, 1945. At this conference plans for USPHS participation in the survey were made. MCWA entomologists were designated who were to meet periodically with the respective water-hyacinth committees of the South Atlantic, lower Mississippi Valley, and southwestern divisions of the Corps of Engineers to discuss the public health implications of any proposed plans of operation and to acquire available information from state health officers on the public health benefits which might accrue from hyacinth eradication in states in which water-hyacinth infestations occur. In addition arrangements were to be made for assistance from specialists of the USPHS office of Water and Sanitation Investigations, Cincinnati, Ohio, in evaluating certain aspects of the public health problems of hyacinth control. During the year entomologists assigned to this work met several times with the divisional committees, and letters were written to interested state health officers requesting information on the problem.

Water-hyacinth cutter of the U. S. Engineer Department cutting aquatic vegetation on the Potomac River.




TRAINING



Courtesy of the David J. Sencer CDC Museum

While servicemen benefited by every preventive technic and therapeutic measure known to science before they were discharged from active service, it was very possible that cases of malaria, filariasis, schistosomiasis, leishmaniasis, ancylostomiasis, and other tropical diseases acquired overseas might present themselves to medical practitioners in any state in the country. In order to cope with the potential hazard introduced by the increasing numbers of discharged veterans returning to every corner of the United States, the MCWA program for the training of physicians and medical technicians in the diagnosis of tropical and parasitic diseases was considerably expanded during this fiscal year. In addition, an entirely new training service was inaugurated at the beginning of the year, known as Internship in Public Health, with the basic objective of giving trainees practical experience under competent supervision in the actual work of a local health department. The in-service orientation and training program was continued for operations personnel, and special seminar courses were offered to malaria control consultants, typhus control personnel, members of the Corps of Engineers concerned with malaria control on impounded water, foreign exchange students, and others. Planning and production of audio-visual materials was accelerated to provide the expanding training programs with instructional aids, of which the supply previously available was both limited and inadequate.

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In-Service Training

Before MCWA had completed its first year of operation, it became apparent that an in-service type of training would be necessary to cope with the lack of available trained technical and professional workers and the high rate of turnover among field personnel, both of which were occasioned by the demands of the armed forces. The first orientation and training course in malaria control was conducted in May 1943 for headquarters personnel. During that summer the Training Division was organized to formally administer in-service training. The second course was offered in December 1943 for field supervisory personnel. By the end of the 1945 fiscal year 36 orientation and training courses in malaria control had been given, in addition to several orientation courses for headquarters clerical personnel. During this fiscal year 16 formal courses were offered, including several to specialized workers and foreign students.

The first in-service courses consisted chiefly of lectures, with little or no follow-up training in the field. The change to include field work was made gradually until, in 1945, approximately one-third of each course was devoted to intensive field training. During this fiscal year the importance of field training and practice was more fully appreciated and an attempt was made to allot at least half the time in each course to field work.

MALARIA CONTROL ORIENTATION. Four orientation and training courses in malaria control were offered this year to newly commissioned officers, field supervisory personnel, and professional people newly employed in the headquarters office. General orientation in the organization of the U. S. Public Health Service at the various levels, including MCWA headquarters, was given to all of the trainees. Special orientation in military courtesies was required for all newly commissioned officers. Instruction in the medical aspects of malaria included epidemiology and identification of malaria parasites. The entomological phases of malaria control covered mosquito surveys and collections, identification, instruction in completing field forms and records used in program evaluation, and the use and care of entomological equipment. The engineering phase was studied through reconnaissance surveys, mapping, control methods and technics, crew management, use and care of equipment, records and reports, and administration of control programs. Trainees usually spent the first week of the course in the classroom in order to get the necessary background material preparatory to field training. The last portion of the course was

Orientation and training courses for newly commissioned officers includes instruction in mosquito collection and paris green larviciding for mosquito control.





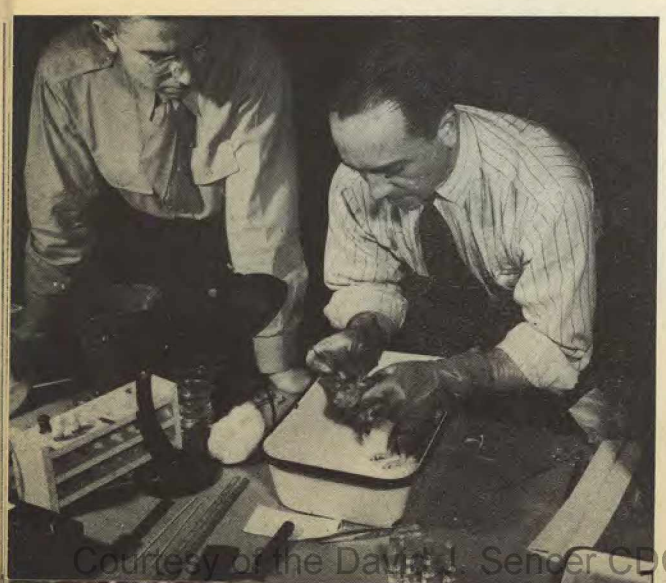
Courtesy of the David J. Sencer CDC Museum



Trainees usually spend the first week of the course in the classroom in order to get the necessary background preparatory to field training.



(above) Rat baits and their use are studied on the rat poisoning program. (below) Rodent ectoparasites are removed from trapped rats and identified.



devoted to field observation and practice in applying the control methods and technics discussed in the classroom.

Several orientation courses were also held for headquarters office personnel. These courses featured studies of the activities of the U. S. Public Health Service and the organization of the headquarters office. In each course a short period was devoted to administrative procedures which were common to all of the divisional offices within the headquarters organization.

MALARIA CONTROL CONSULTANTS. A special course for malaria control consultants was held in August. The five physicians who participated were being trained to act as special consultants in the event of malaria epidemics in their respective states. They received instruction in the identification of malaria parasites and mosquito vectors, malaria survey technics, and malaria control methods.

DDT DUSTING FOR TYPHUS CONTROL. During September and October three DDT dusting training courses, each of two weeks' duration, were offered to new personnel recruited by the respective state offices and headquarters in order to get the typhus dusting program under way. The instruction schedule included films and general discussions on the use of DDT in typhus control; consideration of typhus fever and other rat-borne diseases; the habits and identification of rats, mice, and other rodents, and rat ectoparasites; field practice in the application of DDT dust, and in the setting of all types of traps; and the organization and operation of typhus control programs.

RODENT CONTROL. Two intensive, six-week courses in rodent control were held for state supervisory personnel in order to get state ratproofing projects under way as quickly as possible. These courses, given from November through March, included a consideration

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of the epidemiology of murine typhus fever and other rodent-borne diseases; rodent habits and characteristics; rodent ectoparasites and their control; rat poisoning programs; ratproofing programs; fumigants and fumigation; studies of new rodenticides; field practice in estimating, contracting, ratproofing, and eradication; and administrative procedures in conducting various typhus control programs.

A two-week rodent control course was also conducted during January for personnel from marginal states who would be responsible for promoting rodent control programs. Since these men were not concerned with supervising actual projects, their instruction consisted of six days of classroom lectures and four days of field observation rather than field practice. The lectures covered the same subjects as given in the six-week course, although necessarily condensed. In-service training personnel also assisted states in conducting two-day typhus and rodent control seminars, held at Savannah, Georgia; Boston, Massachusetts; and Hopkinsville, Kentucky. Assistance of other types was given to states as they requested it.



Training in malaria control on impounded water includes field surveys.

PEST CONTROL. In March a special two-day seminar was held to train members of the Georgia Pest Control Operators Association in the proper methods and precautions in the use of 1080 and ANTU rodenticides. The seminar was attended by 36 members of the Association, as well as by a group of trainees who had previously taken one of the six-week typhus control courses.

IMPOUNDED WATER MALARIA CONTROL. A three-week course on malaria control on impounded water was held for personnel of the U. S. Engineering Division, Corps of Army Engineers, during April and May. The USED had many large impoundments under construction and in the planning stages. In order to assist the U. S. Engineer district offices in the field interpretation of malaria control principles as included in the reports and recommendation of MCWA, key personnel from each division were sent to receive this training. The first week of the course, spent in Atlanta, was devoted to lectures in malaria control and discussions of problems and control technics es-



Trainee examining basement for rat signs, as part of rodent control field training.

Courtesy of the David J. Sencer CDC Museum

pecially applicable to impounded water. The last two weeks were spent in the Tennessee Valley observing how the Tennessee Valley Authority had resolved the malaria problem connected with impoundments and had applied control technics. The field trips were conducted by members of the staff of the TVA Health and Safety Department. Before each field trip, a short briefing session was held to acquaint the trainees with the particular phases of control to be observed during the day.

FOREIGN TRAINEES. In June the first of many trainees from foreign countries, who were studying on fellowships at various colleges in the United States, arrived for training in malaria and typhus control. A two-week course was conducted for seven Latin American trainees, including four sanitary engineers, two doctors, and one entomologist. In training students from Latin American countries, instruction had to be modified somewhat because control operations in these countries were usually under the direct supervision of medical men, as contrasted with the system in this country of placing control operations in the hands of engineers. Since a large number of foreign trainees were expected in the next few years, it was planned to enlarge the scope of the training courses to include instruction in basic sanitation for foreign students at one of the field training areas.

SUMMARY. During this year emphasis was placed on actual participation, under close supervision, in field control operations so that the trainees could actually carry out the technics discussed in the classroom. It was also sometimes necessary, particularly for foreign students, to fit the course to the person rather than trying to fit the person into a pre-planned course of training. Because of the wide range in educational backgrounds of the trainees, it was not found practical to set up rigid course schedules (with the exception of typhus control training). Instead, the background of each individual was considered in preparing lectures so that each trainee would receive the basic information necessary for gainful participation in field training. Although the in-service training staff was prepared to give various types of instruction on rather short notice, more efficient and thorough training would have resulted in some cases if the trainees had had proper basic education and experience in the particular field studies. Next year it was anticipated that there would be more decentralized training activities in which groups of public health personnel would be trained locally in the various states.



Actual participation in field work is the keynote of the training courses. Here a trainee is dusting a rat burrow with a Cyano A foot pump duster.

Courtesy of the David J. Sencer CDC Museum

Internship in Public Health

The "Internship in Public Health" section was established July 1, 1945 in an experimental field training area set up in Savannah, Georgia, to study problems in the training of public health workers. From the studies made, a three-month training course was developed for the various types of public health personnel ordinarily employed in a local health department. The basic objective of this course was to give trainees practical experience under competent supervision in the actual work of a local health department, supplementing academic training offered in schools of public health. Trainees were exposed to the routine problems coincident with the operation of a representative local health department, and the methods of solution of these problems were studied.

The Savannah-Chatham County (Georgia) Health Department was selected as the initial training area. Facilities were made available for internship training through the cooperation of the Director of the Savannah-Chatham County Health Department and the Georgia Department of Public Health, through its division of Local Health Organization. Classroom, clinic, laboratory, and field facilities were provided by the local health department. MCWA personnel developed the course, in cooperation with the Director of the Savannah-Chatham County Health Department. The teaching staff was supplied by MCWA, and the training was closely supervised to prevent interference with the regular work of the health department staff. Training aids, equipment, and supplies used in the course were made available from the Training Division of MCWA.

Courses were scheduled at intervals of approximately three months. The first course started on January 1, 1946. The trainees participating in the course fell into one of two general groups: (1) those who had completed or were in the process of completing formal academic training leading to a degree in public health, and who needed field experience to bridge the gap between academic theory and the practical application of public health methods; and (2) those who required training at a sub-professional level to qualify for positions in health departments. The type of training offered differed somewhat within these groups, since it was determined largely by the background and experience of each individual. The course work was made sufficiently broad in scope to meet the needs of the various types of personnel found in health departments. Each clsss was limited to fifteen persons.

The training was divided into a three-week period of general orientation in public health organization and methods and a nine-week period of field demonstrations and training. The first week and a half was spent in Atlanta studying federal and state public health activities and policies. The organization and functions of the U. S. Public Health Service were explained, as well as its relations with state and local health departments. A brief introduction to the study of communicable diseases was given, including etiology, epidemiology, prevention of diseases, and general public health laboratory methods. Lectures were supplemented by a visit to the laboratories of the Georgia Department of Public Health.

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GENERAL INSTRUCTION. The remainder of the course was conducted at the Savannah-Chatham County Health Department, which operates as a joint city-county health center. A short period of general orientation was given to the group as a whole, without regard to background or experience of the individual members of the class. The orientation began with a general survey of the facilities centered in the training area. The group then received instruction in those phases of public health work common to every job in a health department. Training in public speaking was considered essential, since members of a health department should be capable of explaining health programs to the public. Radio technics were also included. Motion pictures and film strips were shown and discussed, including the proper use of projection equipment and film libraries. The importance of pamphlets and posters in disseminating information to large groups was stressed, and the trainees also prepared news items for release to the press.

The basic importance of vital statistics was emphasized, and attention was given to proper organization of records, statistical analysis, and epidemiological data. The trainees prepared and evaluated report forms and individual records, and the correlation between local, state, and federal records was explained. A general course in environmental sanitation was also given to the class so that the trainee might be able to visualize the whole picture of the public health program and the relation of his particular niche to the whole. No formal examinations were given. The work of each trainee was evaluated through his individual preparation of practical health education projects, such as talks, radio programs, pamphlets, posters, and news articles. Each trainee presented his material to the class for discussion and evaluation. A conference period was scheduled at the end of each day's work to discuss the significance of the procedures observed and carried out.

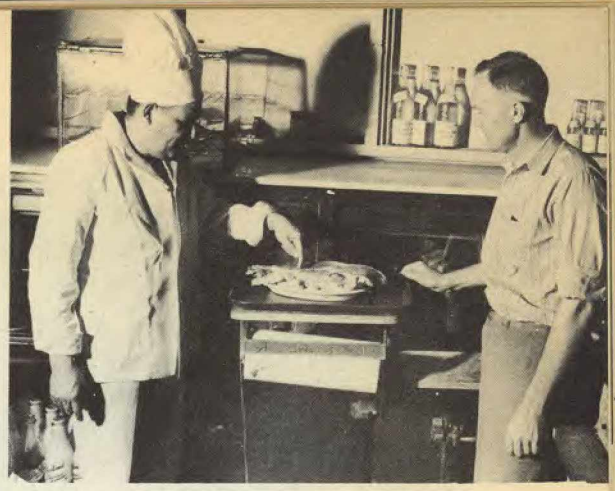
SPECIAL STUDIES. After the period of general orientation, the class was divided into special study groups consisting of sanitary engineers, veterinarians, sanitarians, public health nurses, health educators, and record analysts. Certain members of each group worked intensively in the different parts of the training area previously surveyed by the entire class, and parts of the instruction given as general orientation were amplified and studied with respect to the particular needs of each group after the class was divided. Separate programs within the course were pursued by each group from this point on.

SANITARY ENGINEERS, VETERINARIANS, AND SANITARIANS. The engineer's activities include primarily the technical planning, supervision, and administration of sanitary works. The sanitarian



Interns examine garbage disposal facilities.





Veterinarian trainees inspect dairy herds, and sanitarians visit eating places to study food handling.

carries on the detailed field activities in environmental sanitation. The veterinarian is concerned chiefly with sanitary problems relating to dairy and meat products. The work of these three groups overlaps in certain spheres and, therefore, they were considered together in the training course. The whole class observed the same field activities, but the individual projects carried out by each group differed to some extent.

Field inspections were made of dairies, pasteurization plants, ice cream factories, and special freezing units, and complete records and reports were prepared and evaluated. Each intern also made a general survey of the problems involved in retailing food products. The trainees participated in a practical program of malaria control in the training area, including larviciding, drainage, and residual house spraying. Similarly, ratproofing, rat poisoning, and general sanitation programs were observed in regard to the latest procedures and technics in the control of typhus fever. The trainees were informed of modern practices in the field of water purification, and each was given an opportunity to participate in the operation of both a large and a small water plant, and in the essential chemical and bacteriological control testing. The development and plans of sewerage systems and sewage treatment works were studied, as well as the general field of industrial sanitation. Interns also investigated recreational facilities of Savannah Beach and the public swimming pool. Projects were assigned in rural sanitation which would provide a working knowledge of design, installation, and cost of proper sewage disposal, and of private and semi-private water supplies. Methods of insect control in rural areas were also investigated.

The interns were encouraged to answer complaints of sanitary conditions made by citizens in the community. They discussed necessary corrective measures and then followed through to see that the source of the trouble was eliminated. Premise inspections were made of city blocks in widely separated sections of the city. A series of lectures and demonstrations, together with clinic and home visits, gave the trainees a better understanding of the purpose and scope of public health nursing. Veterinarian trainees spent two weeks of the course in a detailed investigation of the physical facilities of abattoirs and the problems of abattoir inspection. The last part of the course for veterinarian trainees concerned the epidemiology of some of the diseases transmitted by animals. The location of disease foci, the importance to the human population, methods of control, and estimation of cost of controlling were outlined by the intern.

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At the completion of the program for sanitary engineers, veterinarians, and sanitarians, each group had not only a detailed working knowledge of its own specialty, but also an understanding and appreciation of the problems of the other groups, as well as a complete picture of the public health program.

PUBLIC HEALTH NURSES. Intern nurses were taught the accepted technics of home nursing visits, and each was given a series of cases for clinic or home supervision. Clinic organization, administration, and procedure were studied, and the interns participated in the activities of both communicable and non-communicable disease clinics. Nurses were also stationed in child health centers in various sections of the city where they observed and helped in the routine work. In addition to care and inspection in the centers, the interns organized and instructed lay groups in public health problems. Frequently they were called upon to lecture before various clubs and to enlist cooperation in stimulating civic action. The interns also worked closely with regular nurses and teachers in promoting and developing a sound health program in the schools. The intern nurses performed the various nursing duties involved in public health programs under the direction of competent, practicing supervisors.

HEALTH EDUCATORS. The objective of this training was to provide field experience in public health education, and the course was designed to outline methods and sources of materials. An annotated list was prepared of national, state, and local organizations from which health education materials were available, to be used as a guide in obtaining materials for future work. The importance of maintaining a library of health education materials was stressed, both for use of the health educator and other health department staff members. Studies were also made of the material that should be placed in public libraries. Selected books were reviewed and discussed, and surveys of libraries were made to determine adequacy of available health education materials.

Interns were taught proper methods of preparing news articles by conferences with professional news writers, discussions of articles released currently, and by group criticism of articles prepared by individual trainees. Observations were made in clinics and in the field to obtain first-hand knowledge of information





Nurse interns participate in the actual work of the clinic and child health center, besides making routine home visits with public health nurses.

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Health educator interns are taught to evaluate audio-visual and radio technics and materials.

which should be made available to the public, and posters, pamphlets, and news articles were prepared by the trainees and released to the public as part of the various health education programs in progress in the area. Trainees also worked in conjunction with the local health department staff in developing lay information materials on a rabies control program, as representative of an intensive campaign against one problem. In this project emphasis was placed on health education as a joint function of the entire health department staff rather than the sole responsibility of the health educator.

Specific instruction was given as to content, composition, layout, and reproduction of annual reports. Each trainee prepared a dummy copy of an annual report and solicited bids for reproducing by various methods from local printing firms. Interns also received instructions and experience in organizing study courses and in conducting classes for lay and professional groups. The trainee was held responsible for providing suitable pamphlets, posters, motion pictures, and other materials necessary for such courses and for conducting the meetings of the classes so organized. A well-rounded school health program was developed by the intern through individual conferences with teachers, administrators, PTA leaders, school nurses, and children. The health educator also worked toward the formation of a school health council, developed teachers' kits of health materials, and placed selected materials in the school library. All during the



Studies are also made of health education materials to be placed in schools and public libraries.

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training course, methods of objectively evaluating materials and technics of health education were taught.

RECORD ANALYSTS. Record analyst interns reviewed and evaluated records and report forms recommended by the state health department to the local health units, and records designed locally for the recording of local health services. Opportunity was given for constructing record and report forms for administrative, service, and statistical purposes. The interns were trained in the technics of computing and applying public health statistics to local health problems, and in using these statistics as a means of interpreting community health records.

SUMMARY. It should be strongly emphasized that almost the entire time of the trainee during the twelve-week internship course was spent "working on the job" under close supervision. The practical field work provided experience as a supplement to academic training offered in schools of public health. The internship course was made flexible to accomodate both professional and sub-professional people of widely differing backgrounds and experience. Although the internship course was based on and intimately connected with the routine work of the health department activities, there was no interference with this work, since the teaching load was absorbed by the MCWA staff of instructors working in close cooperation with the health department. Specialized study in each course was based upon the nature of requests from state health departments for assistance in training new personnel to carry on sanitation activities.



Record analyst interns review and evaluate records and report forms.

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Diagnostic Laboratory Training

In 1944, when the end of the war was in sight, a memorandum was prepared at a meeting of the American Society of Tropical Medicine by the committee on war and postwar problems, calling the attention of the Surgeon General to the possibility that certain exotic parasitic diseases might be introduced into the United States by returning service personnel and by travelers in this air age. The need for adequate diagnostic laboratory services was apparent, especially to aid the practicing physician in prompt recognition and reporting of such tropical diseases.

Accordingly the recommendation was made that the U. S. Public Health Service consider setting up an information service for practicing physicians designed to emphasize the possibility of the introduction of certain exotic species and strains of parasites, particularly amoebiasis, schistosomiasis, filariasis, ancylostomiasis echinococcosis, leishmaniasis and trypanosomiasis, and malaria; and to assure that adequate laboratory diagnostic services would be available through health departments for the use of the physicians.

FIRST PLAN. Under the direction of the Surgeon General, a plan was proposed in the fall of 1944 to give brief refresher courses in the identification of the principal tropical parasites at one of the several schools of tropical medicine in this country to interested professional and technical men being discharged from the service and then to assign them to state health department laboratories. These trained technicians were to serve the states both in the laboratory diagnosis of tropical diseases and in training other technicians within the state. A survey was made of all colleges and universities in this country to determine whether any had the facilities and were willing to give such courses. It was found that none of the schools surveyed were able to handle such refresher courses by reason of personnel or equipment limitations. In addition, no qualified veterans could be recruited and this original plan proved impracticable.

SECOND PLAN. On February 21, 1945 the responsibility for carrying out a training program was placed with the Office of Malaria Control in War Areas, and it was proposed that a laboratory be established at headquarters in Atlanta, Georgia. To make this plan feasible, it was decided that currently-employed state, city, and municipal laboratory technicians be brought to the MCWA laboratory for brief refresher courses instead of trying to recruit and train new personnel for assignment to the states. This plan was presented to the American Society of Tropical Medicine and to state and territorial health officers, and in the spring of 1945 a Professional Information section was set up in the Training and Education Division of MCWA.

LABORATORY ESTABLISHED. At first the Professional Information section was established for the edification of practicing physicians and functioned to build up a fund of specialized information on tropical diseases, including a lantern slide library and an information service. As additional personnel became available plans were put into operation to establish a laboratory. Space was obtained, facilities planned, and equipment was secured - not without considerable difficulty due to

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Lectures precede each day's laboratory work.

war-time shortages. On September 1, 1945 this section was renamed the Diagnostic and Training Laboratory, under the Training and Education Division. The MCWA laboratory was designed to serve three purposes: (1) to offer an intensive training course in the laboratory diagnosis of tropical diseases; (2) to serve as a diagnostic laboratory for the examination of specimens submitted by state health department laboratories and from various surveys; and (3) to serve as a distribution center for teaching materials. It was obviously impossible for all employed technicians to come to Atlanta for the training course, and it was therefore decided to send teaching materials to the state, county, city, and municipal laboratories for practice diagnosis and instruction. This extension service was started with malaria films. This service was so well-received everywhere and has grown so rapidly that more than 150 laboratories in 48 states and the District of Columbia are now on the mailing list. Sets of prepared slides of fecal material are being sent monthly to about 59 former students in 26 states and Puerto Rico for reviewing the laboratory diagnosis of intestinal parasites.

COURSE WORK. The first course was announced through the USPHS district offices to the various state health department officials. They submitted lists of persons whom they wished to have attend the first course or a subsequent course. A committee from the Training and Education Division of MCWA selected 21 individuals from these lists, based not so much on the educational background or experience of the individuals as on the wishes of the states. An attempt was made to distribute representation throughout the country and to include individuals from the various USPHS districts. Several MCWA technicians were also included in the first class.

On October 1 the first class of 24 students, representing 19 states in eight USPHS districts, reported for instruction. (This was one day after the all-important microscopes were delivered to the laboratory.) The course work was divided into two sections; the first three weeks were devoted to the laboratory diagnosis of intestinal parasites and the second three-week period to the diagnosis of blood parasites. Weekly topics included: diagnosis of intestinal protozoa (amoebae, flagellates, cultivation and concentration technics); diagnosis of intestinal protozoa and helminths (ciliates, coccidia, nematodes, staining and concentration technics); diagnosis of intestinal helminths (cestodes, trematodes, and concentration technics); diagnosis of hemoflagellates, filarial worms, and malarial parasite thin films (leishmaniasis, trypanosomes, filarial worms, four species of plasmodia, and staining of blood films); diagnosis of malarial parasites in thick blood films and arthropods of medical importance; and diagnosis of malarial parasites in thin and thick blood films. Various books on parasitology and tropical medicine and many scientific and technical journals in the library were available for study and laboratory reference, in addition to the several manuals on medical protozoology, helminthology, and arthropods of medical importance supplied to each student for individual use.

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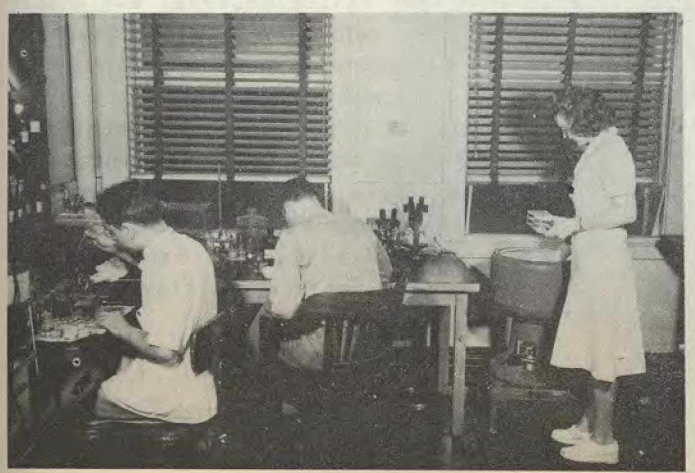


The Preparations Laboratory (left) and the Culture Laboratory (right) prepare specimens and material for course instruction and the extension service.

INSTRUCTORS. Several individuals participated in the instruction; some were visiting lecturers and others were members of the staff. The Malaria Investigations Office of the National Institute of Health loaned a protozoologist to give the section of the course on microscopical diagnosis of malarial parasites. An engineer and an entomologist were loaned by the in-service training section for that portion of the course devoted to the identification of arthropods of medical importance. The lectures and laboratory instruction on the protozoa (except malarial plasmodia) and helminths were shared by two regular staff members.

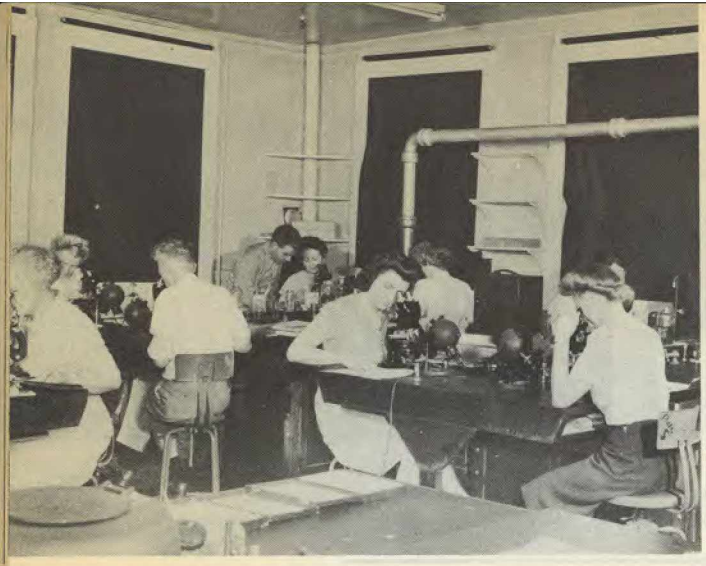
LABORATORY FACILITIES. In addition to class instructors, the assistance of six technicians was utilized during the laboratory exercises. These technicians were permanently assigned to one of the four laboratories maintained as part of the Diagnostic and Training Laboratory. The Preparations Laboratory was responsible for procuring specimens and equipment for instruction and for the preparation of materials for the extension service. The Culture Laboratory maintained strains of intestinal and blood parasites to be used both in the teaching program and for the extension service. The Intestinal Parasite Laboratory participated in intestinal parasite surveys in cooperation with state and local health departments, and received and checked the identity of intestinal parasite material sent in from various sources for class use. This laboratory prepared the daily practice unknowns for identification by the students as part of the course work. The Blood Parasite Laboratory participated in malaria parasite surveys and hematology studies in co-

(left) The Intestinal Parasite Laboratory participates in surveys and identifies specimens sent in for class use. (right) The Blood Parasite Laboratory identifies malaria parasite material received from field surveys, and checks materials for teaching purposes.





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(above) The greatest amount of time and effort is placed on actual laboratory technics.



(center and below) Students are required to satisfactorily diagnose numerous unknown specimens.



operation with state and local health departments and was responsible for checking malaria slides obtained for teaching purposes. The Staff Laboratory was maintained for research projects carried on by members of the Diagnostic and Training Laboratory staff. All of these laboratories were utilized in connection with the clinic service available to MCWA headquarters personnel, and for the diagnosis of material referred to the Diagnostic and Training Laboratory by state and local health departments.

OBJECTIVES. The objectives of the course were seven-fold: to learn the diagnostic stages of the parasites, including their detailed morphology and the clinical material in which they are found; to learn the infective stages and where they are found; to learn the life cycles of the parasites and the methods of transmission; to learn the routine laboratory examination procedures; to evaluate the laboratory procedures and to learn the significance of the results obtained with each; to learn the symptoms and geographical distribution of the parasite diseases in order to facilitate the laboratory search for the etiological agents; and to learn the arthropod vectors of parasitic and tropical diseases.

COURSE DETAILS. The course was planned from the practical laboratory standpoint. The greatest amount of time and emphasis was placed upon the actual performing of laboratory technics and the microscopical identification of organisms. The students were required to satisfactorily diagnose numerous unknown specimens. A large quantity of fresh, living material was available for this course due to the maintenance of experimental infections and cultures of various parasitic strains, as well as from surveys that were run concurrently by the Diagnostic and Training Laboratory. Additional material was also obtained through the cooperation of the National Institute of Health, the Army Medical School, and the Georgia and Florida Health

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Laboratories. Recently a staff member was assigned to the School of Tropical Medicine in Puerto Rico for the express purpose of collecting additional material to be used in this course.

The greatest effort was made to train the students to be able to find and diagnose parasitic organisms. In addition, it was considered most important that they be capable of interpreting their results and know the values and limitations of the procedures used. In order to assist the lecturers in the presentation of this and more theoretical information, the laboratory staff aided in the preparation of film strips and motion pictures related to parasitology. Some of these were produced specifically for the course, whereas others were designed not only for laboratory use but also for presentation to practicing physicians, medical students, and other professional groups. To provide individual attention, it was found advisable to break the class up into small groups for the purpose of holding discussion sessions and oral quizes to determine the progress of each student, and to clear up any questions over which the students might be puzzled.

The course was flexible enough to make modifications best suited to each class, although the basic information remains much the same for each group. Enthusiastic comments from the students have been very encouraging. Since October 1945 three six-week courses have been given, and 59 individuals representing 26 states and Puerto Rico participated. Those individuals who were deemed to have successfully completed the course were presented with a certificate signed by the Surgeon General of the U. S. Public Health Service.

OTHER SERVICES. On March 1, 1946 the laboratories were separated from the Training and Education Division, and a separate Division of Laboratory Services was created. This was in line with the reorganization of the Office of Malaria Control in War Areas for its evolution into the new Communicable Disease Center, which was scheduled to occur on July 1, 1946. The Division of Laboratory Services conducted various surveys; blood slides were obtained from North Carolina, Arkansas, and Puerto Rico and, to date, 9,861 have been examined for malaria parasites. Fecal



Consultative services are rendered to state and local health departments and practicing physicians.

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examinations for intestinal parasites were made on 450 children from a church clinic in Atlanta, Georgia, and quantitative studies to determine the degree of infection with hookworm were being made of a rural population in South Georgia.

Consultative diagnostic services were rendered to state and local health department laboratories and to practicing physicians who requested them. Field investigations were carried on in cooperation with the National Institute of Health during an outbreak of amoebic dysentery in an Alabama institution. A number of studies were conducted to evaluate and possibly improve various laboratory technics which are used in the diagnosis of parasitic diseases. These included cultivation and staining technics for intestinal protozoa, concentration technics for intestinal protozoa and helminths, and staining methods for malaria parasites. On April 1 the Division of Laboratory Services took over the Rabies Research Laboratory of the Rockefeller Foundation at Montgomery, Alabama for bacteriological and virus investigations. During the next month the complement-fixation work for typhus fever and the mosquito host-preference serology studies were transferred from Washington and Savannah, respectively, to this laboratory.

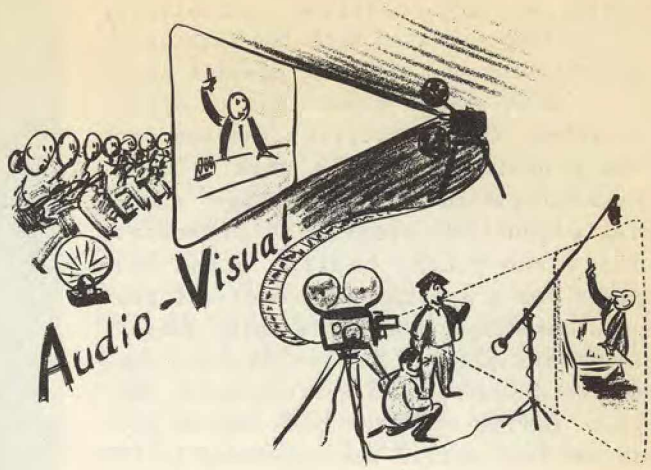
Although much has been accomplished in the past year, the Division of Laboratory Services is still in its infancy. With the establishment of the Communicable Disease Center, this division will be ready to contribute its share to the ever-expanding responsibility of guarding the nation's health, undertaken by this new agency of the U. S. Public Health Service.



Field investigations were carried on in cooperation with the National Institute of Health during an outbreak of amoebic dysentary in Alabama.

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Training Aids



Training aids are indispensable to the proper execution of a modern training or educational program, and the production and correct use of these aids are highly important in the organized presentation of such programs. In the logical sequence of producing aids to training, the first step is to plan audio-visual material as an integral part of the training program; the second step is to produce these aids. In actual practice planning must take account of the mechanical and technical limitations of any process used, and therefore these two steps are never entirely separate operations.

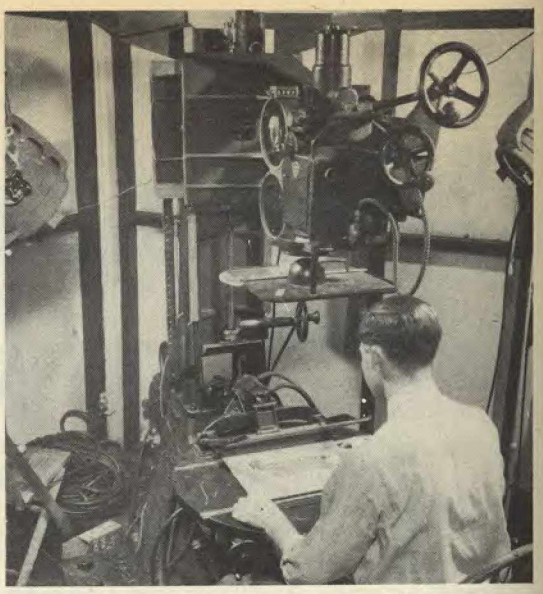
PLANNING During this fiscal year the planning section of the Training and Education Division continued its primary function of planning films, film strips, and exhibits for use in the various technical training activities carried on by MCWA. To keep pace with the ever-increasing demand for audio-visual aids as the training program expanded, it became necessary to reorganize the procedures of script development and production processing. A working procedural flow chart was developed to check the progress of individual projects and the program as a whole. The development of visual materials was sub-divided into the stages of pre-planning, planning, production, release and distribution, and utilization and evaluation. The necessary steps within each stage, and the administration and duties of the participating personnel, were resolved and put into operation. Recruiting personnel to meet the demands of expansion has been a continuing process.

The training of project supervisors, who are responsible for all of the stages in the planning and production of a particular film or film strip, was implemented by a workshop on production technics. In the workshop the project supervisors were assigned a subject of their own choice for development into a motion picture or film strip. Under close supervision they carried the subject through all of the steps of pre-planning and planning as if an actual production were under way. Special consideration was given to story conferences, in which all of the technics used were discussed in detail and where the advantages and limitations of each process were studied. Visual materials already in use were scrutinized at great length with a view toward criticism and improvement of technic. Some of the material so developed in the training workshop was incorporated into the regular program. Technical

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advisors, who are consultant scientists, had to be indoctrinated with the principles of presentation and with the special problems of audio-visual production of scientific films. This indoctrination was part of the planning section's work.

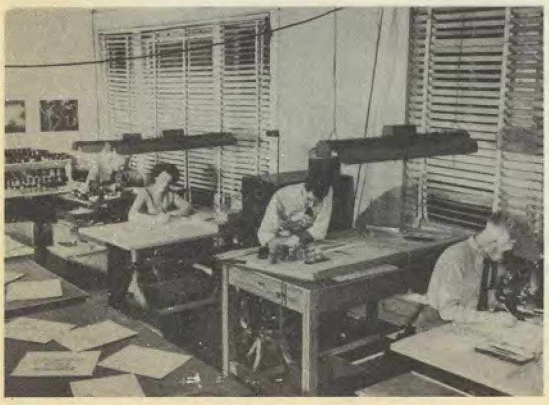
In anticipation of a long-range, audio-visual production program in preventive medicine and public health, plans were prepared for a preliminary, over-all prospectus based upon the three major subject areas: principles of public health, communicable diseases, and environmental sanitation. During the year both motion pictures and film strips were produced in the last two of these three subject areas, but their production was determined largely by the needs of the training and education programs rather than as a part of a comprehensive program in preventive medicine and public health.



Story boards for film strips are photographed in sequence on an animation machine.

PRODUCTION. The training aids production section also expanded considerably in personnel and production facilities during this year. Equipment for rush and emergency work was installed since competent processing laboratories are located at great distances from Atlanta and long delays were sometimes involved in obtaining service from them. However the policy of utilizing the services of commercial laboratories in the routine mass production of motion pictures and film strips was still being adhered to.

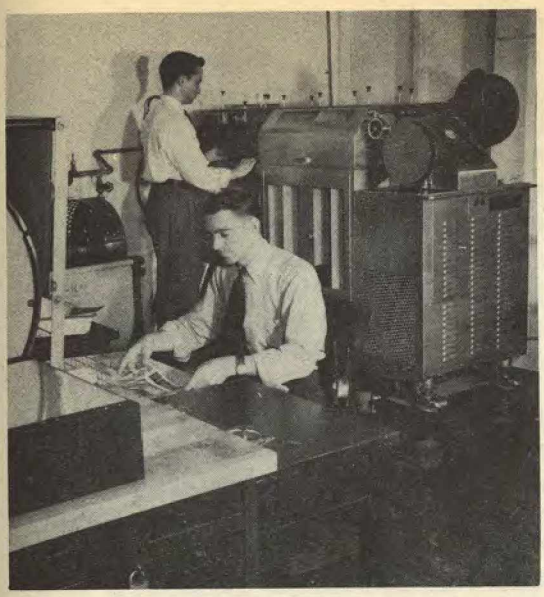
With the equipment available it was possible to turn out the first prints of film strips and recordings on very short notice. Such had frequently been the case during the year when audio-visual material was urgently needed for a new class or where a special foreign-language recording was required for a national or international meeting. Further steps were being taken in this direction to provide MCWA with the latest production equipment, permitting a more finished and professional type of motion picture and film strip. Also, a satisfactory color film strip process was developed and a large majority of the film strips produced were in color, which adds considerable audience interest to the presentation of the subject.



Illustrations for publications and films are worked up by the art unit.

During this year 15 motion pictures and 26 film strips were completed and released. The number of motion pictures by subjects were: impounded water, four; laboratory

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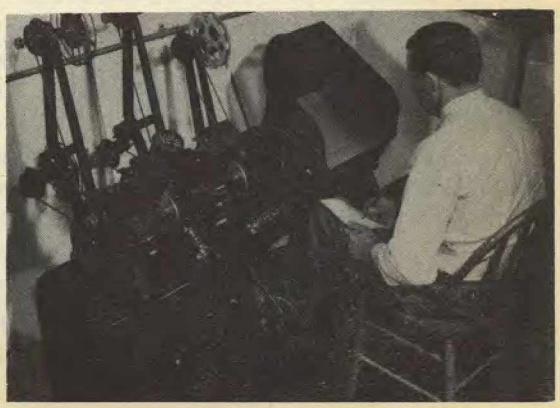


Developing a film in a 16 mm. developing machine.

processes, two; medical aspects of malaria, one; dengue and yellow fever, three; malaria control technics, 12; tropical diseases, three; yellow fever and dengue control, three; malaria lay education, two; malaria entomology, one; typhus, four; and milk sanitation, one. Work was also begun and partially completed on nine other motion pictures and 21 film strips. Although these and other projects initiated in the past will be completed, the policy of the organization has shifted from the preparation of visual aids for both lay and professional groups to preparation exclusively for professional people.

The production section also furnished three exhibits for display at major scientific meetings in this country and provided photographic and art material for handbooks, field bulletins, and reports released by MCWA. In carrying out the foregoing work, and in supplying services to other divisions of MCWA, this section produced 6,767 black-and-white and 2,774 color photographs, 21,224 black-and-white and 138 color prints, and 662 projection slides. The art unit was called on for a variety of chores, including retouching 300 photographs, 232 art story boards, 105 overlays, 75 film strip and motion picture titles, 55 lettering jobs, 45 general illustrations, 24 maps, 18 charts, 15 cover designs, 15 pictographs, 12 photo-montages, designing 6 exhibits, and 28 miscellaneous jobs.

FILM LIBRARY. For the efficient use of visual aids, especially in light of the planned production expansion, a well-organized film library was a "must." A member of the staff of the Training and Education Division was assigned to the task of surveying existing audio-visual materials and the facilities for projection, maintenance, distribution, and exchange. Based on his recommendations, plans were to be drawn for a film library. On November 7, 1945 a memorandum was issued for the establishment of a library which was to serve as a national distribution center for films and other visual aids on tropical diseases. The scope included materials produced by MCWA headquarters, materials acquired from other sources for distribution by MCWA, and an in-service library for exclusive use by headquarters. Types of materials involved included: 16 mm. motion pictures, sound and silent; film strips,



Editing motion picture film.

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For the efficient utilization of visual aids, a well-organized film library is a "must".

sound and silent; lantern slides, color and black-and-white; charts and portfolios; projectors; and pertinent literature, such as film lists, circulars, and study guides. Detailed plans were also drawn up for the physical lay-out of the office, library, shipping and receiving room, maintenance and repair room, and the projection theater. A policy of distribution and exchange was tentatively proposed.

On April 15, 1946 a film librarian was hired to revise and put into operation the plans previously proposed. The physical lay-out became a reality, including an air-conditioned theater. Necessary personnel was hired to staff the library. A definite distribution policy was approved and set in motion, including: closer cooperation with district offices; working arrangements with state, city, and county health departments for the showing of films to the general public; reciprocal aid between this office and other government agencies, both foreign and domestic; agreements with many commercial companies for the use of their films; a loan policy with the U. S. Army and Navy; and exchange arrangements with colleges, universities, and institutions interested in the public health. Cataloging and booking files were devised. A film source file with approximately 1,000 sources from which to procure films was established. Assistance was garnered from commercial distributors located in Atlanta for large-scale repairs of projectors and related equipment. A training course was worked up for personnel concerned with the proper usage and maintenance of audio-visual projection equipment. While only a beginning was made in all of this work, the plans were set and the film library began to expand rapidly toward its goal of becoming a national distribution center for visual aids in tropical medicine.

PUBLICATIONS. In addition to the use of films, film strips, and exhibits, the training and education programs conducted by MCWA were implemented by various handbooks, bulletins, and reports. Three handbooks on the use of DDT were prepared during this fiscal year. Two of these were concerned with operational programs: "DDT for Control of Murine Typhus Fever," and "DDT Residual Spray Operations." The third handbook was issued in response to requests for information on the use of DDT in homes. The title of this was "DDT for Control of Household Insects Affecting Health." Other handbooks were prepared or extensively revised during the year. These included: "Drainage Maintenance," "That Drainage Job," "Identification of Female Anophelines of the United States," "Larviciding," "Schistosomiasis," "So You've Had Malaria," and "Entomological Field Handbook."



Tireless research is required to produce handbooks, bulletins, and reports.

Courtesy of the David J. Sencer CDC Museum



The mainstay of any training program is a comprehensive reference library.

Five Field Bulletins were issued for distribution to MCWA and other interested personnel. These contained statistics of operations and articles of informative and technical nature concerning program operations. Many of the articles were prepared by field personnel. Field Bulletins averaged about 16 pages per issue and contained numerous photographs, drawings, and tables. The Annual Report of MCWA activities for the previous year was prepared and published. This volume, consisting of 136 pages profusely illustrated with photographs, charts, maps, and drawings, was circulated to members of the organization and other interested persons. In March 1946 a compilation of "History of Malaria Control in War Areas" was begun. This is to be a detailed account of activities of the MCWA office since its inception. It is anticipated that this report will be completed during the current fiscal year. The reports section also supplied scripts for use in the preparation of film strips and motion pictures to be used in connection with the training program. These included subjects on entomology and engineering.

Nearly two million pieces of literature were sent by MCWA to district and state offices during the year to be used in public relations and lay education work. By title, the number distributed to the public, in schools, and at various group meetings was: "Malaria Folder No. 1," 500,000; "How DDT Spray Keeps Malaria Away," 300,000; "Spraytime Topics," 250,000; "Malaria, Lessons on Its Cause and Prevention, For Use in Schools," by H. R. Carter, 200,000; "Kill That Flea," 107,000; "DDT For the Control of Household Insects Affecting Health," 78,000; "Mosquito Cut Out," 75,000; "So You've Had Malaria," 75,000; "Dengue and Yellow Fever are Carried by This Mosquito, *Aedes aegypti*," 75,000; "This Mosquito Carries Dengue and Yellow Fever," 50,000; "Handbook of DDT Residual Spray Operations," 50,000; "Impida El Dengue Y La Fiebre Amarilla," 35,000; "Entomological Field Handbook," 30,000; "Malaria Education," by Elma Rood, 30,000.

REFERENCE LIBRARY. The mainstay of any training, education, or research program is a comprehensive reference library. When MCWA was first organized most of the professional people brought their own personal collections of books with them for reference purposes, and no central library existed. New purchases of books for use in MCWA work were made on a sectional and divisional basis and a series of small, specialized library collections grew up within each division of MCWA. As training activities expanded, it became necessary to provide students with reference materials for use in their course work. Most of this material was scattered throughout the divisions and sections of MCWA headquarters and it was obvious that a central library system was needed not only for use by students but also to provide more facile reference facilities for headquarters personnel.

Accordingly, in October 1945, plans for a library committee were formulated, members to the committee were appointed, and space was provided for a central library to serve the entire MCWA headquarters. On December 6, 1945 the Library

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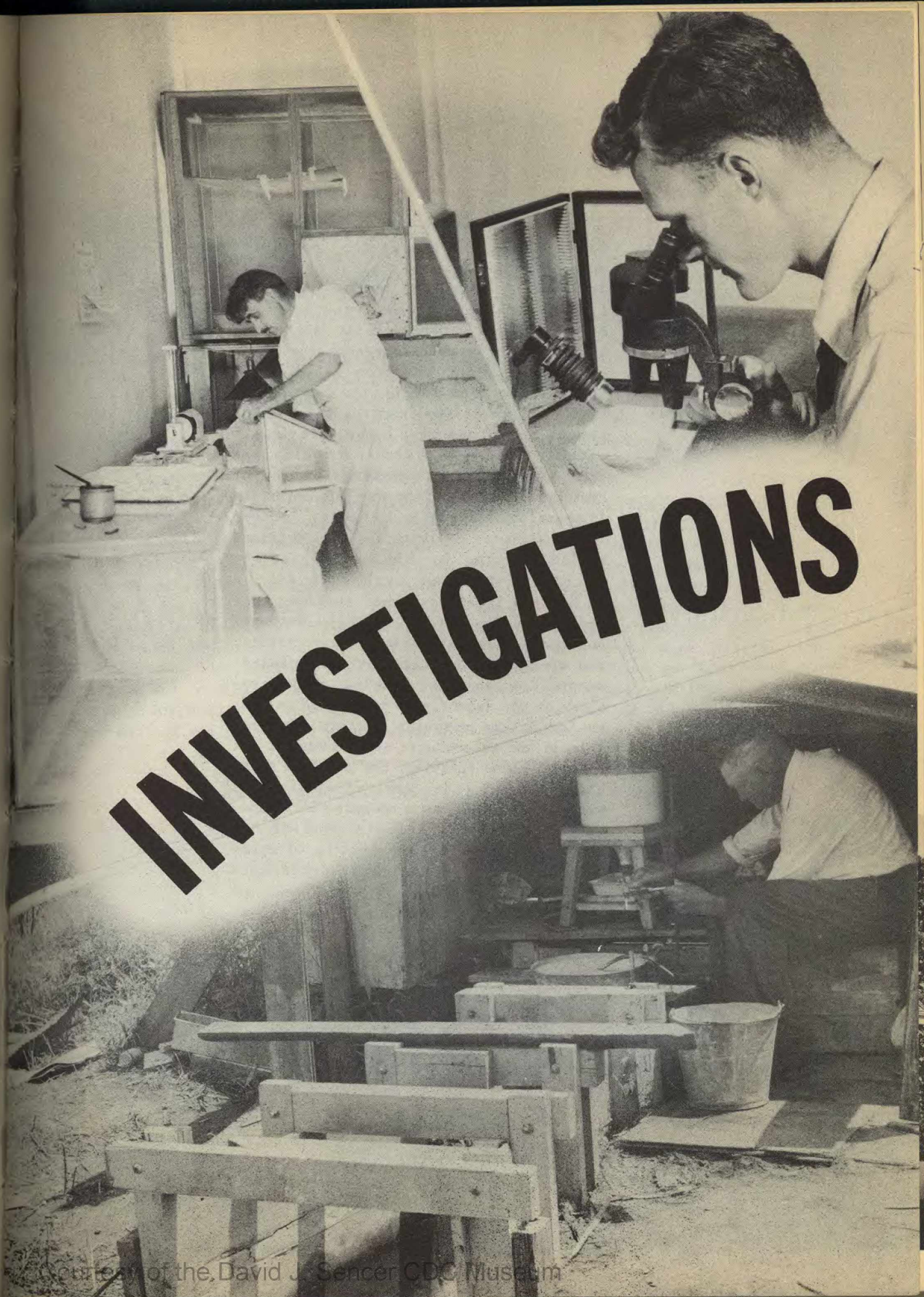
Board (nee Library Committee) met to formulate a policy. It was decided that the library should contain basic reference or source books in the various sciences related to infectious disease control and a comprehensive collection of the current periodicals in the fields related to infectious diseases. An abstracting service was contemplated for any employee of MCWA requesting it. The library also was to work in close liaison with the National Institute of Health library on an exchange basis to take advantage of its greater facilities. In January 1946 a member of the MCWA staff was appointed acting librarian and the actual organization of the library began with the gathering of the reference materials from the various sections and divisions into one central library. A full-time librarian assistant was appointed in April and the huge task of cataloging the books and periodicals on hand and purchasing additional books and periodicals to carry out the original plan of the Library Board was begun.

By the end of this fiscal year the library was able to offer efficient reference facilities to both students and headquarters personnel, despite the fact that only a small portion of the proposed total number of books and periodicals had been acquired. An exchange service was established with the colleges, universities, and medical schools in Atlanta and vicinity to supply reference materials not yet possessed by the library. Its resources were made available on a short or long term loan basis to other departments, institutions, and individuals interested in public health. At the present time the library is expanding to include those services offered elsewhere only by the library of the London School of Hygiene and Tropical Medicine.

Training aids are the result of innumerable conferences on planning, production, and utilization.



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Knowledge gained from laboratory and field investigations is the foundation upon which operational control of disease is based. A large part of the investigational work this fiscal year was concerned with the objective of at least maintaining malaria at its present low level of morbidity and possibly eliminating it entirely from the United States. To this end, operational control was concentrated on DDT residual house spraying in endemic areas to protect the civilian population against the possibility of contracting malaria from carriers returning from malarious areas overseas. Another important phase of investigation pertained to DDT dusting for the control of rat ectoparasites and typhus fever.

Related investigational studies, carried on in cooperation with the National Institute of Health, several universities, and state health departments, included: anopheline bionomics studies; determinations of the infectivity of foreign malarias for native mosquito vectors; epidemiologic and entomologic evaluations of DDT residual house spraying; the residual durability of DDT under various conditions; evaluations of DDT as a mosquito larvicide, and its possible effects on fish and wildlife; the design and testing of spray equipment; anopheline host-preference studies; and DDT dusting in relation to human typhus prevalence. Other investigational studies this year were concerned with the implication of insect vectors in the transmission of certain virus infections.

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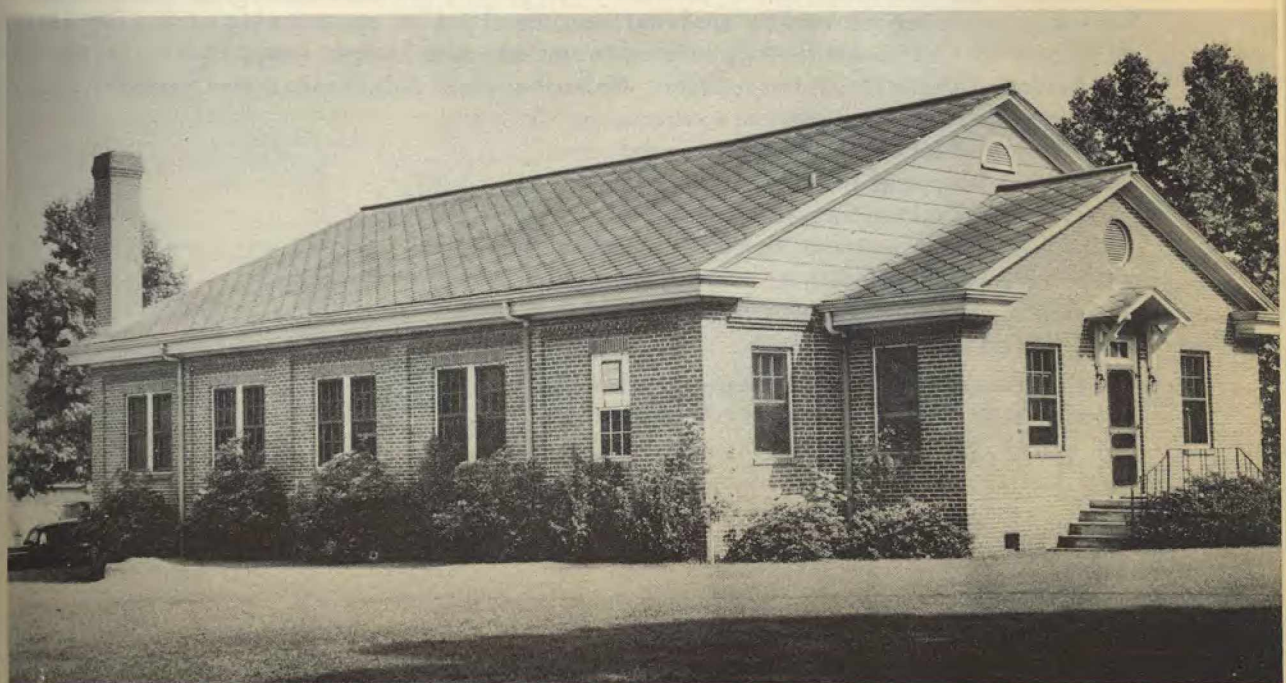
Technical Developments

During the year the residual house spraying technics developed at Carter Memorial Laboratory in Savannah, Georgia, were put into operation on the Extended Malaria Control Program of MCWA. With the acceptance of these technics in large-scale application, the work of the laboratory was directed toward the solution of other DDT problems. Emphasis was placed on developing an acceptable technic for using DDT as an anopheline larvicide, and observing the effects of such larviciding on fish and fish-food organisms. Detailed investigations were made of some of the factors affecting the residual effectiveness of DDT wall spray. Further studies were carried out on the use of DDT in premise sanitation, particularly from the standpoint of control of houseflies in a variety of food-processing and food-handling establishments. An investigational program for the control of rodents and their ectoparasites was initiated this year. As in years past the development and testing of new and improved equipment for mixing and applying insecticides formed an important part of the work of the laboratory.

ANOPHELINE LARVICIDING

Extensive studies on the control of "quad" larvae resulted in the development of a technic for hand larviciding involving the application of DDT in an oil-mist spray. An atomizing nozzle such as is used in fuel oil burners was fitted to an air pressure sprayer similarly to those already in use in residual spraying. At a pressure of 30 to 50 pounds per square inch the nozzle delivered three gallons of No. 2 fuel oil per hour as a fine mist spray. At a convenient pace of about 75 feet per minute an acre could be covered by one gallon, assuming the effective swath width to be about 30 feet. This is a treatment rate of 20 minutes per acre spraying time. Total actual spraying time is more likely to be nearer 1.7 hours per acre, including pumping and refilling. To insure a positive spreading pressure, and thus a more uniform distribution of the surface film, the addition to the DDT-oil solution of one-half of one percent of a spreading agent was recommended.

Carter Memorial Laboratory, Savannah, Georgia



Courtesy of the David J. Sencer CDC Museum



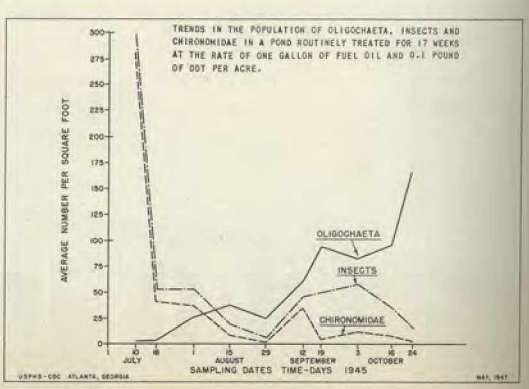
Field trials of DDT oil-mist larviciding.

When DDT in an oil-mist spray was used routinely on the control project, material and labor cost from $1.15 to $1.35 per acre and required 1.7 man-hours per acre. On paris green hand dusting programs the cost per acre for material and labor was from $2.25 to $2.75, and 3.1 man-hours were required. Fuel oil applied by hand cost from $8.50 to $11.50 per acre for labor and material and required three to six man-hours. It was found in using the DDT oil-mist technic that 0.05 pound of DDT per acre was adequate to insure 90 percent control of all instars of anopheline larvae and most culicine larvae and was reasonably safe from the standpoint of damage to fish and fish-food organisms. Extensive field testing by a regular MCWA larviciding crew during the 1945 season proved so satisfactory as to permit recommendation of this technic for large-scale testing by the individual states.

EFFECTS OF DDT LARVICIDING ON OTHER ORGANISMS

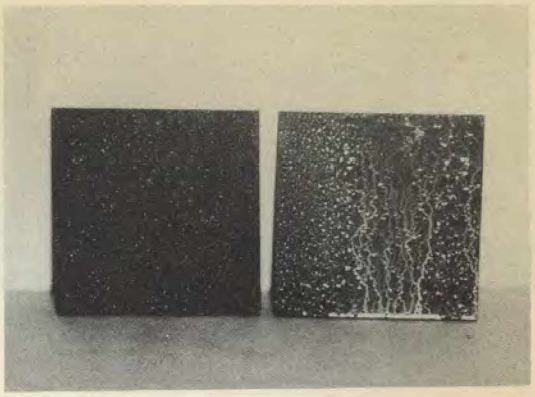
Results of studies of the effects of a larvicide upon fish and upon the major groups of organisms known to be important as fish-food may well be the determining factor in its use. Accordingly a study of the effects of DDT on fish, on surface organisms, on bottom organisms, and on plankton was initiated during this fiscal year. Studies in small, shallow ponds showed that DDT was least harmful when applied as a dust and most harmful when applied as a tight emulsion. A surface film of DDT-oil solution was relatively safe to fish in single doses of up to 0.1 pound of DDT per acre. Even this dosage killed numerous surface insects. Dosages of 0.5 pound and more of DDT per acre was definitely harmful to fish.

Single applications of 0.1 pound DDT per acre killed many surface Hemiptera and Coleoptera. Repeated weekly applications resulted in appreciable reduction in populations of Chironomidae, Ephemeroptera, and the larger members of the families Gyrinidae, Dytiscidae, Haliplidae, Hydrophilidae, Corixidae, and Gerridae. Oligochaeta, Nematoda, and Copepoda were apparently not affected. No significant reductions in populations were noted in any of the plankton organisms as a result of as many as 18 routine weekly treatments with 0.05 pound of DDT per acre. Bottom samples were taken, but have not yet been classified and counted.



Fish apparently suffered no direct effects from single surface applications of 0.1 pound DDT per acre, although crawfish were killed. After from ten to 13 routine

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Proper application of a DDT spray emulsion is shown on the left, and treatment to the point of "run-off" is shown on the right.

applications at this dosage, dead and sick fish were noted. At a dosage of 0.05 pound DDT per acre, dead fish were first found at about the thirteenth to fifteenth weekly treatment. The actual number of treatments required to start killing fish seemed to depend upon the size and depth of the test pond. Since all of these ponds were smaller and more shallow than those normally of importance for fish, it was considered that 0.05 pound of DDT per acre may be safely used for mosquito control in larger ponds containing deep water. This is especially true if only the margins are treated.

During the year, in cooperation with the Fish and Wildlife Service of the Department of the Interior, a series of tests were begun using airplane applications of DDT both as a spray and as a thermal aerosol, using Velsicol NR-70 as the solvent. This experiment was to extend over one full season and possibly a second season, so that results will not be available for some time. Effects on aerial insects, birds, and small mammals were also being studied in this experiment.

RESIDUAL SPRAYS

With the initiation of large-scale use of residual-type DDT sprays on the Extended Malaria Control Program, it was possible to devote a greater proportion of effort to improving formulae and investigating the more basic problems affecting residual spray effectiveness. Considerable time was spent both in the chemical laboratory and in field trials in testing a large variety of solvents to find something more satisfactory than xylene. Availability, ability to dissolve DDT, explosibility, toxicity of the vapors to man, effect upon various surfaces, and emulsifiability were all considered. So far a better solvent has not yet been found. Similarly a wide variety of commercially available emulsifiers was tested.

More detailed field tests of dosage and type of coverage have shown that the over-all spraying of a room is preferable to spot spraying of corners, undersides and backs of furniture and pictures, and other preferred resting places of mosquitoes. Also it was concluded that the extra expense of applying 200 mg. DDT per square foot in place of 100 mg. is justified by a better percentage of kill from three to four months after treatment. Laboratory tests have shown that the nature of the sprayed surface will greatly affect the length of residual effectiveness. Unfinished pine plywood was used as

Age of Residue (months)	MG. DDT PER SQUARE FOOT			
	100		200	
	Percent Knockdown	Percent Mortality	Percent Knockdown	Percent Mortality
0	94	100	86	100
1	47	85	81	95
2	55	80	75	90
3	23	75	35	80
4	-	-	-	-
5	14	50	35	75

Percent knockdown and 48-hour mortality of *A. quadrimaculatus* adults from 60-minute exposures to deposits of 100 and 200 mg. DDT per square foot from a xylene-DDT spray at 0 to 5 months after application.

Courtesy of the David J. Sencer CDC Museum



Test panels used for studies of chemical recovery of DDT.

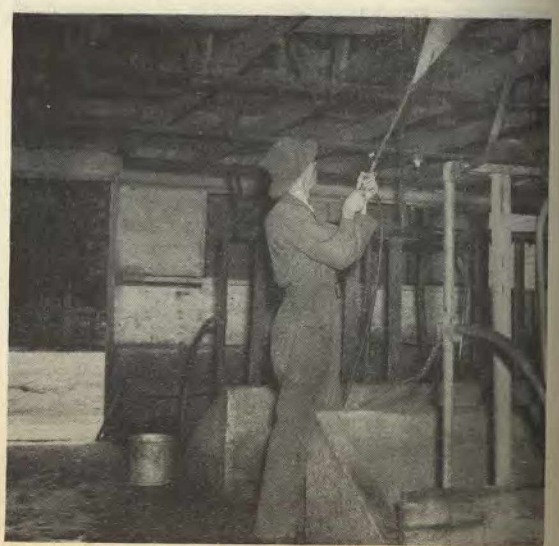
a standard for comparison. Results equal to or better than this standard were obtained on fabrics (mohair, canvas, cotton goods, and window-shade materials), on wallpaper, and on rubbing varnishes that had dried for at least one month previous to spraying. Somewhat inferior results were obtained on rubbing varnishes that had dried only ten days prior to spraying, and on casein-water paint, weathered gloss enamel, fiberboard, and wire screen. Much poorer results were obtained on whitewash, spar varnish, and on gloss and flat paints that had dried for from one to 17 weeks. Very little residual toxicity was obtained on linoleum, and practically none on adobe-like clay panels.

Chemical recovery of DDT from test panels showed that temperature definitely affected the loss of technical DDT. Thus, after one month at 40 degrees F., 76 percent of the DDT applied in kerosene solution was recovered from glass panels. When similar panels were held at room temperature, 63 percent of the DDT was recovered after one month. At 140 degrees F., the recovery was only nine percent. Not more than half of one percent of the DDT could be flaked off a panel by a total of 42 severe, standardized jars over a period of one month. The exposure of test panels to a large number of houseflies was shown to reduce the residual effectiveness of DDT much more rapidly than similar exposure to mosquitoes *(A. quadrimaculatus.)*

INSECT PREMISE SANITATION

Further studies were made in the use of DDT for the control of houseflies in a variety of food-processing and food-handling establishments, such as dairies, pasteurizing plants, abattoirs, sea food plants, markets, and restaurants. New problems were encountered in the control of blowflies around abattoirs and sea food plants. Blowflies of the calliphorid group do not rest inside of buildings at night, so that interior residual sprays were not too effective. Studies of their nighttime resting habits resulted in the application of DDT to the exteriors and to the vegetation within a radius of 30 feet around the building. Preliminary results indicate that some of the newer "candidate" insecticides may have some advantage over DDT for this type of

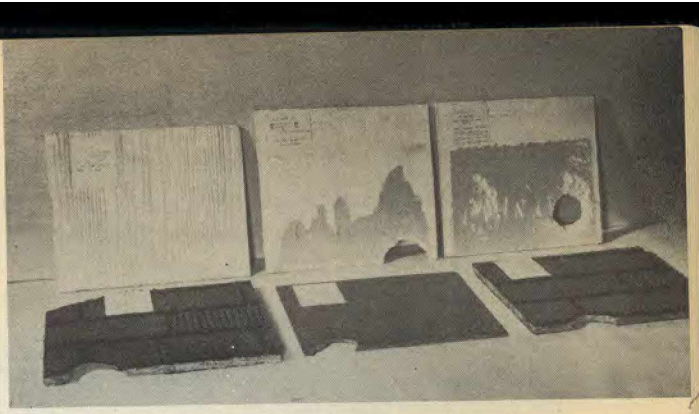
(below) Calliphorid flies used the oak outside the oyster house as a night resting place. (right) The DDT spray is applied to the edges of the overhead beams where the flies rest in the dairy barn.





Courtesy of the David J. Sencer CDC Museum

exterior residual spray. Limited studies on the use of DDT in controlling bedbugs indicated that the simplest treatment tried, i. e., thoroughly spraying the mattress on both sides and around the edges with 2.5 percent DDT in xylene, resulted in apparent eradication of bedbugs for at least 16 weeks following treatment.



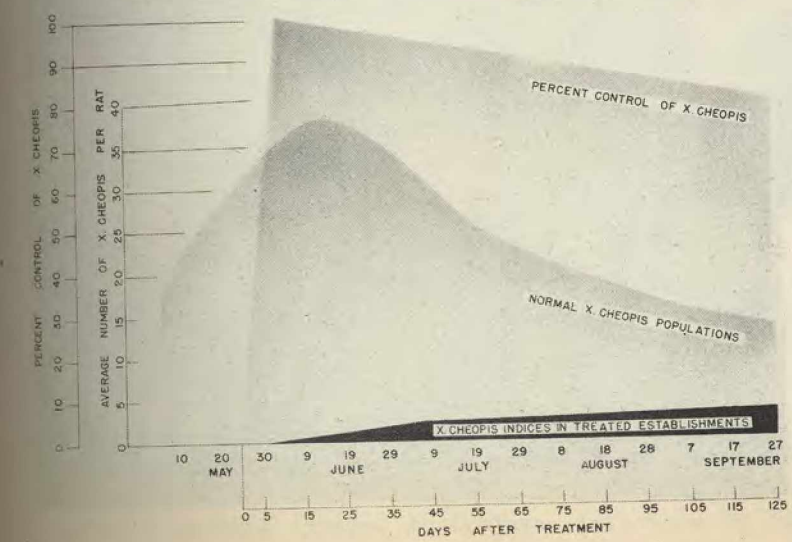
Panels of asbestos board, gypsum board, insulbrick, and masonite were tested to determine their values in ratproofing construction.

The most satisfactory treatment for control of German roaches proved to be a combination of a spray and dust. A five percent DDT-xylene spray was used to drive the roaches out of hiding, thus disclosing their daytime resting places. This was followed by an application of ten percent DDT-pyrophyllite dust to the hiding places revealed by the spray. With this technic the greatest mortality occurred during the first three or four days. Roaches were apparently eliminated in from two to eight weeks in most cases and no reinfestation had occurred 16 weeks after treatment.

RODENT AND ECTOPARASITE CONTROL

A new project concerned with the control of murine typhus fever and other diseases transmitted by rat ectoparasites was undertaken during the year. The fact that ectoparasites tend to leave dead rats in search of other hosts may temporarily increase the transmission of typhus immediately after the instigation of rat poisoning measures. Although rats themselves may act as disease reservoirs, transmission from rat to rat and from rat to human is largely dependent upon the activity of ectoparasites. The control of ectoparasites, therefore is especially important before or at the same time that rodent control measures are applied.

Ten percent DDT in pyrophyllite effectively controlled ectoparasites, especially *Xenopsylla cheopis*. A combination of ten percent DDT, 50 percent ANTU (alpha naphthylthiourea), and 40 percent pyrophyllite served as an excellent rodenticide



CONTROL OF
X. CHEOPIS FLEAS
WITH
10 PERCENT DDT DUST

Courtesy of the David J. Sencer CDC Museum

and ectoparasite control. After initial field testing, this procedure was recommended for more extensive field testing on an area-wide basis by selected state programs. Preliminary technics were also established for testing panels of construction materials to determine their values in ratproofing.

EQUIPMENT DEVELOPMENT AND TESTING

During the year extensive tests were conducted on a wide variety of equipment. Several sprayers for specialized purposes were developed and tested. An aluminum hand-sprayer designed for residual house spraying on a small scale had the advantage of being light in weight and therefore less tiring to use. For larger buildings a portable five-gallon sprayer mounted on rubber tires was developed, using a gear pump driven by a small, directly-connected electric motor. This sprayer weighed about 50 pounds, was readily stored, and was easily transported in a pickup truck. A wheelbarrow-type exterior sprayer was developed for use by the Dysentery Control Project in Texas. It was made up of two surplus U. S. Army oxygen containers, one of which contained the spray material and the other compressed air. The spray chamber had a capacity of nine gallons and the pressure chamber was charged with 100 pounds per square inch air pressure. The pressure dropped to 40 pounds per square inch in the course of spraying the nine gallons. Numerous modifications and improvements were made on equipment previously developed.



(left) A wheelbarrow-type exterior sprayer was developed for use by the Dysentery Control Project in Texas.



(right) An improved DDT power mixer developed by Carter Laboratory.

Courtesy of the David J. Sencer CDC Museum

Malaria Bionomics Observations



Emory University Field Station, Newton, Georgia.

The objective of MCWA activities at the Emory University Field Station, Newton, Georgia, was to maintain an up-to-date appraisal of malaria morbidity in the United States. Observations of the factors responsible for the natural occurrence of human malaria had been made since 1939. MCWA participation was begun in 1944 to utilize the backlog of information on malaria epidemiology collected previously. With the extensive information available, this station was able to serve as one of the principal outposts for the observation of malaria and the factors accountable for its occurrence.

Malaria morbidity in the area under study was declining in comformity with the recession observed generally in North America. During initial periods of observation, appreciable amounts of malaria were encountered. Malaria morbidity rates gradually became negligible, and the last blood-positive malaria cases were observed in 1944. No malaria control measures were intentionally applied nor were significant changes discerned which could have been responsible for the apparent elimination of malaria from this area. This year's observations, which were continued to detect as promptly as possible any factors which might contribute to an accelerated transmission of malaria, were included in three general catagories: epidemiological, biological, and hydrological.

EPIDEMIOLOGICAL OBSERVATIONS

Epidemiological data were collected from approximately 1,000 persons residing in an area which was formerly highly malarious. In past years all persons living in the area were visited at frequent intervals by competent public health nurses

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Epidemiological data were collected from approximately 1000 persons in the area.

and accurate individual case histories were maintained. Upon manifestation of any clinical symptoms suggestive of malaria, thick-film blood slides were obtained. Diagnosis of malaria was contingent upon demonstration of the parasites. In consideration of negligible malaria rates for the past three years, routine nursing visits to persons in the experimental area were discontinued. Periodic observations were conducted in the area to apprehend cases had they occurred. Blood parasite surveys were made in schools and in selected groups in the experimental section. No cases of malaria were detected during the year.

BIOLOGICAL OBSERVATIONS

Measurements of *Anopheles* density were maintained for use in connection with investigations of *Anopheles* bionomics. Because of the sustained depression of anopheline populations observed for the past two years, efforts were concentrated in selected areas. In the environs of the five ponds where intensive observations were being conducted, weekly quantitative measurements of adult mosquito densities and qualitative appraisals of larval mosquito populations were obtained.

OBSERVATIONS ON OVERWINTERING OF *ANOPHELES*. Studies to determine the manner in which *Anopheles* pass the winter were continued. Results obtained from work of the previous year pointed to the possibility of "quads" overwintering in the egg stage. Efforts were made to recover eggs from breeding places during the winter months when larvae could not be detected. Since the harboring places of anopheline eggs are not well known, the work was only partially successful. The first male mosquito collected at the beginning of the season is assumed to indicate emergence of the first generation of spring. No male anophelines were collected during the period between December 20, 1945 and March 15, 1946, indicating the probable absence of *Anopheles* emergence throughout this period. During the first week in March an attempt was made to recover "quad" adults from favored resting places by fumigation. No specimens were obtained, confirming observations of the previous year that a progressive decline in mosquito population occurs during the winter until adult mosquitoes are virtually or actually absent by spring.



Collecting adult mosquitoes from artificial resting place to measure *Anopheles* density.

It is believed that oviposition occurs throughout the winter when atmospheric conditions are favorable to anopheline activity. Review of physical data accumulated suggested that "quad" populations are adversely affected by humidity below

Courtesy of the David J. Sencer CDC Museum

40 percent and temperatures below 70 degrees F. Requirements for mosquito egg development are not well known; indications are that eggs are extremely resistant to low temperatures, but that development of the embryo occurs only when the temperature is above a "development zero," which is 50 degrees F. according to the experience of other investigators. Much additional information is necessary, but the continued accumulation of data under natural conditions together with information obtained in the insectary would probably permit a much better understanding of the manner in which "quads" pass the winter.



Typical anopheline breeding place in environs of the field station.

ANOPHELES ACTIVITY STUDIES. Attempts were made to modify the "New Jersey" light trap to make it attractive to "quads." From results obtained, it seems that the light waves shorter than those of the visible spectrum may be more effective in attracting "quads" than visible light. It was found that very intense light attracted a greater number of *Anopheles* than did the 25-watt bulbs ordinarily used. If a more satisfactory light trap can be devised, many problems concerning nocturnal activity of anophelines could be investigated.

For the study of mosquito migration, a technic of marking adults with particles of fluorescent compounds had previously been worked out at the field station. Further studies along this line were aimed at finding suitable fluorescent materials, ingestible by the larvae without harm, which would persist in the adult stage. Five compounds showed promise, but further work was contingent upon an adequate supply of mosquitoes from the insectary.

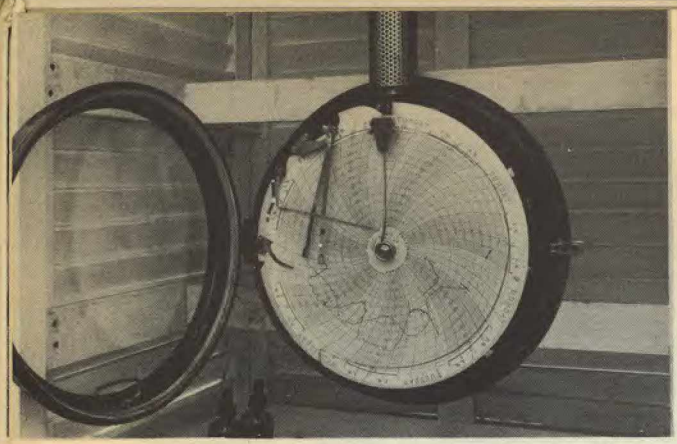
HYDROLOGICAL OBSERVATIONS

Hydrological observations were conducted with the continued cooperation of the Water Resources Branch of the U. S. Geological Survey. Observations of physical factors related to *Anopheles* breeding included measurements of precipitation at 12 points in the area, records of pond stages at 15 ponds, and records of stage and discharge from seven stream gaging stations. Three of these stations were located on large streams and the others were on small streams typical for the area. Data on ground-water variations were obtained by neasurements of 90 observation wells. These observations were made over the entire experimental area. During the year an effort was made to intensify measurements in selected areas in order to obtain more precise information on the physical factors related to *Anopheles* breeding.



Making measurements with tape gage at observation well.

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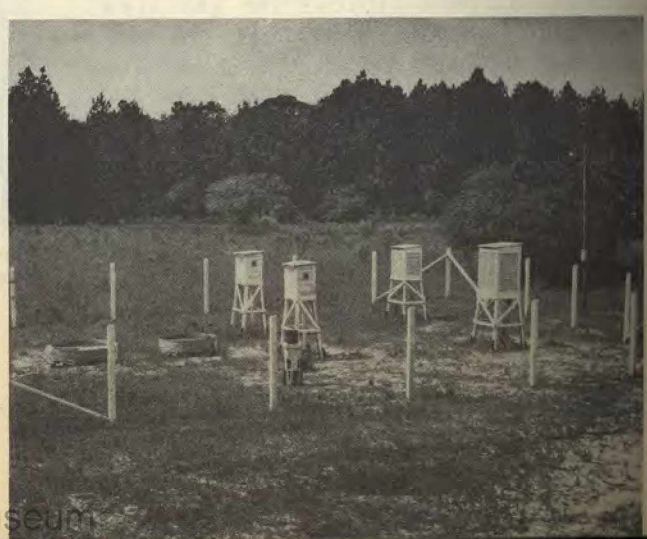
Recording hydrothermograph.

PONDS. Four ponds were selected for an intensive study. At these locations hydrological observations included measurements of water level, surface-water temperature, precipitation, wind movement, and atmospheric temperature and humidity. Most of these data were collected on continuous recording instruments so that a record was preserved of intensity and duration rather than maxima, minima, or means. Further work on the analyses of factors contributing to storage of water in ponds indicated that prediction of pond levels could be made with considerable accuracy if such influences as run-off and precipitation were known. The present concept of the role of ponds in the hydrological picture may be considerably revised as a result of detailed information collected in the immediate vicinity of ponded areas. The possibility was evident that ponds in the region under observation might be contained in relatively impervious basins, separate from underground water. If this is proved correct, factors responsible for the occurrence of ponds would be simpler than previously believed, and the collection of data for predicting the amount and extent of surface water storage would be materially simplified.

EVAPORATION. An evaporation station was established during the year to permit more critical evaluation of factors responsible for water losses from ponds. Measurements were made of the same factors being measured in the pond; i. e., water surface temperature, wind movement, precipitation, and atmospheric temperature and humidity. Since a record of the water level in the pond was also maintained, the linear amount of water loss from the pond was determinable and could be compared with evaporation loss from an artificial container. Thus, water loss due to seepage and transportation could be approximated. Records from the evaporation station were available from the beginning of 1946. These included measurements of evaporation from a standard type of Weather Bureau evaporation pan and from an insulated pan of the same size. The length of the record did not include the season of maximum evaporation, nor were correlations of data from the evaporation stations and ponds complete. Preliminary analyses did indicate however that evaporation and possibly transpiration could be calculated indirectly from the factors under observation. Studies along these lines were being continued.

(left) Stream flow gaging station above a small dam at Emory University Field Station. (right) Evaporation station for determining amount of water loss from ponds.



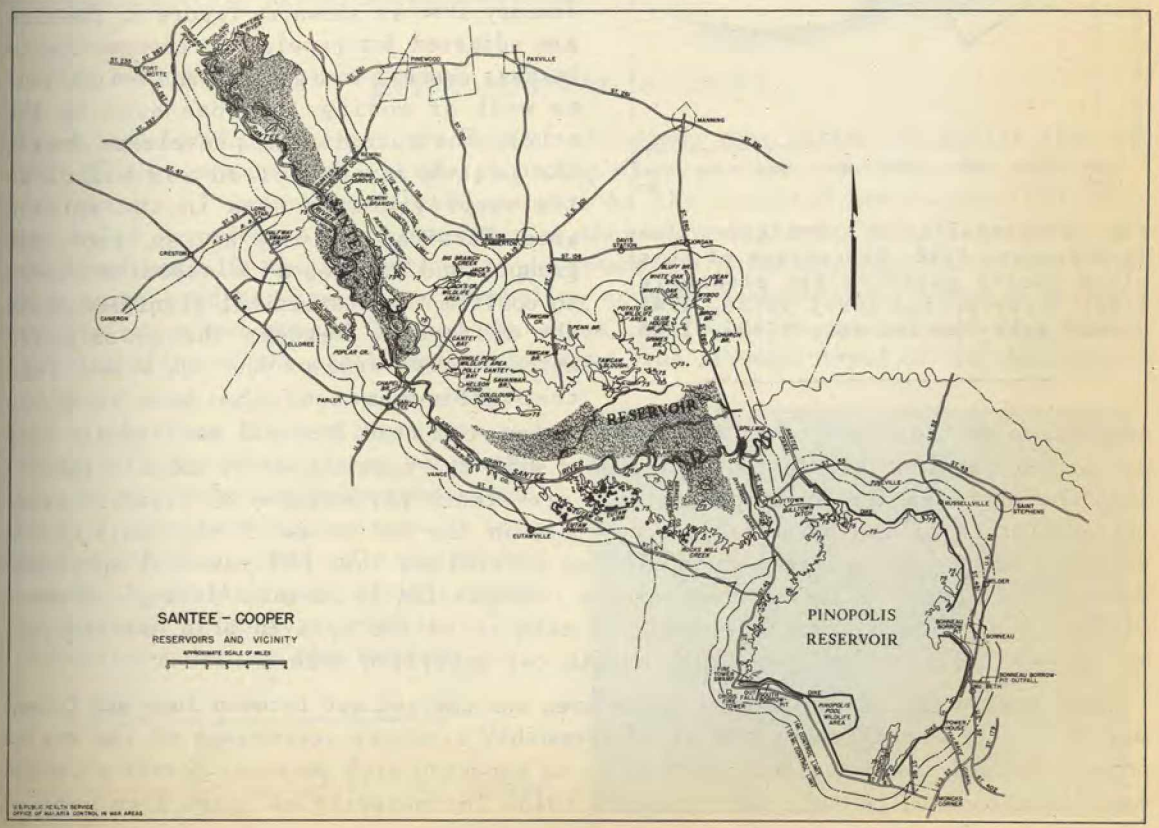


Courtesy of the David J. Sencer CDC Museum

Malaria Field Studies

Investigations carried on by the Malaria Field Research Station, Manning, South Carolina, in cooperation with the South Carolina State Board of Health, centered around a study to determine the efficacy of DDT residual spray in preventing transmission of human malaria. In addition observations were made on the epidemiology of malaria in an endemic area.

The area chosen for study of the effect of DDT residual spray was located in the only known highly endemic malaria region in the United States, the Santee-Cooper reservoir area in the coastal plain of South Carolina. The Santee Reservoir is 30 miles long and about three and a half miles wide with a total water-surface area of 97,000 acres and a shore line of over 497 miles at the 75-foot contour. The smaller Pinopolis Reservoir, connected with the Santee by a diversion canal, is about 12 miles long and ten miles wide and has a total water-surface area of about 65,000 acres and a shore line of 151 miles at the same contour elevation. Records taken over a ten-year period in the vicinity of the Santee River showed that malaria increased after water was impounded in the Santee and Pinopolis basins in 1941. Minor epidemics occurred during the seasons of 1942 and 1943 in Clarendon County near the Santee Reservoir.



Courtesy of the David J. Sencer CDC Museum

The study area was divided into two approximately equal parts; one part was set aside for spraying, the other left unsprayed. Each of the areas had a population of about 1,500 people, of whom 90 percent were Negroes. Most of the people worked on farms. Ninety percent of the houses were not mosquito proofed. The majority of malaria in the area was caused by *Plasmodium falciparum*. Houses were sprayed with residual DDT during the last two weeks of April 1945 and again three months later. The methods of spraying were the same as those used on the Extended Malaria Control Program of MCWA. A residuum of 100 mg. of DDT per square foot was left on the sprayed surface of the walls and ceilings of each room in the house. Porches and privies were treated, but other outbuildings were left unsprayed.

EPIDEMIOLOGICAL STUDIES

The parasitemia prevalence during the pre-spraying period showed a continuous downward trend from October 1944 to April 1945, as might be expected over the winter months. In October 1944 the prevalence was 20.7 percent in the sprayed area and 16.3 percent in the unsprayed. In April 1945 it was respectively 6.1 and 5.1 percent in the same areas. Thick film blood smears were obtained at monthly intervals during the post-spraying period, beginning the first of June 1945. More than 90 percent of the 3,000 people in the entire study area were tested during each survey.

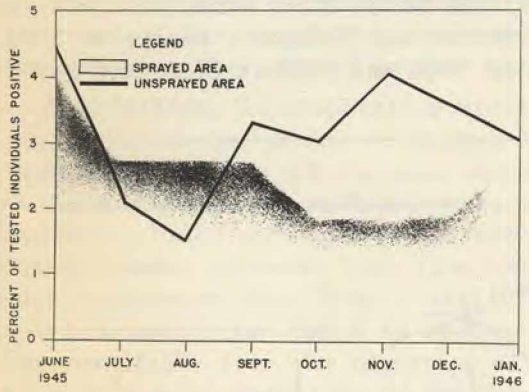


Fig. 1. Parasitemia prevalence, June 1945-January 1946. Percentage of thick blood smears positive for plasmodia. First spray period April 15-30, 1945. Second spray period July 15-30, 1945.

A graphical comparison of gross parasitemia prevalence percentages in the sprayed and unsprayed areas from June 1945 to January 1946 is shown in Figure 1. The data are adjusted for population changes due to births, deaths, immigration and emigration, as well as moving from one area to the other. The parasitemia prevalence during the post-spraying period was higher in the unsprayed area than in the sprayed area. Detailed analyses by sex, race, age groups, and species of *Plasmodium* served to confirm the statistical significance of the difference between the gross parasitemia prevalence of the two areas. Further refinements of the data to allow comparison of incidence rates in the two areas, computed from all individuals with parasitemia against all tested individuals with the same number of monthly smears, also corroborated the gross parasitemia prevalence percentages as a satisfactory representation of the parasitemia occurrence in the two areas. On the basis of the analyses of the parasitemia data, it was determined that DDT residual spray was found to be effective in reducing malaria transmission in humans. Although evidence of the occurrence of new infections of malaria in the sprayed area was seen, it was at a significantly lower rate than in the unsprayed area.

A clinical study of the people in the area was carried out between June and December 1945. This study consisted of semi-monthly sickness screenings of the entire population and follow-up medical studies on reported sick persons. Severe clinical manifestations of malaria were rare in 1945. The majority of cases seen were of

Courtesy of the David J. Sencer CDC Museum



Typical housing in the Santee-Cooper area.

the mild localizing type, only rarely confining the individual to bed or house. The most frequent complaints were irregular night fever, headache, backache, and malaise. Typical proxysms were infrequent. Certain human host factors were examined and measured for tendencies which might affect the parasitemia prevalence. The observed infection rates were considered in relation to the total tested population: well persons, sick persons, individuals with parasitemia, and those without manifest parasitemia. Crude quantitative effects of certain human host factors, such as prevailing illness and frequency of anti-malarial self-medication, were determined.

The comparability of the two areas as to certain human host factors was demonstrated and the effects of some important host-parasite relationships on the monthly parasitemia rates were presented. It was shown how parasitemia prevalence rates are functions of biological phenomena acting prior to the taking of blood smears, and how sickness from all causes might affect the parasitemia rates by increasing self-medication with anti-malaria drugs. It was also shown that the effects of these human host factors may cause minor fluctuations in monthly parasitemia prevalence.

ENTOMOLOGICAL STUDIES

Entomological observations were made in the study area during the entire season of 1945. These consisted of: (1) the recording of anopheline populations at selected "index stations," approximately 20 percent of the occupied homesteads; (2) the dissection of anophelines for sporozoites in the salivary glands; and (3) the testing of the blood meals in the anophelines to determine the hosts upon which they had fed.

Population studies showed that anopheline density distribution, although uneven within the areas and unequal between the areas, conformed in general with the domicile distribution of the parasitemia infections. The seasonal trend of the *Anopheles quadrimaculatus* populations in stables showed a rise from June to September and October 1945. November showed an abrupt decline in *A. quadrimaculatus* population, although *A. crucians* was present in some numbers throughout most of this month. Throughout the post-spraying period, houses in the sprayed areas were generally free of mosquitoes during the daytime.



Terrain of the Santee-Cooper area favors anopheline breeding.

Courtesy of the David J. Sencer CDC Museum

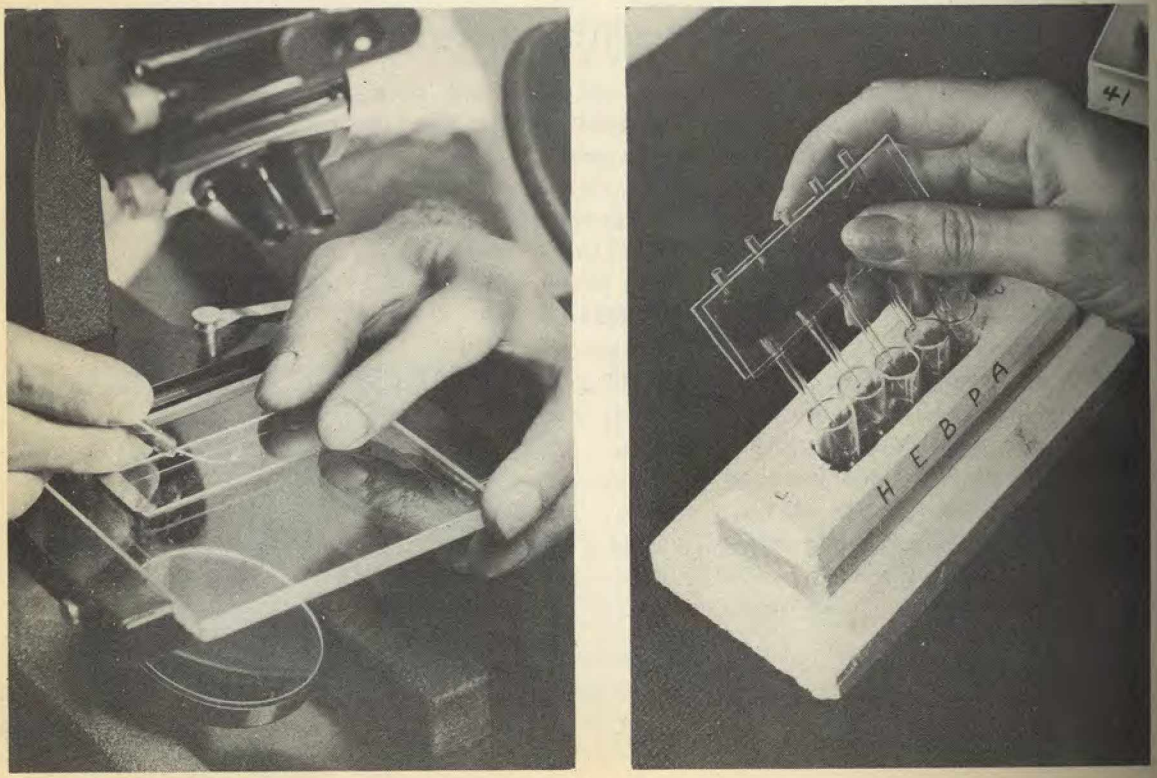
A. quadrimaculatus were collected for dissection, beginning May 29, 1945, until this species virtually disappeared about the first of November, after which time some *A. crucians* were also dissected. The sporozoite rate increased with the advancing season, conforming in general with the fall rise of the parasitemia prevalence. For the entire season, ten infected "quads," or 0.14 percent, were found in 6,963 dissected from the sprayed area, while 20, or 0.19 percent of the 11,862 from the unsprayed area showed sporozoites.

HOST PREFERENCE AND INFECTIVITY STUDIES

Determination of host preference by precipitin tests of engorged mosquitoes showed that 12, or 0.76 percent of 1,577 tested from the sprayed area had fed on human blood, while 210, or 7.5 percent of 2,793 tested from the unsprayed area had fed on humans. The latter percentage included specimens caught in houses, whereas mosquitoes were not found in houses in the sprayed area. When the out-building samples were compared for the two areas, there was virtually no difference in the percentage of human feedings; 0.76 percent for the sprayed area and 0.75 percent for the unsprayed.

In cooperation with the National Institute of Health Malaria Investigations Laboratory at Columbia, South Carolina, studies were carried out to determine the infectivity to native mosquitoes of native cases of malaria in Negroes. Results of these investigations are given in the "Imported Malaria Studies" section immediately following.

(left) *A. quadrimaculatus* were dissected. (right) Precipitin testing to determine number of mosquitoes which had fed on human blood.



Courtesy of the David J. Sencer CDC Museum

Imported Malaria Studies

Imported malaria studies were continued during this year by the Malaria Investigations Laboratory, National Institute of Health, Columbia, South Carolina, in cooperation with MCWA. Four laboratories were operated to determine the public health significance of returning malaria carriers. These laboratories had access to troops in about 12 Army and Navy hospitals and the cooperation of six mental hospitals for study of malaria infections. Studies conducted during the previous year indicated that foreign malarias relapsing in returning troops could be spread by our native vectors and that control measures were necessary against these foreign malarias in returning carriers.

During the course of studies on foreign malarias, it was found that an infection with a foreign strain of *Plasmodium vivax* gave little or no immunity against a subsequent infection with a domestic strain (St. Elizabeth). The reverse was also true. Over 200 patients were observed in delayed primary attacks. These attacks followed soon after the discontinuation of suppressive dosages of atabrine and were characterized by lower parasite densities than the later relapses. However when treatment was denied, comparably high parasite density levels were reached. The observations on the delayed primary attack were compared with similar observations on induced primaries and the similarities indicated that the delayed primary more nearly resembles the natural primary than the relapse attack.

Relapses tended to follow a pattern, according to individuals. An individual with a high parasite count during one relapse would be likely to show high parasite counts during other relapses. Similarly, in some individuals gametocytes are produced more consistently than others. Little difference in parasite levels was exhibited during early and late relapses. Parasite levels were similar in Pacific and Mediterranean cases, but in the latter high gametocyte counts were noted.

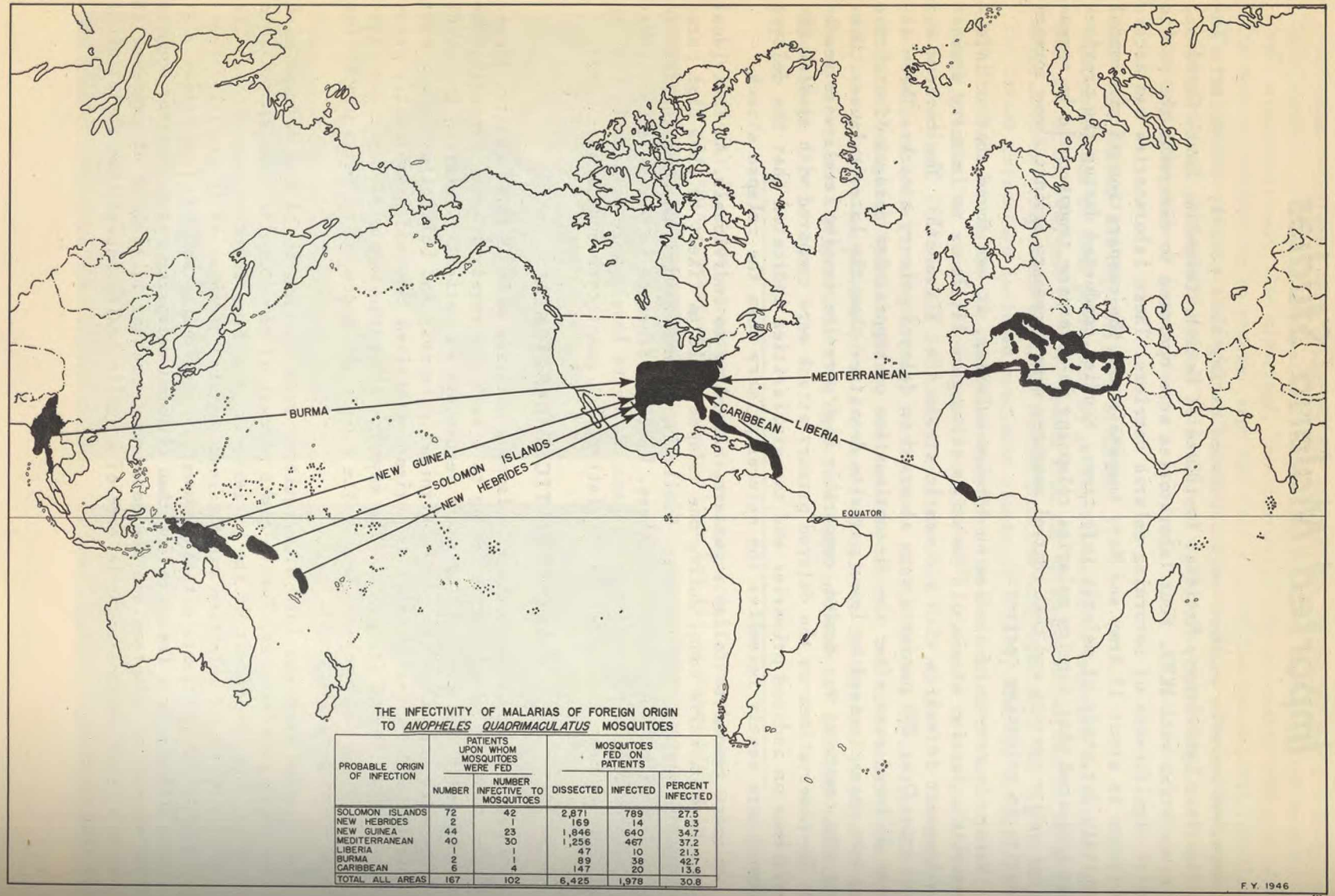
ASYMPTOMATIC PARASITEMIA

The parasitological patterns of relapsing malarias were of three general types: (1) most patients showed parasites up to a week, or rarely longer, preceding the onset of fever (relapse); (2) a small percentage of patients exhibited transient asymptomatic parasitemias between clinical relapses; and (3) following the last clinical attack, a small number of patients exhibited terminal asymptomatic parasitemias which lasted for months. The asymptomatic parasitemias showed a low parasite density on the average. Gametocyte production appeared to be in proportion to the total parasite count.

One hundred eighteen lots of mosquitoes were applied to 34 individuals with asymptomatic parasitemias. Twenty-eight percent of the mosquito lots showed some infection, and 12 percent of the patients at some time infected mosquitoes. The highest incidence of infection was obtained just before onset of fever. This clearly indicated that patients with asymptomatic parasitemias could infect native mosquitoes, although to a lesser extent than clinical relapsing cases. However because of the absence of symptoms and the consequent greater likelihood of exposure to mosquitoes, such persons might be more of a public health hazard than the clinical relapsing cases.

Courtesy of the David J. Sencer CDC Museum

Courtesy of the David J. Sencer CDC Museum

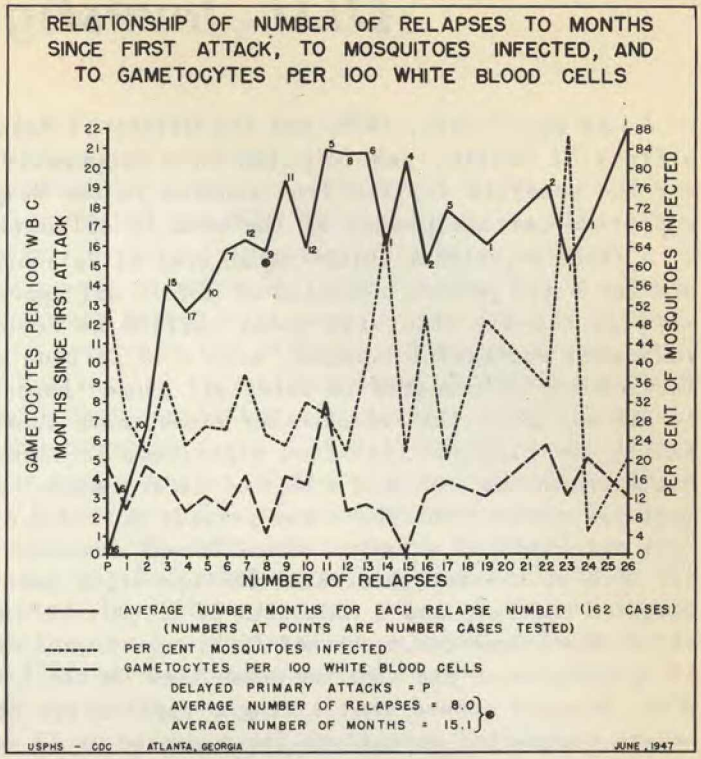


THE INFECTIVITY OF MALARIAS OF FOREIGN ORIGIN TO *ANOPHELES QUADRIMACULATUS* MOSQUITOES

PROBABLE ORIGIN OF INFECTION	PATIENTS UPON WHOM MOSQUITOES WERE FED		MOSQUITOES FED ON PATIENTS		
	NUMBER	NUMBER INFECTIVE TO MOSQUITOES	DISSECTED	INFECTED	PERCENT INFECTED
SOLOMON ISLANDS	72	42	2,871	789	27.5
NEW HEBRIDES	2	1	169	14	8.3
NEW GUINEA	44	23	1,846	640	34.7
MEDITERRANEAN	40	30	1,256	467	37.2
LIBERIA	1	1	47	10	21.3
BURMA	2	1	89	38	42.7
CARIBBEAN	6	4	147	20	13.6
TOTAL ALL AREAS	167	102	6,425	1,978	30.8

F. Y. 1946

In cooperation with the Malaria Field Research Station, studies were made at Manning, S. C., to determine the infectivity to native cases of malaria, principally asymptomatic, in Negroes. A total of 115 lots of mosquitoes were fed on 96 patients. Out of eight cases of *P. malariae,* two were infective to mosquitoes. Out of 106 cases of *P. falciparum,* 16 infected mosquitoes. The single feeding on *P. vivax* did not infect mosquitoes. The infections were produced in mosquitoes during the winter as well as in the summer. The patients infecting mosquitoes showed a very low gametocyte count. All were below 34 per cmm., and 11 of the 18 had a count below ten gametocytes per cmm. Conversely, some gametocyte carriers with 121 and 165 per cmm. did not infect mosquitoes.



During the course of the investigations it was learned that neuro-syphilitic American Negroes showed a general resistance to foreign *P. vivax* as compared to white neuro-syphilitic patients, who were virtually non-immune. The difference was statistically significant.

FILARIASIS STUDIES

Fourteen species of native mosquitoes were fed on a patient infected with *Wuchereria bancrofti* from Bora Bora in the French Society Islands. Microfilariae were present in the peripheral blood stream. *Culex pipiens* and *C. quinquefasciatus* were highly susceptible. Low grade infections were found in *C. erraticus, C. salinarius, Anopheles punctipennis, Aedes triseriatus, A. aegypti, A. atropalpus,* and *Mansonia perturbans. Anopheles walkeri* was found to be moderately to highly susceptible, but the number of dissections was small. No infections were found in *Anopheles quadrimaculatus, A. freeborni, Aedes atlanticus* (or *tormentor?*), and *Psorophora ferox.*

A periodicity of the microfilariae was demonstrated. The larvae were most numerous in the peripheral blood stream during the afternoon daylight hours. Larvae were present throughout the day and night, the ratio between the mean high and low counts being 3.2. Seven papers resulting from the cooperative work between NIH and MCWA were published in scientific journals during the fiscal year.

Courtesy of the David J. Sencer CDC Museum

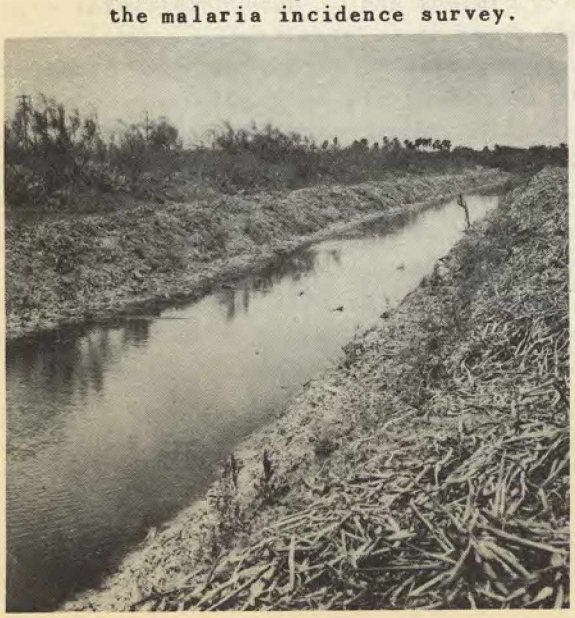
DDT Investigations

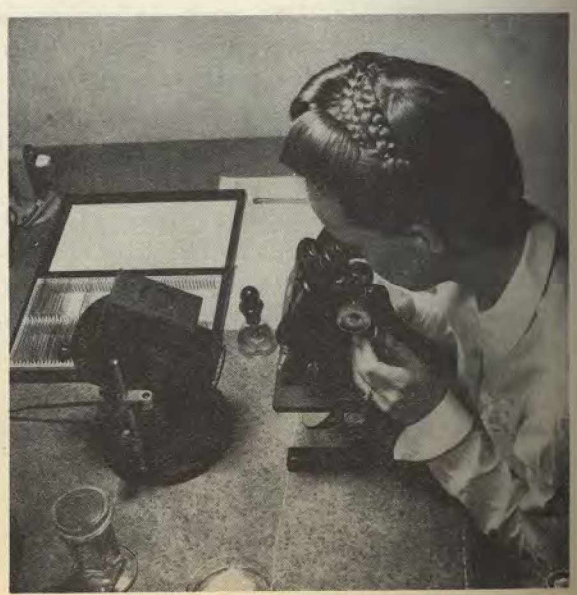
As in past years, MCWA and the Office of Malaria Investigations, National Institute of Health, participated in a cooperative program of research. In return for the benefits derived from studies in the Memphis, Tennessee, laboratory, MCWA supported certain phases of the work by allocation of funds and personnel.

A field experiment involving an area of 24 square miles was designed to determine whether a two percent solution of DDT in oil applied at the rate of 6.5 gallons per acre at ten-day intervals would suffice to control mosquito production. Results indicated successful control, with a 40 percent reduction in over-all cost of the larviciding as compared to using oil alone; however, the dosage of two percent DDT in oil was above that which other experiments showed could be utilized routinely and safely for fish and fish-food organisms. To ascertain whether a reduction in mosquito production could be effected under unusually difficult conditions, an experiment was devised whereby a two percent solution of DDT in oil was applied at 1000-foot intervals to a large, slow-flowing drainage ditch at the rate of six gallons per acre at ten-day intervals. The operation was successful from the standpoint of mosquito control, and a reduction of 80 percent in cost was obtained. Another phase of the investigations concerned field experiments with DDT residual spray. The methods of spraying were the same as those used on the Extended Malaria Control Program of MCWA. Results showed that a single application of DDT residual spray in inhabited houses controlled mosquitoes for a period of 17 weeks.

Examinations of 13,812 thick film blood smears from the southeastern United States and Puerto Rico were made during the fiscal year as part of the MCWA malaria incidence survey. Of these slides, 0.36 percent were positive for malaria parasites. The greater number of smears were taken in the southeastern states and only 0.18 percent of these were positive. The much smaller number of slides from Puerto Rico showed 2.2 percent positive. Three technicians were trained in the thick film method at the Memphis laboratory, and a member of the laboratory staff conducted four classes for the training of technicians in cooperation with MCWA.

(left) Slow-flowing drainage ditch of the type used for experimental larviciding with DDT in oil. (right) Thick film blood smears from southeastern United States and Puerto Rico were examined as part of the malaria incidence survey.





Courtesy of the David J. Sencer CDC Museum

Typhus Investigations

A proposal to institute a Typhus Investigation Program in south Georgia was initiated in August 1945, and its organization was begun during that month. Plans outlining the proposal, scope, and operating procedures were approved by representatives of the Georgia Department of Public Health and MCWA as of October 1, 1945. Operating out of headquarters in Thomasville, actual investigations have been under way since September 24, 1945. The study area selected included Brooks, Thomas, Grady, Cook, and Decatur counties; Grady County served as a control area for the project.

The purpose of this study was to determine the efficacy of murine typhus fever control methods, particularly DDT dusting, as they affected the incidence and prevalence of the disease in human and rodent populations. In order to obtain accurate information on the incidence of human typhus cases within the study area, it was considered necessary to carry out a census survey designed to locate mild or unreported cases. By the end of this fiscal year 18,262 premises had been surveyed. Typhus cases appearing since January 1, 1945, were investigated in detail, as well as any other illness which might possibly be typhus fever. Up to July 1, 1946, 278 possible typhus cases had been examined. Case histories were taken of 281 individuals who supposedly had "suspicious" illnesses but who were considered to be negative for typhus. Blood specimens from 273 individuals were sent to the laboratory for the Weil-Felix and complement-fixation tests.

The other major aspect of the investigation program was concerned with rat-reservoir and ectoparasite-vector studies. Through the end of the fiscal year a total of 5,642 rats were trapped. Blood specimens from 3,346 rats were sent to the laboratory, of which 3,170 were found satisfactory for complement-fixation test-

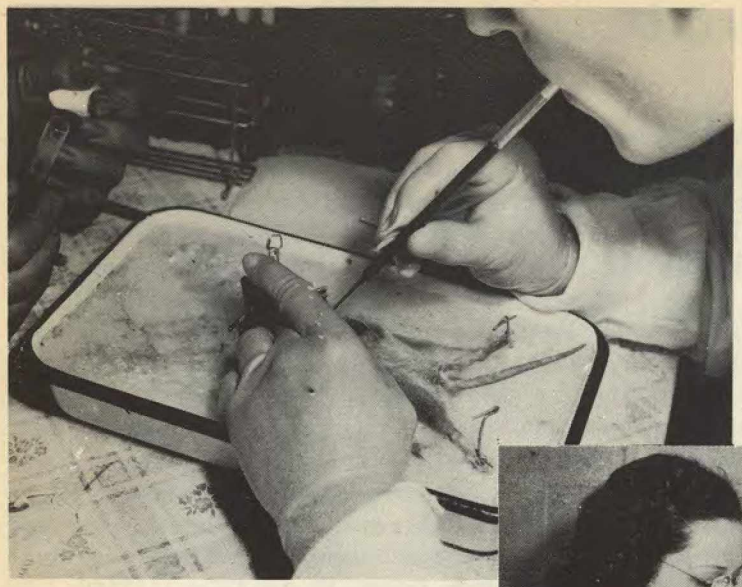


(right) It was necessary to carry out a census survey designed to locate mild or unreported typhus cases.



(left) 72,260 rat ectoparasites were collected and identified.

Courtesy of the David J. Sencer CDC Museum



(left) Blood specimens from 3,346 rats were sent for complement fixation tests.



(right) An endemic typhus vaccine was given to operational personnel.

ing. Of these, 1,387, or 43.4 percent, gave positive typhus complement-fixation reactions. Ectoparasite examinations were made on 4,098 rats, and 72,260 ectoparasites were collected and identified. One round of DDT dusting was completed in Brooks, Cook, and Thomas counties prior to the end of the fiscal year. At the same time a county-wide rat poisoning campaign was conducted in Decatur County. Results are not yet complete enough to report the effectiveness of these operations.

TYPHUS VACCINATION PROGRAM

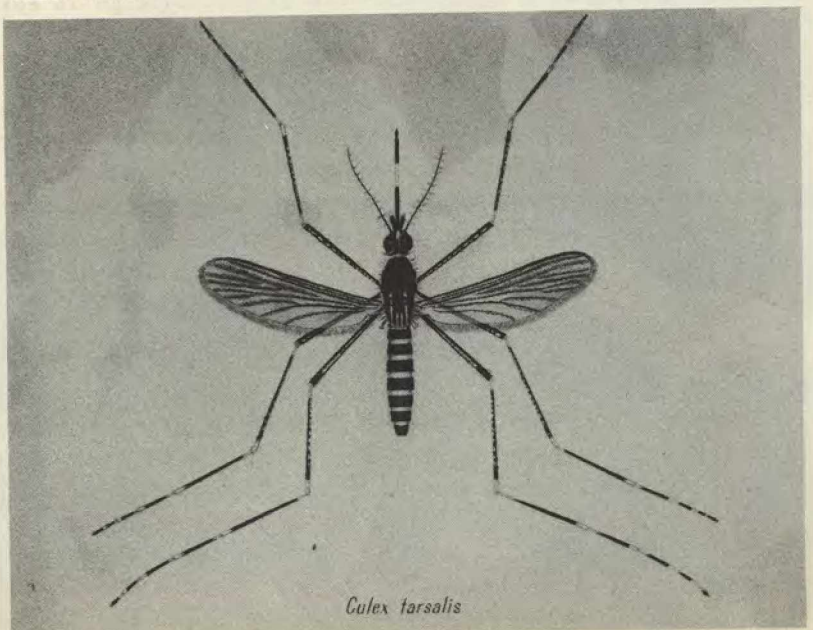
With the inauguration of the typhus program as a part of MCWA activities, methods of protecting operations personnel from the hazards of contracting the disease were considered. An endemic typhus vaccine was being manufactured by a commercial biological supply house. Since this vaccine was still in the experimental stage, it was not being offered on the open market. However, a quantity sufficient to vaccinate about 650 employees was made available to this office, and this material was distributed to the various states conducting typhus control programs. Blood samples were taken before and after vaccination and sent to the company in order to study the efficacy of the vaccine. A consistent increase in antibody titre was noted among personnel on this project who received the murine typhus vaccine.

Courtesy of the David J. Sencer CDC Museum

Encephalitis Studies

In connection with investigations being conducted on the epidemiology of encephalitis by the Hooper Foundation of the University of California at Berkeley, two entomologists, one ornithologist, and one assistant were assigned to that organization by the U. S. Public Health Service to aid in an attempt to determine the importance of wild birds and their blood-sucking parasites as reservoirs and vectors of encephalitis. The proposed investigation included the searching of birds' nests for mosquitoes, mites, and ticks, and the identification and testing of these arthropods for the presence of the encephalitis virus. Smears for avian malaria and mosquito dissections were planned to obtain data to serve as an index of certain bird-mosquito relationships, particularly in respect to *Culex tarsalis*, the most incriminated vector of encephalitis. "Wild" *tarsalis* resting and feeding habits were to be investigated for the first time and determinations made of the flight range of this species.

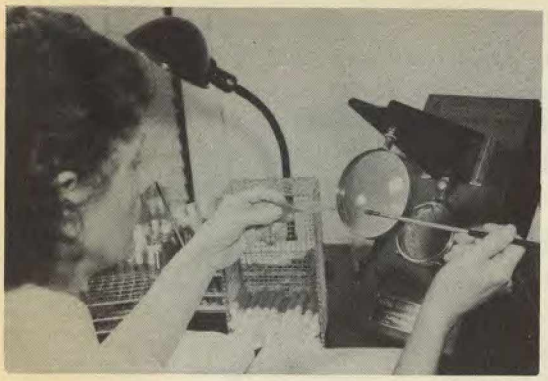
These studies were important as a supplement to those already completed or being conducted on domestic fowl by the Foundation. It was essential to determine the principal source from which *C. tarsalis* mosquitoes derive their encephalitis infections in order to provide the most effective mosquito control measures. If wild birds were the important source rather than domestic fowls, DDT residual sprays for mosquito control around human habitation would be a less effective measure since there would be little probability of the infected mosquitoes resting on sprayed surfaces. If domestic fowls were of greater importance as reservoirs of infection, such measures as DDT spraying of chicken houses would be a most effective control. The transfer of mites and ticks from wild to domestic birds could also be of importance in establishing domestic reservoirs of infection. This study was not begun until April, and results of the work are not sufficient to warrant reporting at this time.



Culex tarsalis

Courtesy of the David J. Sencer CDC Museum

Dysentery Control Studies





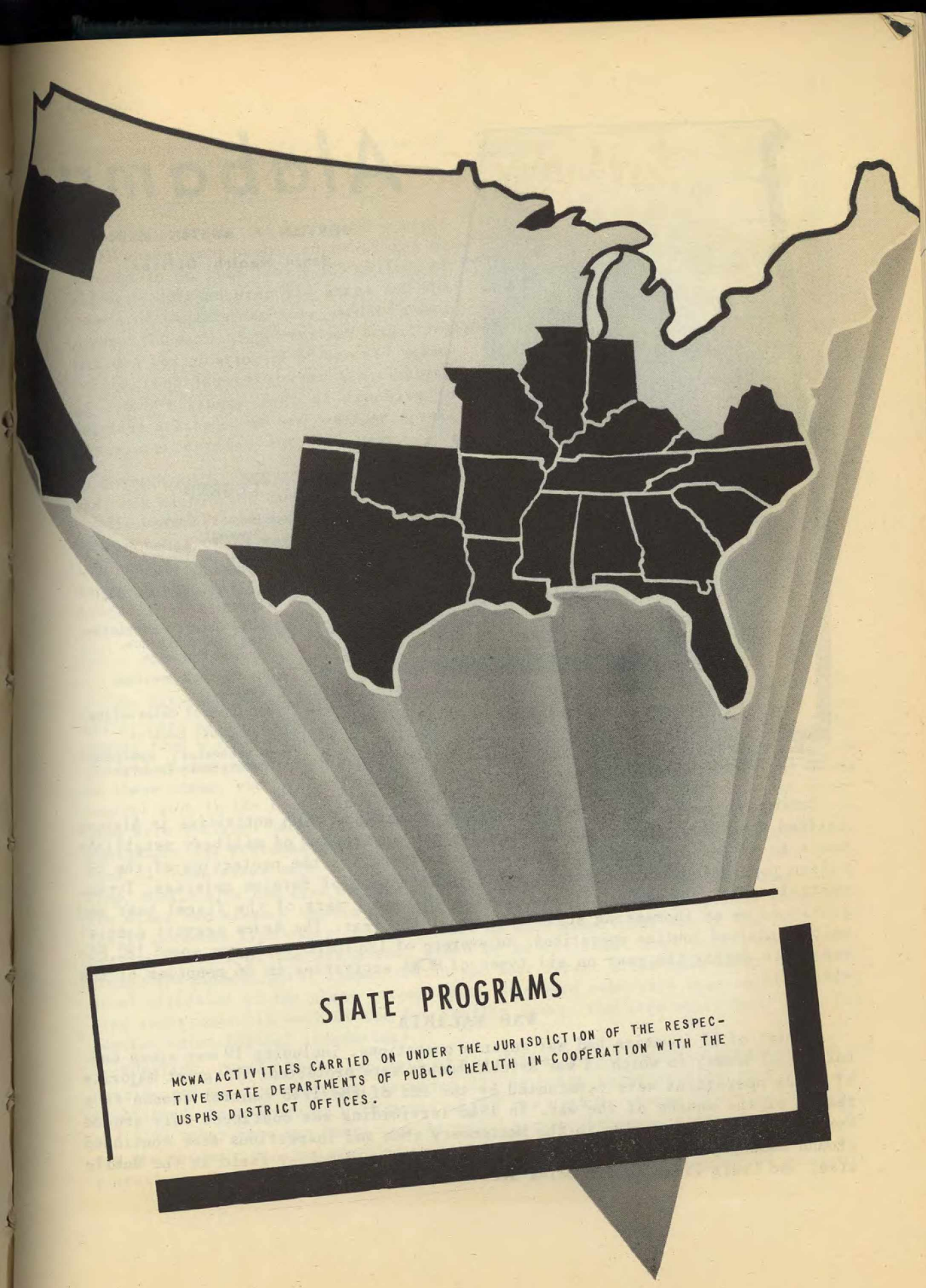
Throughout this fiscal year MCWA and the National Institute of Health cooperated in an investigational program designed to determine the role of flies in the transmission of dysentery and diarrhea. Fly control operations were the responsibility of MCWA, and NIH had charge of the epidemiological phases of the work. The program, operating out of Pharr, Texas, was begun in the fall of 1945.

Hidalgo County was chosen as the site of the dysentery and diarrhea control operations because of the high incidence of these two diseases there. Actual work was being conducted in five towns, while five comparable towns were being used as controls. In the towns where fly reduction operations were being carried on, DDT residual and space sprays were used against the adult flies, and orthodichlorobenzene was used as a larvicide.

(top) Inoculating Klegler's agar slant with picked colonies in epidemiological studies. (middle) DDT residual spray on foliage. (bottom) DDT space spraying.



Courtesy of the David J. Sencer CDC Museum



STATE PROGRAMS

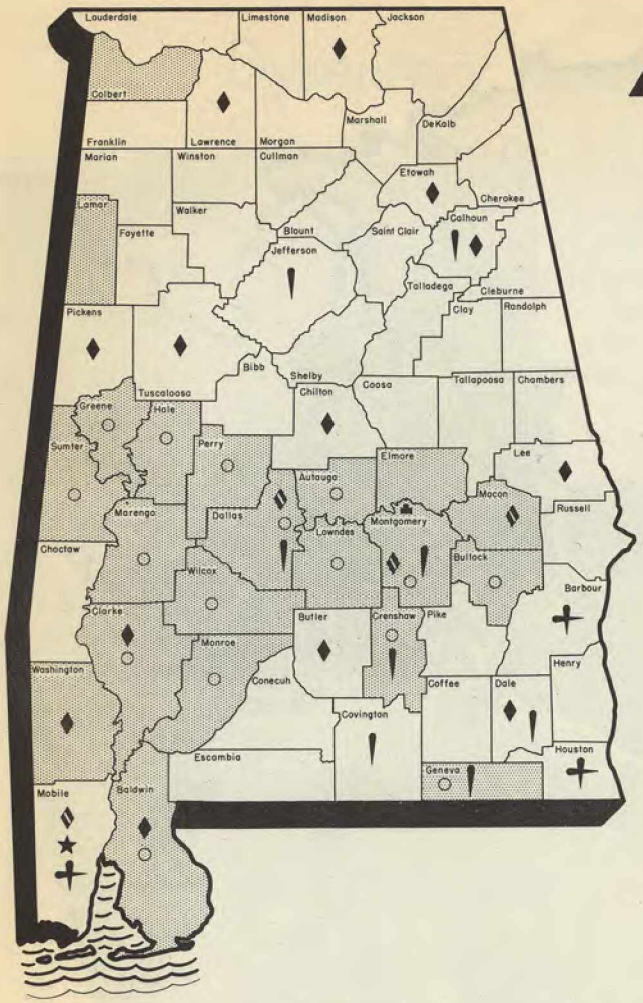
MCWA ACTIVITIES CARRIED ON UNDER THE JURISDICTION OF THE RESPECTIVE STATE DEPARTMENTS OF PUBLIC HEALTH IN COOPERATION WITH THE USPHS DISTRICT OFFICES.

Courtesy of the David J. Sencer CDC Museum

Alabama

BURTON F. AUSTIN, M. D.

State Health Officer



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Residual Dusting
- Typhus Control Ratproofing
- *Aedes aegypti* Control
- Virus Laboratory, Montgomery (Montgomery County)

During the course of the fiscal year the emphasis of MCWA activities in Alabama shifted from war malaria larviciding for the protection of military establishments to extended program residual house spraying for the protection of the civilian population against the possible introduction of foreign malarias. Typhus control operations were initiated during the early part of the fiscal year and continued on an increasing scale throughout the year. The *Aedes aegypti* control unit maintained routine operations. An average of 128 USPHS employees spent 181,852 man-hours during the year on all types of MCWA activities in 36 counties of the state.

WAR MALARIA

A total of 17 counties had war malaria operations, including 19 war areas containing 33 zones, in which 74 war establishments were protected. The great majority of these operations were terminated by the end of the 1945 control season as a result of the ending of the war. In 1946 larviciding was continued only around Maxwell and Gunther Fields in the Montgomery area and inspections were continued around Tuskegee Army Airfield in the Tuskegee area, Brookley Field in the Mobile area, and Craig Field in the Selma area.

Courtesy of the David J. Sencer CDC Museum



Former *Anopheles* breeding pond completely filled in with saw dust.

LARVICIDING. Sixteen war establishments in 11 zones were protected by oiling or dusting. To do this job, 4,753 gallons of oil were sprayed over 174 acres and 500 pounds of paris green were used to cover another 373 acres. Supplementary activities included the clearing of 48 acres of aquatic and land vegetation and the cleaning of 264,804 linear feet of ditching to maintain drainage. No new drainage operations were carried out this year.

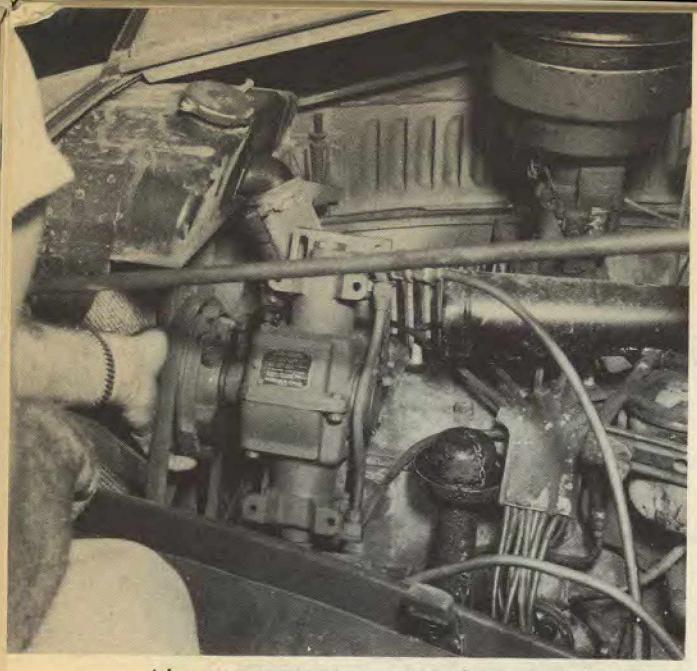
ENTOMOLOGICAL SURVEILLANCE. Since the bulk of the mosquito-producing areas had been eliminated during previous years by major drainage operations, most of the war establishments this year were protected by entomological surveillance. Of the total of 74 war establishments, 58 in 22 zones were kept under constant inspection to apprehend high "quad" breeding indices. In those areas which remained active after the end of the war, entomological surveillance indicated the necessity for only a relatively small amount of larviciding and ditch maintenance.

EXTENDED PROGRAM

The Extended Malaria Control Program was expanded during the year to include all or part of 21 counties. The areas in which malaria control work was done were chosen from a consideration of malaria statistics and entomological findings. The general policy was to apply DDT residual spray to all occupied rural residences in these areas, and to determine by entomological surveys the necessity for doing control work in the towns. In the larger towns larviciding and minor drainage measures were utilized rather than residual spraying for reasons of economy. The organization for residual house spraying was set up under seven area headquarters. Four of these areas were comparatively large; Montgomery area contained six counties, Mobile area had five counties, Greene had five counties, and Selma had three. The other two areas — Geneva and Colbert — were one-county operations geographically detached from other control areas. An area supervisor was in charge of the program in each of the six areas, aided by an assistant area supervisor in two areas. The entomological inspectors in the four larger areas were under the technical direction of the state entomologist, but were otherwise responsible to the area supervisor. In each of the two smaller areas, the area supervisor made the routine entomological inspections.

SPRAYING. During the first half of the fiscal year, spraying operations were carried out in six counties, in which 21,964 house spray applications were accomplished. An average of 0.76 pound of DDT was used per house spray application, and 1.40 spray crew man-hours were expended per application. After the end of the war the extended program expanded to include 21 counties and 45,711 house spray applications. Experience gained by previous spraying lowered the number of man-hours

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Air compressors mounted on truck motors supplied pressure for spray cans fitted with valve stems.

per house application to 1.15, and the amount of DDT per application was increased to 0.80 to obtain greater residual effectiveness. The personnel for spraying crews was recruited in the various counties, consideration being given to the location of the homes of the crew members with reference to the working areas. In many cases it was more practicable for crews to proceed routinely to work from the foreman's home rather than to report to a central headquarters each day. Three-man spraying crews — foreman and two laborers — proved to be the most efficient operating unit. In a few instances it proved profitable to add a fourth man temporarily when working in a thickly populated area, where a complete additional crew was not justified.

Spraying was done with a number of different makes of knapsack pressure sprayers, none of which proved entirely satisfactory for the purpose. Ten crews were equipped with engine driven compressor units adapted to Dodge ½-ton military vehicles and Lofstrand sprayers modified by replacing the sprayer pumps with caps and tire valves. This arrangement proved successful because it eliminated all trouble connected with the sprayer pump. Time saved by eliminating hand-pumping was rather insignificant. No other attempts were made to modify the spraying equipment but it is apparent that there is a definite need for a better hand-pressure sprayer. Vehicles of ½-ton or ¾-ton capacity proved best for the work. The four-wheel-drive feature was advantageous in some localities and in wet weather but considerable mechanical difficulty was experienced with the old model Army vehicle (½-ton truck).

LARVICIDING. At the beginning of the fiscal year the cities of Montgomery, Prattville, and Fort Deposit were given extended protection by larviciding and minor drainage operations, while Selma, Entaw, and Demopolis were kept under entomological surveillance. In 1946 larviciding protection was continued in the three above-mentioned cities while surveillance was increased to include 16 cities in 13 counties. No major drainage was considered necessary during the year.

EXTENDED PROTECTION. More than half a million residents of Alabama received malaria protection in one form or another through extended program operations. A total of 67,675 house spray applications were made during the course of the year, requiring the use of 53,430 pounds of DDT and 83,502 spray crew man-hours to provide this protection.

TYPHUS CONTROL

Typhus control was initiated during the first part of the fiscal year and operated in a total of 11 counties. Rodent extermination was combined with practically all of the DDT dusting activities and rat-stoppage was promoted wherever possible.

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Approximately three-quarters of a million residents of Alabama were accorded typhus protection through the services of 32 USPHS employees during the year. Treatment of some 58,800 residences and business establishments required the expenditure of 93,650 local and MCWA labor man-hours. The program was well received this year both in urban and rural areas, which was not the case during its inauguration.

RESIDUAL DUSTING. Inspections for rats and ectoparasites were carried out in 42,931 premises in 28 cities and 32,091 premises were found to be infested. Alabama was one of the few states which carried on residual dusting in rural areas this year; Crenshaw, Covington, Geneva, Houston, and Dale counties contained rural dusting beats. Approximately 9,144 business establishment dustings were accomplished as against 23,915 residence dustings; some of the premises required more than one application. In carrying out the fore-going work, 144,133 pounds of ten percent DDT were used, averaging 4.3 pounds per premise dusting. Labor and foreman man-hours per application averaged 0.86 during the year.

RATPROOFING AND POISONING. Three cities – Mobile, Dothan, and Eufaula – had ratproofing campaigns in which a total of 120 business establishments were treated. An average of 22.5 labor and foreman man-hours were needed to treat each establishment. Rat poisonings were carried out in approximately 24,940 premises in conjunction with both residual dusting and ratproofing. About 29,555 pounds of bait and 5,211 pounds of cyanogas were used, requiring 0.43 labor man-hour to distribute 1.19 pounds of bait per premise poisoning.

EPIDEMIOLOGY. An analysis of reported cases of typhus fever for the period January 1 to July 1, 1946 did not allow any definite conclusions when compared to the number of cases occurring for a like period during past years. Complement-fixation tests did not show a reduction in the number of positive rats as the reservoir of infection. The ectoparasite index showed a considerable reduction in the number of fleas, although seasonal conditions might have been a contributing factor. A more thorough examination for parasites and infected rats was anticipated during the fall months.

AEDES AEGYPTI CONTROL

The *Aedes aegypti* control unit continued its routine operations in Mobile during this fiscal year. A monthly average of six MCWA employees inspected 51,850 premises and found 2,250 to be infested, an *aegypti* breeding index of 4.34. As an incidental result of these control measures, the 201,000 residents of the city benefited from the rubbish collections and general improvements in premise sanitation.



(left) Inspecting for rat signs in a basement. (below) *Aedes aegypti* inspectors checking water containers for mosquito breeding.



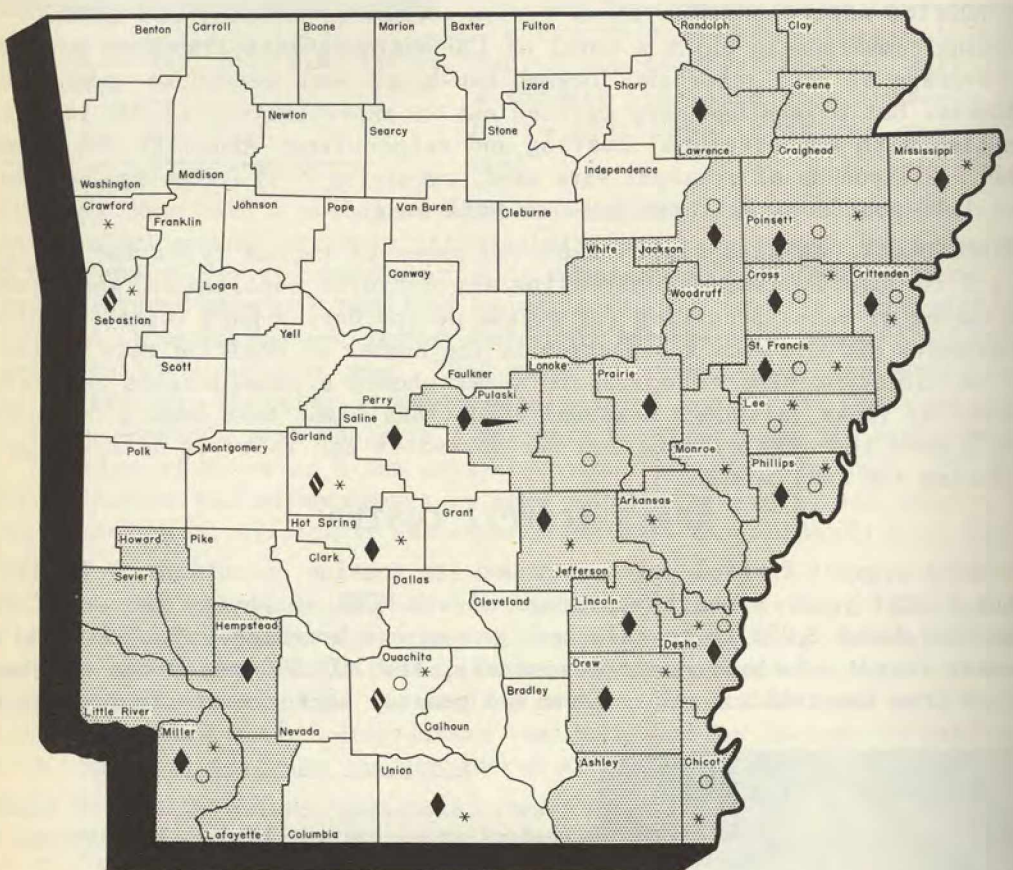
Courtesy of the David J. Sencer CDC Museum

Arkansas

T. T. ROSS, M. D.

State Health Officer

The number of residual house spray applications in Arkansas exceeded that of any other state in the country during this fiscal year, and the war malaria larviciding program was surpassed only by one other state. As in other states, the end of the war caused a marked curtailment in war malaria control operations and an increase in other phases of the program. During the year a monthly average of 367 USPHS employees worked 571,366 man-hours on all phases of MCWA activities, including typhus control.



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Ratproofing
- Typhus Surveys

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WAR MALARIA

War malaria activities were carried on in a total of 22 counties during the year, including 53 zones in 20 areas, and protected 40 war establishments and 17 housing and recreational areas connected with them. Residual spray operations were utilized as a war malaria control expedient in 12 of these establishments and two housing projects where it was impractical to carry out larviciding. Approximately 319,000 man-hours were expended to accomplish the larviciding, residual spraying, clearing and cleaning, and drainage necessary to maintain war malaria control during the year. Since the great majority of the military installations terminated soon after the end of the war, only six – Fort Smith and Camp Chaffee in Sebastian County; Shoemaker Ordnance Plant and a Camden installation in Ouachita County; the Army-Navy Hospital and Lake Catherine Rest Camp in Garland County – were protected by larviciding during the second half of the fiscal year, and Lake Hamilton Rest Camp in Garland County was kept under entomological surveillance.

LARVICIDING. During the first half of the fiscal year 37 war establishments and 13 war housing and recreational areas in 39 zones were protected by larviciding operations. These numbers dropped to six in each case with the curtailment of war malaria control operations at the beginning of 1946. Larviciding problems were intensified by the fact that the majority of larvicidal zones were located in sections of the state affected by the four successive floods in 1945. Many new breeding areas were created, and many others usually easy to control were rendered inaccessible because of high water. Routine oiling covered 9,927 acres and required 167,360 gallons of oil. Paris green dust, 2,447 pounds, was spread over 1,564 acres. To facilitate larviciding, 426 acres of aquatic vegetation and 369 acres of land vegetation were cleared out.

DDT-OIL LARVICIDING. Reports submitted from 11 areas where the new DDT-mist type oil larvicide was used experimentally were very encouraging. It proved to be equally or more effective in control than the older-type of larvicides, with the added advantages of greater ease in application, increased spray swath, great penetration of vegetation, and savings in labor and material costs. In all areas, supervisors reported a reduction in man-hours and material used. Savings in material ranged from 63 percent in Mississippi County to 90 percent observed in six areas. Savings in labor ranged from a 20 to 50 percent reduction in St. Francis County to 80 percent in Lee County. The new larvicide was popular with the crews because of its easier methods of application brought about by use of a lighter can and less frequent refilling.



DDT mist-type oil larvicides proved equally or more effective than the older-type larvicides.

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DRAINAGE. Certain areas in the state required drainage operations to effectively control mosquito-breeding. Drainage work undertaken as a part of the war malaria program was completed during the first half of the fiscal year. In all, 93,242 linear feet of hand ditching and 1,500 feet of dynamite ditching were accomplished. Approximately 637,743 linear feet of old ditching were cleaned and 2,295 feet were lined with cement slabs. Fifteen acres of water surface were eliminated as breeding places.

ENTOMOLOGICAL SURVEILLANCE. All zones where larviciding was carried on were kept under entomological surveillance to detect any increases in the mosquito breeding index. In addition, entomological inspections were used to determine when to start and stop larviciding and the extent of the control zone. After the war those war establishments which were not terminated were protected by larvicidal operations, which included regular entomological inspections.

THERMAL AEROSOL EXPERIMENT. This experiment, based upon work done by the Tennessee Valley Authority and others, consisted of spraying rice fields with DDT thermal aerosol by airplane. Its purpose was to determine if damage to the rice would result from a weekly application schedule heavy enough to control malaria mosquito breeding. A 220 horsepower PT-17 made flights at a height of 20 feet, spraying in 100-foot swaths. The thermal aerosol equipment was calibrated to discharge 0.12 pound of DDT per acre using a 20 percent DDT mixture in Velsicol NR-70.

Two fields at Stuttgart, one of 32 acres and the other 40 acres, received a total of eight weekly treatments from July 28 to September 18; three other fields served as controls. These treatments covered the period from the second flooding of the rice until the water was drained off for harvest. All flights were made at daybreak so as to take advantage of the low wind velocity generally found at this time of day. Larval population were sampled weekly by 200 random dips in each of the five fields under observation; very few or no larvae were found in the treated field.

An agronomist from the U. S. Department of Agriculture visited the rice fields three times: after the first, fifth, and eighth sprayings. The rice appeared to be developing normally at these times. The rice pathologist of the University of Arkansas examined samples of the harvested rice and confirmed observations that there was no discernable injury to the rice as a result of these DDT treatments.

EXTENDED PROGRAM

At the beginning of the program, house spraying activities were hampered by lack of equipment — both transportation and sprayers — and because of the difficulty in obtaining and maintaining a supply of DDT concentrate in all areas. After the program had been in operation for a time, adequate equipment was obtained for all crews. A central supply house was set up in Little Rock and a regular delivery system to all areas was established. With crews properly equipped and supplied, houses were sprayed with a minimum expenditure of man-hours.

SPRAYING. A total of 32 counties had all or part of the county under residual spraying control, eight of these 32 counties were added to the program in 1946. Approximately 88,915 residual spray applications were completed during the first half of the year, requiring an average of 1.09 labor and foreman man-hours to spray 0.39 pound of DDT per application. The spraying program expanded during the second half of the year to accomplish 135,327 house spray applications. Labor and fore-

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man man-hours per house spraying decreased to 1.05 as a result of experience gained and public education. The amount of DDT per application was increased to 0.65 pound to obtain a longer-lasting residual effectiveness. Spraying was done by three-man crews — two sprayers and a lead man. Each crew was equipped with a ½-ton truck carrying two five-gallon cans for DDT concentrate, a drum for water, three sprayers, cover cloths, and a foot-locker containing replacement parts.

SPRAY CREW TRAINING. The crews in each area were trained by the area supervisors and malaria control assistants. They were shown the training film strips, "Hand Spraying of DDT" and "Safe Practices in the Use of DDT," and were given considerable time for supervised practice spraying before going into houses. They were also given a brief training course in the basic facts about malaria and its control so that they might be able to answer questions asked of them by people whose houses they sprayed. The lead man was trained to make contacts immediately ahead of the spray crew and see to it that the house was prepared for spraying. Previous information as to how houses should be prepared was given through community meetings and radio and newspaper publicity. The monthly publication "Arkansas Malaria Bulletin" was first issued in April 1945. The purpose of this bulletin was to present a coordinated account of the work to field personnel and to provide a stimulus for malaria control activities by exploiting the spirit of competition of field personnel. Monthly tabulations of results of entomological, operational, and educational activities were published.

LARVICIDING AND DRAINAGE. According to the recommended practice, 26 cities in 11 counties were given extended malaria protection by larviciding operations during the first half of the year. This number was later increased to 27 cities in 16 counties to meet the requirements of an expanding extended program; six of the original cities larvicided in 1945 were dropped while seven additional cities were added to the extended larviciding program in 1946. One major drainage project around the McGehee Housing area in Desha County was completed during the first half of the fiscal year.

PUBLIC EDUCATION. Considerable attention was given to health education of children in the schools, with the cooperation of the teachers. Short courses or workshops in four Arkansas colleges helped prepare and train instructors to teach malaria sanitation. Attention was also given to adult lay education for the purpose of creating an awareness to the malaria problem and the formation of permanent malaria control organizations. Talks were made at meetings of numerous social and civic groups. Proper instruction of persons and families affected with malaria was an important part of the education program. These persons were usually interested and provided an ideal means of promoting malaria control sanitation. This work was directed through the medium of the county or district health office to the physicians attending cases. Malaria control assistants contacted physicians to explain the methods and objectives of the program and to work out with the doctor procedures for handling case reports. The people were urged to go to a physician for treatment of malaria. As an inducement, the offer was made to spray the house of each person whom a physician reported as having malaria, provided the house had not been sprayed within 30 days previously. As part of the program for apprehending malaria cases, attempts were made to locate discharged servicemen who had malaria while in service. Local draft boards cooperated by question-

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ing each veteran reporting for reclassification. Personal contacts are being made with these men to inform them in methods of malaria sanitation.

In both the promotional work and in the program of general malaria control education, the educator worked closely with school superintendents, health officers, home demonstration agents, and various organizations already existant in each county which were interested in the malaria control programs. Twenty-four towns in the extended program area contributed a total of $37,500 for malaria control work. This local financial participation was partially the result of promotional work of the educational section.

ENTOMOLOGICAL SURVEILLANCE. Entomological surveillance on the extended program consisted of regular inspection in all larvicidal zones and surveys of sprayed and unsprayed houses with nearby adult resting places in the residual spray area. Of 3,102 sprayed houses inspected in the first quarter of the fiscal year, 6.67 percent had mosquitoes in the afternoon as compared with 48.04 percent in unsprayed houses. In the last quarter 0.82 percent of 6,738 sprayed houses inspected had mosquitoes in the afternoon as compared with 33.07 percent in unsprayed houses. Entomological inspectors collected 1,535 engorged anophelines during the last quarter, 11 of which showed a positive test for human blood.

EXTENDED PROTECTION. Approximately 772,000 residents of Arkansas were accorded extended malaria protection. To provide this protection 239,191 labor and foreman man-hours were expended on 224,215 residual house spray applications and 122,977 pounds of DDT were used, in addition to larviciding in a number of towns.

TYPHUS CONTROL

Typhus control operations in Arkansas consisted mainly of rat poisoning and ratproofing campaigns in the cities of Little Rock and North Little Rock. In addition, typhus surveys were made in 30 other cities in 21 counties to obtain data on typhus fever cases, ectoparasite populations, and rat blood samples. The survey got underway in October and continued until malaria control personnel returned to their regular assignments. Early in January a ratproofing program was initiated in Little Rock; in June a similar program was started in North Little Rock. During this period an average of 22 employees were engaged in surveys, rat poisoning or ratproofing, and approximately 186,000 residents of the state were protected by typhus control activities.

RAT ERADICATION. In the two cities where rat poisoning or ratproofing were carried on, 408 premise poisonings were accomplished with 21,183 Red Squill torpedoes and 3,126 pints of "1080" poisoned water used to supplement the bait. An average of 7.1 labor and foreman man-hours were required to spread approximately 52 torpedoes of bait per premise treatment. One hundred eighty-nine establishments were ratproofed during the year, requiring 2,896 local and MCWA labor and foreman man-hours. This was an average of 29.2 man-hours per establishment.

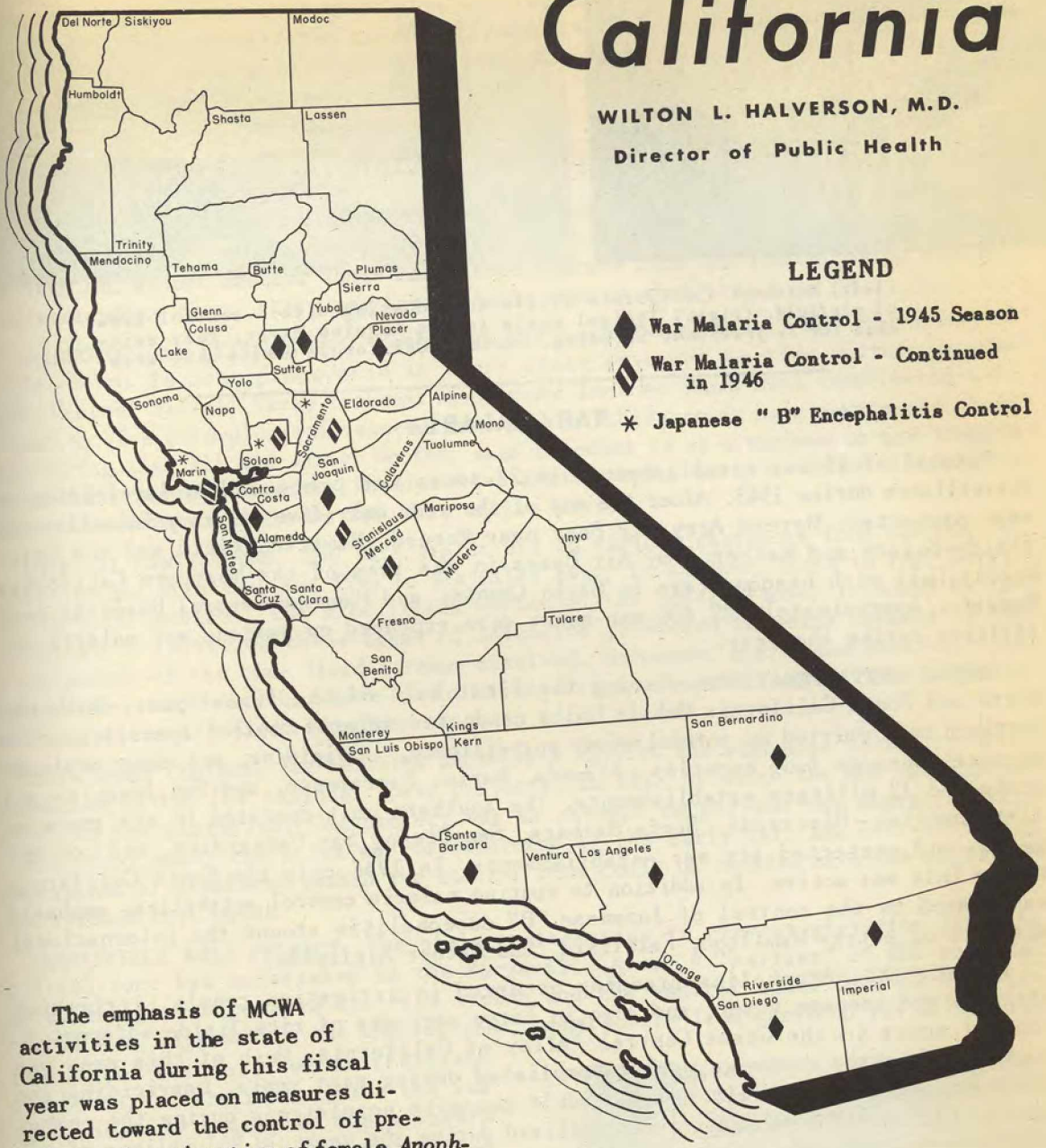


Surveys were made to obtain data on typhus fever cases, ectoparasite populations, and rat blood samples.

Courtesy of the David J. Sencer CDC Museum

California

WILTON L. HALVERSON, M.D.
Director of Public Health



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- * Japanese "B" Encephalitis Control

The emphasis of MCWA activities in the state of California during this fiscal year was placed on measures directed toward the control of prehibernation migration of female *Anopheles freeborni*, the western malaria vector. This migration directly affected the control measures because the peak of reported cases of malaria occurred during this period of migration. Emphasis was also placed on the use of DDT larvicide in connection with control measures aimed at preventing the establishment of Japanese "B" encephalitis in areas adjacent to international airports of entry. DDT was used to control the breeding areas of *Culex tarsalis*, the most incriminated vector of indigenous mosquito-borne virus encephalitis in California.

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(left) Northern California mobile unit dusting within control area of airfield. (right) Typical pools in Los Angeles River, very suitable for *A. freeborni* breeding. Southern California mobile unit area.

WAR MALARIA

A total of 25 war establishments in 22 zones was protected by larviciding or surveillance during 1945. After the end of the year only five military installations were protected: Merced Army Air Base near Merced; Hamilton Field and the Fairfield–Suisun and Mather Army Air Bases in the area of the Northern California Mobile Unit with headquarters in Marin County; and Hammond General Hospital near Modesto. Approximately 22,450 man-hours were expended on various war malaria activities during the year.

MOBILE UNIT OPERATIONS. During the first half of the fiscal year, both the North and South California Mobile Units conducted malaria control operations. The northern unit carried on entomological surveillance, larviciding, and minor drainage in nine zones in four counties–Alameda, Marin, Sacramento, and San Joaquin– and protected 12 military establishments. The southern unit operated in six zones in five counties–Riverside, Santa Barbara, San Diego, San Bernardino, and Los Angeles–and protected six war establishments. In 1946 only the North California Mobile Unit was active. In addition to routine malaria control activities, emphasis was placed on the control of Japanese "B" encephalitis around the international airports of entry–Hamilton, Fairfield, and Mather Airfields.

LARVICIDING. Anopheline breeding occurred in irrigation canals, irrigation spillage and seepage water, and also in large acreages of rice fields adjacent to control zones in the Great Central Valley of California. Much of this area was controlled by the drainage work accomplished during past years. Larviciding and minor drainage effectively reduced adult mosquito populations during the summer months. Oiling was most extensively utilized during the year; 10,951 gallons of oil were used to larvicide 1,003 acres. Supplementary dusting with paris green covered an additional 11 acres. Nineteen acres of vegetation were cleared to facilitate larviciding operations.

DRAINAGE. Some new ditching operations were carried on during the year. In the vicinity of Marysville and Yuba City a dragline was used to excavate 1,800 feet of new ditching in 1945. Some 600 feet of hand ditching was accomplished during the 1946 season by the Northern California Mobile Unit. Altogether, 42 acres of water surface were eliminated by the ditching operations and the cleaning and maintenance of 64,500 feet of existing irrigation drainage ditches.

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ENTOMOLOGICAL SURVEILLANCE. Twelve war establishments in 11 zones were under entomological surveillance during the first half of the fiscal year. Inspections were carried on at five military establishments in 1946, four of which required larviciding as a malaria control measure.

CONTROL OF MIGRATION OF *ANOPHELES FREEBORNI*

Although larviciding and minor drainage can control mosquito populations during the summer, an incredible number of mosquitoes are produced in rice fields during the fall and winter months. These mosquitoes migrate from the fields, owing perhaps to overcrowding or to their seeking suitable winter shelters.

ENTOMOLOGICAL EVALUATIONS. Each year during mid-September, the migration of *A. freeborni* is most pronounced in those areas adjacent to rice culture in the Great Central Valley. Three resident MCWA zones located there have experienced this migration. The entomological records from each of these zones have constantly shown that during the fall and winter months, when breeding is at a minimum or has stopped completely, counts of adult females have averaged better than 30 per station in control-zone resting places for this entire period.

PHYSICAL LIMITATIONS. The rice fields are at various distances from the control zones. In one area they are five to six miles away; in another, three to four miles; and in still another, the rice fields border on the control zone. It would be impractical to larvicide these areas of intensive *freeborni* breeding because of the great extent of the rice field acreage involved. Moreover, inside the control zones during the summer months there is no noticeable increase in adults that might be attributed to rice field breeding.

DDT—SPRAY CONTROL. The measures undertaken against the migration of *A. freeborni* consisted of two DDT residual spray projects, in both of which the DDT was applied prior to the migration. One project was an attempt to prevent the migration into the control zone; the other was to determine if the early fall and over-wintering population of *freeborni* within the control zone could be reduced once the migration had reached that point.

MARYSVILLE AREA PROJECT. The project attempting to prevent migration into the control zone was undertaken in the Marysville Area. A "barrier" of DDT residual spray was placed between the rice fields and the control zone. Some of the rice fields were adjacent to the control zone; others were from three to six miles distant. The "barrier," which traversed the border of the rice fields and was approximately a mile in depth toward the control zone, was not continuous but concentrated in the separate farmsteads staggered throughout the one-mile zone. DDT residual spray was deposited



A "barrier" of DDT residual spray was applied to the interior of all buildings except dwellings.

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on the interior surfaces of 937 buildings in this zone, with the exception of dwellings. The spray was a DDT-Triton-xylene-water emulsion applied at the rate of 100 mg. of DDT per square foot with a 50-gallon power sprayer equipped with two conventional fan-type DDT residual spray nozzles. A 100-foot hose connected each nozzle to the power sprayer which was operated at 60 pounds per square inch pressure. All the equipment was mounted on a ½-ton pickup truck and was handled by a three-man crew. Although the spray was applied prior to the migration (the first two weeks in August), and the reduction of *freeborni* was practically 100 percent in the sprayed shelters, nevertheless there was no apparent decrease of *A. freeborni* within the control zone stations during the fall and winter months.

MERCED AREA PROJECT. In the second project, to determine whether the immigrant population could be reduced after it had reached the control zone, DDT residual spray was applied to the interior surfaces of all buildings, except dwellings, within the Merced Area control zone. The DDT was applied in the same manner and at the same rate as for the Marysville Project. During the first two weeks of September 825 buildings were sprayed. The results were excellent, for the adult population was practically reduced to zero from the time of the spraying until February 1946 in all of the buildings that had been treated. The cantonment area of the protected military establishment in this zone was also treated with DDT residual spray by the Post forces prior to the start of this project.

OVER-ALL RESULTS OBTAINED. The over-all effectiveness of spraying DDT inside the protected area can best be shown by the results obtained. As indicated by a comparison of this year's weekly larval collections with those of last year for the same period, the first observed breeding of *freeborni* during the spring of 1946 was delayed approximately one month. This may have resulted from the great reduction of the adult population of *freeborni*.

JAPANESE "B" ENCEPHALITIS

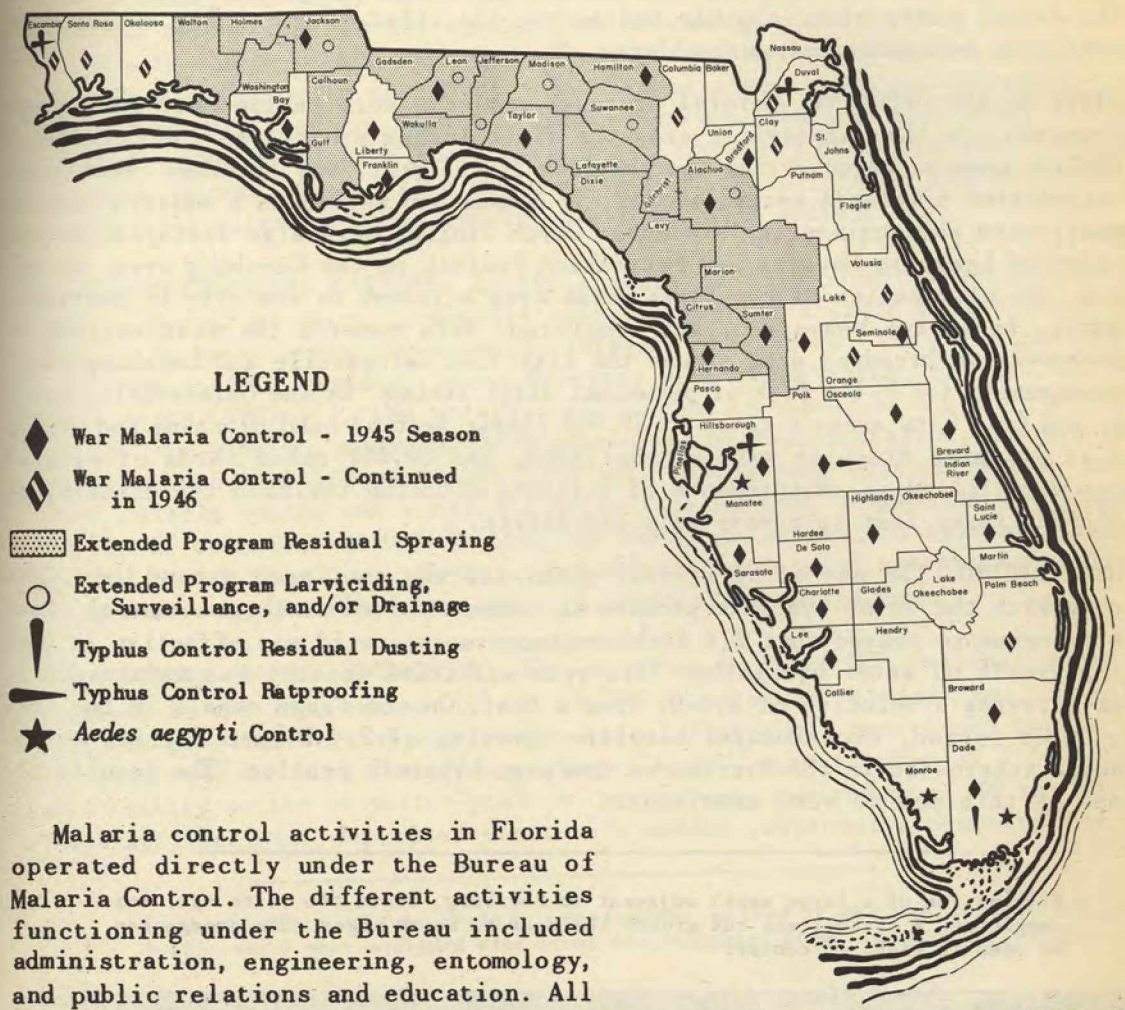
DDT larvicide was used in connection with control measures aimed at preventing the establishment of Japanese "B" encephalitis in areas adjacent to the international airports of entry into this country. Hamilton, Fairfield–Suisun, and Mather Airfields, in the Northern California Mobile Unit area, were the destinations of much of the military air-traffic arriving from endemic areas in the Pacific. Inspection and spraying of inbound planes were performed by the Division of Foreign Quarantine. MCWA activities were designed to prevent the possible spreading of the disease to native vectors. DDT-Diesel oil plus an emulsifier-spreader was used as a mosquito larvicide from mid-April of 1946 on.

DDT-OIL LARVICIDE. Thus far the results indicate that when this larvicide was applied as a mist spray it was equal to straight Diesel oil in effectiveness of larval kill. The path of the mist, however, was so dependent upon every slight change in wind direction that complete coverage, and hence 100 percent larval kill, were not always obtained. Nevertheless, with good entomological inspection following closely behind the larvicide application, excellent control could be obtained. The cost of the labor in applying the DDT-oil mist larvicide was so greatly reduced as compared to the use of straight Diesel oil that even if an area needed retreatment this method was still more practical and economical. The proper dosage per acre and the frequency of application still remain to be determined, but it is hoped that these data will become available as more use is made of the larvicide.

Courtesy of the David J. Sencer CDC Museum

Florida

WILSON T. SOWDER, M. D.
State Health Officer



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Residual Dusting
- Typhus Control Ratproofing
- *Aedes aegypti* Control

Malaria control activities in Florida operated directly under the Bureau of Malaria Control. The different activities functioning under the Bureau included administration, engineering, entomology, and public relations and education. All issuance of supplies, major repair work on automotive equipment, and DDT mixing were performed at the central headquarters in Jacksonville.

WAR MALARIA

Ninety-one war establishments in 82 zones received malaria protection of one kind or another during the year. Programs in the 37 counties included larviciding, major drainage, and entomological surveillance. In accordance with established policy the end of the war caused a drastic curtailment in the extent of war malaria operations. During the second half of the fiscal year only 19 war establishments, distributed among 18 zones in ten areas, were protected by war malaria con-

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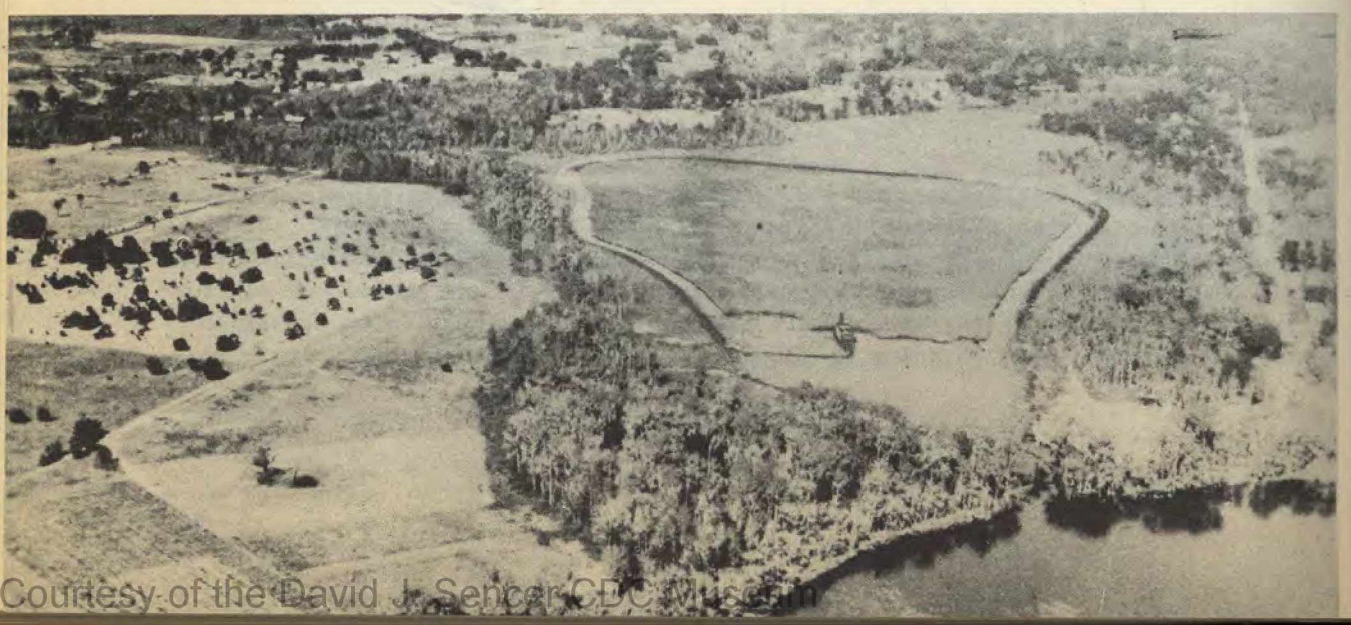
trol measures, and the scope of operations was narrowed down to nine counties. Over the course of the year 136,979 man-hours were expended on war malaria control alone.

LARVICIDING. A total of 21,191 gallons of oil and 6,008 pounds of paris green were used to effectively control the 4,801 mosquito-producing acres around the 49 war establishments protected by larviciding during the year. Only three war establishments remained to be guarded by oiling or dusting during the latter part of the fiscal year, after the war had ended; the other 16 remaining active were protected by entomological surveillance.

DITCHING AND DREDGING. Several drainage projects were carried out during the 1945 season. In the Gainesville area the ditch lining project on the University of Florida campus, begun during the previous fiscal year, was finished. This project eliminated a malaria hazard around the campus and served as a malaria control demonstration for engineering students. Ditch linings were also installed around the city of Leesburg Housing and Recreation Project in the Leesburg area. In addition, the elimination of the large marsh area adjacent to the city by hydraulic dredging, begun two years ago, was completed. This removed the most serious *A. quadrimaculatus* breeding area around the city. The Gainesville and Leesburg projects accounted for 9,444 feet of permanent ditch lining. In the Gainesville, Leesburg, and Lake City areas a total of 79,900 linear feet of hand ditching and 10,676 feet of dynamite ditching were accomplished, and 30,000 cubic yards of watered places were filled in. Maintenance of existing ditching included the cleaning of 1,168,497 linear feet to remove silt and debris.

HERBICIDING. The use of herbicidal chemicals was continued around Lake City to cope with the water hyacinth problem in connection with malaria control. Last year experiments proved that 2,4 dichlorophenoxyacetic acid was effective in combating growth of water hyacinths. This year effective control was maintained by power-spraying a solution of 2,4-D. from a boat. On the large canals in the Lake Okeechobee region, experimental airplane spraying of 2,4-D. was carried out by agencies interested in the Everglades drainage hyacinth problem. The results obtained by this method were excellent.

Elimination of a large marsh adjacent to Leesburg, begun two years ago, was completed. A channel was cut around the area to be dredged. The dredge can be seen to right of center.



Courtesy of the David J. Sencer CDC Museum

EXTENDED PROGRAM

For operational purposes under the Extended Malaria Control Program, the state was divided into three districts, each under the supervision of an engineer. District I included Jackson, Walton, Holmes, Washington, Calhoun, and Gulf counties; District II contained Leon, Madison, Gadsden, Wakulla, Jefferson, Dixie, Lafayette, Gilchrist, and Taylor counties; and District III encompassed Hamilton, Marion, Levy, Sumter, Hernando, Suwannee, Citrus, and Alachua counties. Each engineer was directly responsible for all spraying and entomological operations in his district, and was in charge of all personnel. The districts were sub-divided into areas with an area supervisor in charge of each. Two or three counties comprised the area unit, depending upon the number of houses sprayed. The area supervisor was responsible for the assignments and activities of the spray crews and the crew-leaders' reports. He was often called on to solve problems of either public relations or operational nature arising from the previous day's activities.

EPIDEMIOLOGICAL FACTORS. In the absence of entomological records extending over a period of years, equitable apportionment of a state-wide control program had to be based primarily on epidemiological histories. The counties which were selected for DDT residual house spraying were those which, in the last malaria peak years (1933-37), had malaria death rates in excess of 25 per 100,000 population. In order to minimize the mathematical misrepresentation possible with low numbers such counties must also have had, during some year on record, more than five malaria deaths and a malaria death-rate of over 50 per 100,000 population. Of the 29 counties which fell into the above classification six were deleted due to low vector densities. Within a county the recent and current anopheline densities were used to indicate the need for control operations.

EXTENDED CONTROL OPERATIONS. Ten counties received DDT residual spray applications in the 1945 season. Of the 24,113 house spray applications, monthly control inspections on a random sample basis of sprayed, unscreened houses and unsprayed outbuildings showed an average "quad" vector ratio of 1:550. Further, the monthly series of vector-positive percentages derived from 100 mg. per square foot applications, deposited one to six months previously, demonstrated a defi-

Around Palatka the navigation problem was solved by the use of hyacinth saw boats, which were equipped with front and outrigger booms of circular saw blades.



Courtesy of the David J. Sencer CDC Museum

nite loss of protection after the third month. During the second half of the fiscal year 27,516 house spray applications in 23 counties were accomplished. The number of man-hours per house application was reduced from 1.62 for the 1945 season to 1.18 for the 1946 season by reason of the increased experience of spray crews. As recommended for cities having more than 2,500 population, Marianna, Live Oak, Monticello, and Madison were given extended protection by larviciding during the 1945 mosquito-breeding season. In 1946 further control around Madison was considered unnecessary, but Tallahassee, Gainesville, and Perry were added to the list of towns which required larviciding operations. Entomological surveillance was maintained throughout the state where control operations were not being carried on. Approximately 188,000 residents of Florida were protected from malaria by operations on the extended control program, which expended 71,569 man-hours of labor and 43,094 pounds of DDT.

TYPHUS CONTROL

Eleven cities in six counties had typhus control programs in operation during the past fiscal year. Approximately 29,400 residual dusting applications were carried out in business establishments and residences in nine cities, and 0.56 labor and foreman man-hour was expended to spread 1.7 pounds of ten percent DDT dust per premise application. Ratproofing a total of 411 business establishments in the cities of Pensacola, Jacksonville, Tampa, Bartow, and Haines City required an average of 20 man-hours for each establishment. To accomplish 320 premise poisonings, a total of 181 pounds of bait and 38 pints of "1080" water were used, and 0.56 man-hour was expended per premise poisoning. In addition to 13,930 man-hours of local labor, a monthly average of 14 MCWA employees worked 21,658 man-hours during the year on the various kinds of typhus control activities and afforded typhus protection to 579,800 residents of the state.

AEDES AEGYPTI CONTROL

Aedes aegypti control projects were operated in Key West, Miami, and Tampa. In the city of Key West 10,052 premises were inspected for *aegypti* breeding places and 1,528 were found infested; an index of 15.20. In Miami 11,826 premises out of 240,165 were found to be infested; an index of 4.89. Tampa showed 3,060 infested premises out of 19,440 inspected, or an index of 15.74. An average of 23 USPHS employees worked full-time on *aegypti* control operations and public education work, effecting the protection of half a million people in Florida against the re-introduction of dengue and yellow fever.

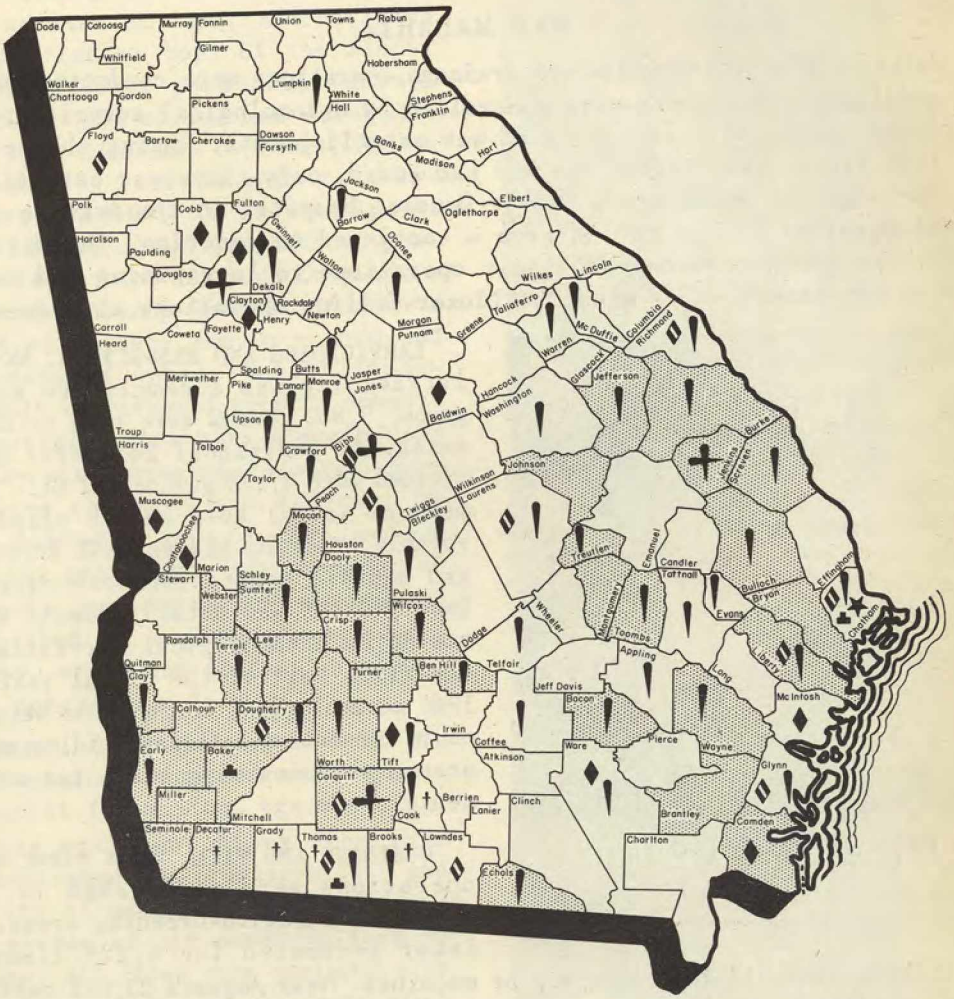
AIRCRAFT DISINSECTIZATION

The inspection for insects and spraying of all commercial planes arriving at Miami from quarantine areas was continued during the 1946 fiscal year under the Division of Foreign Quarantine of the U. S. Public Health Service. The cessation of hostilities was followed by a steady increase in commercial air traffic and more than 40 different airlines were operating into the Miami airport during this fiscal year. The aerosol formula used to spray planes consisted of five percent pyrethrum extract, three percent DDT, five percent cyclohexanone, two and a half percent deobase, and 84.5 percent dichloro-difluoromethane (Freon 12).

Courtesy of the David J. Sencer CDC Museum

Georgia

T. F. ABERCROMBIE, M. D.
Director of Public Health



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Typhus Control Residual Dusting
- Typhus Control Ratproofing
- *Aedes aegypti* Control
- Thomasville Typhus Investigation Projects
- Thomasville Typhus Investigation Office (Thomas County)
- Carter Memorial Laboratory, Savannah (Chatham County)
- Emory University Field Station, Newton (Baker County)

Courtesy of the David J. Sencer CDC Museum

Malaria mortality in Georgia during the calendar year 1945 reached an all-time low of 0.8 per 100,000 population, and the reported morbidity for the first six months in 1946 was also the lowest on record. The Extended Malaria Control Program was received with wholehearted and almost unanimous approval by the general public and interested local authorities. Numerous requests were received to expand the program to include rural outbuildings and practically every type of building occupied for portions of a day.

WAR MALARIA

War malaria larviciding and minor drainage operations were conducted in 11 areas and an additional four areas were controlled by entomological surveillance during the calendar year 1945, protecting 85 war establishments. During the second half of the 1946 fiscal year, after the war had ended, only three war establishments – Robins Field in the Macon area, Oliver General Hospital in the Augusta area, and the Naval Hospital in the Dublin area – continued to function. The five remaining full-time employees confined their operations to larviciding and inspection work, with the exception of minor bulldozer-filling operations at Augusta.



Paris green larviciding with rotary duster.

LARVICIDING AND INSPECTION. Most of the larviciding was accomplished with paris green; 9,802 pounds were used to dust 7,553 acres. An additional 241 acres were larvicided with 2,182 gallons of oil. To insure maximum larval kill and to eliminate favorable breeding places, 143 acres of land and aquatic vegetation were cleared out. Twenty-eight war establishments were protected by entomological surveillance dur- the first half of the fiscal year. During 1946 entomological inspections were carried on in connection with larviciding activities around the remaining three war establishments.

DRAINAGE AND FILL. Some minor drainage operations were undertaken in 1945 to eliminate mosquito-breeding areas. Manual labor accounted for 6,229 linear feet of new ditching, and 113 feet were dug by machines. Near Augusta 23,062 cubic yards of earth were moved in filling operations. A total of 24 acres of water surface was eliminated during the year by draining and filling operations.

EXTENDED MALARIA CONTROL

In the first half of the fiscal year operations were conducted in 14 counties grouped in four areas. In the latter half operations were conducted in 36 counties grouped in 11 areas and three districts. The state office and warehouse at Macon served as the central office and distribution center. Warehouse facilities were ample for storage of chemicals, equipment, and supplies, mixing of concentrate, repairs to vehicles and equipment, and other services necessary to the program.

Courtesy of the David J. Sencer CDC Museum

OPERATIONAL PROCEDURE. A supervisor was employed, trained, and assigned to each county and was responsible for all county operations. In multiple crew counties one to two assistants were employed to assist the county supervisor in laying out crew routes, advising the householders concerning operational procedures, recording sanitation data, and revising maps. In the latter half of the fiscal year all spray-crew personnel, spray-crew vehicles, and office and warehouse facilities were furnished by county health authorities at a cost amounting to approximately $73,000, or an average of $0.81 per unit spraying. Operational procedures followed were designed to perform the residual spraying operations with a maximum of efficiency and to record and assemble data of public health importance. Weekly operational reports embodying all pertinent data were prepared and submitted by all county supervisors. These reports were reviewed and analysed by area and district supervisors and by state office personnel, who summarized these reports and, during the subsequent week, furnished all supervisory personnel with county, area, and district rankings based on operations data.

EQUIPMENT. Each crew used a 30- to 55-gallon container, equipped with a quick-opening outlet for mixing, transporting, and storing emulsion. After June 1945 tests demonstrated the practicability and desirability of using stored compressed air as a source of air power in lieu of hand pumping. All crews were equipped with 60- to 80-gallon compressed air tanks which were filled at service stations at no cost. All hand sprayers were modified by removing the hand pumps and installing air-filling valves for delivery of air from the storage tanks. This procedure eliminated all pump maintenance and also considerably reduced manpower requirements for maintaining proper air pressure in the sprayers. Using this equipment, hand spraying operations were more efficient,





(above) Filling spray can with DDT emulsion from drum on truck. Air compressor behind drum provides pressure through valve stem on spray can. (below) Mobile DDT residual spray unit working in Terrell County.

Courtesy of the David J. Sencer CDC Museum

even in urban areas, than conventional power spraying. The major item of equipment developed in 1946 was a 300-gallon concentrate mixer made entirely from salvaged Army equipment. This was a rectangular vat in which agitation was secured by means of a four-blade paddle wheel, with supplementary agitation by a one-and-a-half or two-inch pump. The temperature of the solution could be raised by forcing hot air along one side of the tank, or by use of submerged electric heating elements.

RESULTS. During the first half of the fiscal year 44,733 house spray applications were completed, using approximately 0.75 pound DDT per house. From January through June 1946, 90,314 house spray applications were completed. The applications were completed. The application rate was doubled in 1946 to 200 mg. per square foot, increasing the DDT used to 1.38 pounds per house. Labor and foreman man-hours per house were reduced from 1.08 in 1945 to 0.61 in 1946, mostly by development of the compressed air spraying technic and the preparation of households for spraying before the arrival of spray crews. Written comments from health officials and members of the medical profession, in the absence of reliable morbidity data, generally credited the extended program with reducing malaria morbidity and with substantially reducing the incidence of enteric diseases among the approximately 500,000 residents of the sprayed counties. In small towns, although no business establishments were sprayed, an almost complete absence of flies was noted.

TYPHUS CONTROL

During the fiscal year a total of 54 counties participated in the residual dusting program either on a full-time or intermittent basis. Of the 23 counties which had full-time dusting programs, four – Bibb, Colquitt, Fulton, and Jenkins – also had ratproofing activities. (The city of Atlanta in Fulton County also had a dusting and ratproofing program separate from county activities.) Due to the intermittent and scattered nature of operations in some sections of the state, dusting and rat eradication control measures in these sections, located in parts of 31 additional counties, were carried on by mobile units operating out of the Macon field office.

OPERATIONS. Rat harborages were found in almost all of the 82,654 premises inspected in 54 counties. An average of 0.88 labor and foreman man-hour was utilized to spread 4.2 pounds of ten percent DDT dust in each of the 77,567 premise dustings completed during the year, mostly in business establishments. Some 325 business establishments in the cities of Macon, Moultrie, Millen, and Atlanta were ratproofed, requiring an average of 58.3 man-hours per treatment. Approximately 23,675 premise were treat-



Dusting DDT into rat hole with hand pump dust gun.

Courtesy of the David J. Sencer CDC Museum

ed with rodenticides, requiring 298 gallons of "1080" water, 17,419 pounds of red squill bait, ten pounds of "ANTU", and 12 pounds of cyanogas dust.

EVALUATION AND INVESTIGATIONS. Biologic and entomologic activities were conducted in each of the 23 counties having full-time dusting programs by three crews, each consisting of a biological aide and a trapper, under the immediate supervision of the field entomologist. A total of 2,324 rats were trapped from both dusted and undusted premises. The flea index (all species) of rats trapped in dusted premises was 2.1 percent as compared to 7.7 percent in undusted premises, indicating 72.7 percent control. Out of a total of 1,670 rat-blood specimens examined, 608, or 36 percent, were found positive for typhus fever by the complement-fixation test.

Typhus and rodent control investigational studies were conducted in Brooks, Thomas, Cook, Grady, and Decatur counties by MCWA personnel operating out of headquarters in Thomasville, with joint administrative responsibilities shared by MCWA and the Georgia Department of Public Health. A county-wide experimental rat poisoning program was carried on in Decatur County. Brooks, Cook, and Thomas counties had county-wide residual dusting investigations. Rodent ectoparasite and blood surveys were conducted in Grady County, which served as the control county of the project.

TRAINING PROJECT. A project to train typhus control personnel from the various states was carried on under supervision of MCWA training personnel in cooperation with the City of Atlanta Health Department and the Georgia Department of Public Health. The training consisted of classroom and field work, involving rat-proofing of buildings, rat eradication, and residual DDT dusting. The project also served as a typhus control program for the City of Atlanta Health Department.

TYPHUS PROTECTION. In addition to 55,268 man-hours of local labor, a monthly average of 43 MCWA employees spent a total of 65,338 man-hours to protect approximately 2,000,000 residents of Georgia from the ravages of murine typhus fever during this fiscal year. Since rat ectoparasites serve as the vectors of human infection, most of the protection afforded was by means of residual DDT dusting.

AEDES AEGYPTI CONTROL

MCWA *Aedes aegypti* control operations in Savannah terminated at the end of March 1946. Up to that time five inspectors examined 28,609 premises for *aegypti* breeding places and found 680 premises infested; an index of 2.4. Approximately 150,000 residents of the city enjoyed protection against the re-introduction of dengue and yellow fever, and an improvement in general sanitation as a result of this program.



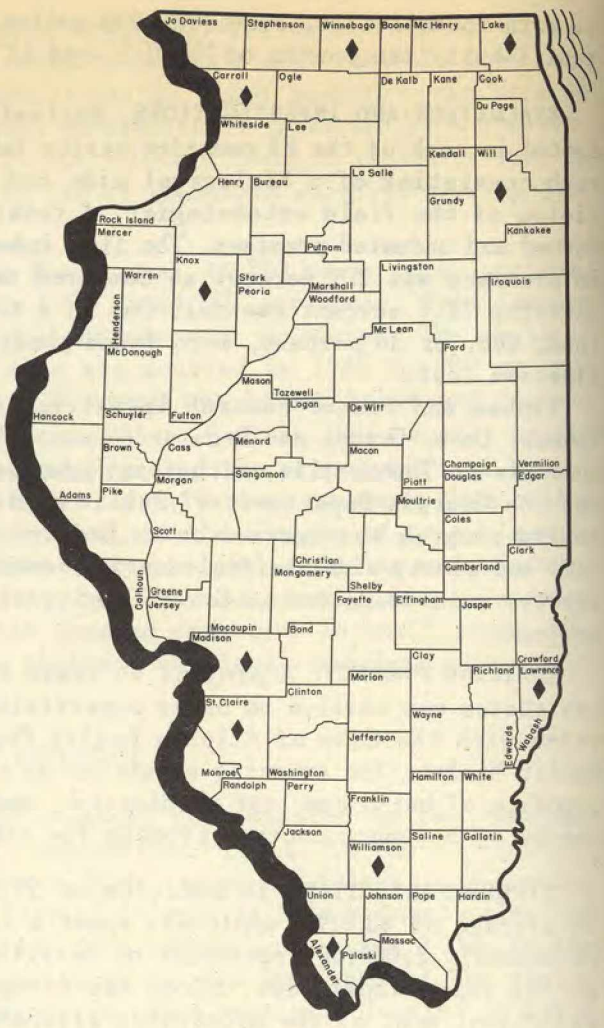
An inspector shows a housewife *Aedes aegypti* larvae which he found in water plant container.

Courtesy of the David J. Sencer CDC Museum

Illinois

ROLAND R. CROSS, M. D.
Director of Public Health

The war malaria control program in Illinois was operated under the jurisdiction of the state department of public health until late in October 1945, after which activities were directed by USPHS District No. 3 personnel in close liaison with the state department of public health. Entomological surveillance, larviciding, and major and minor drainage activities were accomplished in nine counties during the first part of the fiscal year. In 1946 necessary surveillance around the war establishments which remained active was maintained by the military authorities in cooperation with local health departments and District No. 3 personnel.



LEGEND

♦ War Malaria Control - 1945 Season

ACCOMPLISHMENTS. During the fiscal year a total of 1,563 pounds of paris green was used to dust 1,287 mosquito-producing areas and 5,165 gallons of oil were used to larvicide an additional 181 acres. A small amount of brush and aquatic vegetation clearing, 3 acres, was necessary to facilitate larviciding. A considerable amount of previously constructed ditches required cleaning and many new ditches had to be dug, totalling 28,245 feet of ditch cleaning, 4,145 feet of hand-ditching, and 5,090 feet of dynamite ditching. Seven acres of water surface were eliminated by these methods, requiring a total of 10,366 man-hours.

LARVICIDING AND DRAINAGE

Eight projects in three counties required larviciding and minor drainage during 1945 and one major drainage project was completed around Scott Field, St. Clair County. A request was received for assistance in controlling a mosquito problem in the vicinity of the Navy Spare Parts Warehouse in Joliet, Will County. After inspection the problem was found to be mostly one of pest mosquitoes. Larviciding of the Illinois-Michigan Canal by two Navy men with Navy equipment under MCWA technical guidance effected good control. Water-emulsifiable DDT was sprayed from a boat with a four-gallon Myers sprayer.

Courtesy of the David J. Sencer CDC Museum

SCOTT FIELD ZONE. The Silver Creek flood-plain with its numerous sloughs, meandering intermittent streams, and many low areas represented the greatest problem to malaria control. The bottom lands were inundated every spring and during the fall of 1945 they were also flooded several times. A close entomological check was kept on all breeding areas and only those areas harboring "quad" larvae were oiled under the selective larviciding program in effect. As in previous years many drainage ditches had to be reopened and in a few instances new ones had to be dug. A major drainage program was begun July 9 to permanently drain Leibrock's Slough. These areas were completely drained and were dry for a short period in August, but floods from September on damaged drainage ditches considerably and additional ditching was again required. Future ditching work will depend in great measure on floods along Silver Creek. Entomological surveillance was maintained in Scott Field by military personnel during the 1946 mosquito-breeding season.

ILLINOIS ORDNANCE AREA. The principal source of *A. quadrimaculatus* breeding in this area in Williamson County, which included the Illinois Ordnance Plant, the Veterans' Hospital, an FHA Housing Project and the city of Marian, and an FHA Project and the city of Carterville, was a 1,000-acre area of the upper portion of Crab Orchard Lake. This is an artificial impoundment which had not been properly cleared before impounding. It was noted that larvae were found only in a narrow zone 20 to 50 feet wide along the shoreline early in the season and that as the season advanced the growth of aquatic plants gradually caused the widening of the breeding zone. Early in the season the shoreline zone was treated with paris green larvicide by means of a large Root power duster mounted on a sled and pulled by a small crawler-type tractor. As the season advanced and mosquito breeding became general over the extensive shallow lake areas, it was necessary to employ airplane paris green dusting to adequately treat the main portion of the lake. Use of the ground unit was continued along the narrow bays and irregular shoreline areas which were impractical and uneconomical to treat by airplane.

ENTOMOLOGICAL SURVEILLANCE

In addition to the inspections carried on in conjunction with the above-mentioned larviciding and drainage projects, ten war establishments in seven counties were kept under entomological surveillance to discover and control conditions favorable to malaria transmission. Reconnaissance surveys of natural resting place stations were made in extra-cantonment areas and New Jersey light traps were also used to collect data on mosquito populations. Inspections on the military posts were conducted by military personnel under MCWA guidance. In 1946 surveillance was continued in the military installations by military personnel in cooperation with district and local health department personnel.

LAWRENCEVILLE AREA. George Army Airfield and the city of Lawrenceville are both located in the Lawrenceville area in Lawrence County. During 1945 the MCWA pro-



New Jersey-type light traps were used to collect data on mosquito populations.

Courtesy of the David J. Sencer CDC Museum

gram around the city of Lawrenceville consisted of inspections of natural resting place stations and light trap collections in the northern part of the city. Anopheline breeding was recorded rather early in this fiscal year because of heavy rains throughout July, August, and September. Although malaria statistics show a mild rate of endemic malaria in this region over the last ten years, state or federal control was not believed to be warranted; the most satisfactory solution of the situation was felt to be an abatement program by the local government in cooperation with the state health department. The principal "quad" breeding areas around George Field were drainage ditches and gravel pits. Since July, August, and September were wet months, the rate of flow in the ditches remained high. For this reason, and also because vegetation was slow in developing, breeding was kept below normal. After July 31 post personnel took over the inspectional work and no further MCWA activity was necessary. Post personnel also carried out a DDT residual spraying program in George Field during 1945.

OTHER AREAS. A reconnaissance survey around the city of Savanna in Carroll County indicated that there was a low number of *A. quadrimaculatus* present throughout this area. From previous experience with this area together with the reduction of activities at the Savanna Ordnance Depot, it was decided that no further work, either control or inspectional, was justified. The Naval Ordnance Plant in the Cairo zone of Alexander County was accorded malaria protection through entomological surveillance during the first part of the fiscal year. A series of ponds constituted the major "quad" breeding problem around the Army Engineers Depot in the rezoned Granite City area of Madison County. Control measures were never considered necessary during the 1945 season, but since "quads" were present surveillance was continued during the 1946 season by post personnel. In addition to large numbers of Army personnel at Camp Grant in Winnebago County, there was also present a considerable number of prisoners of war. For this reason it was felt best to maintain entomological surveillance in this zone, although the number of "quads" taken from natural resting place stations was very low throughout the 1945 season. Post personnel continued surveillance in 1946.

An inspection of 23 natural resting place stations around Mayo General Hospital in Knox County at the beginning of the fiscal year yielded a total of 31 adult "quads". No further action was taken since neither malaria nor mosquitoes were a problem in this zone. Actual control operations and collection work in the Great Lakes zone in Lake County were under the direct jurisdiction of the Great Lakes officials and were carried out by their personnel with technical assistance from MCWA personnel. Because of the large amount of drainage work completed in 1944, the over-all malaria mosquito problem on the post was materially reduced, although pest mosquito control proved a difficult problem. No cases of local transmission of malaria were recorded in spite of the large number of malaria patients in the Naval Hospital. Surveillance was continued in 1946 by Navy personnel.

SCHICK GENERAL HOSPITAL Although Schick General Hospital is located across the Mississippi River in Clinton County, Iowa, one survey of natural resting places was made at the beginning of the fiscal year by Illinois MCWA personnel. Results of this survey showed no significant numbers of "quads" within one mile of the hospital and no further surveys were made. Because of the large numbers of veterans and service-men located at this hospital who had malaria histories, post personnel continued surveillance in 1946.

Courtesy of the David J. Sencer CDC Museum

Indiana

L. E. BURNEY, M. D.

State Health Commissioner



LEGEND

◆ War Malaria Control - 1945 Season

During the 1945 mosquito-breeding season larviciding operations were carried on in the Terre Haute, Fort Harrison, and Evansville zones. A total of 333 acres were treated with 4,621 gallons of oil and an additional 65 acres were dusted with 52 pounds of paris green. Approximately 3,400 feet of ditches were cleaned of debris during the season. Six additional zones containing military installations and industrial plants were kept under entomological surveillance to locate and eliminate any areas that showed signs of becoming serious mosquito-breeding places. Surveys of five new prisoner-of-war camps revealed a situation at one, near Morristown, which favored local malaria transmission. This breeding area, in an old gravel-pit lake, was effectively controlled by weekly larviciding with a 50-gallon Hardie power sprayer mounted in a boat. All MCWA operations in Indiana were concluded in October 1945. Control measures carried on in 1946 were initiated and financed locally.

TERRE HAUTE

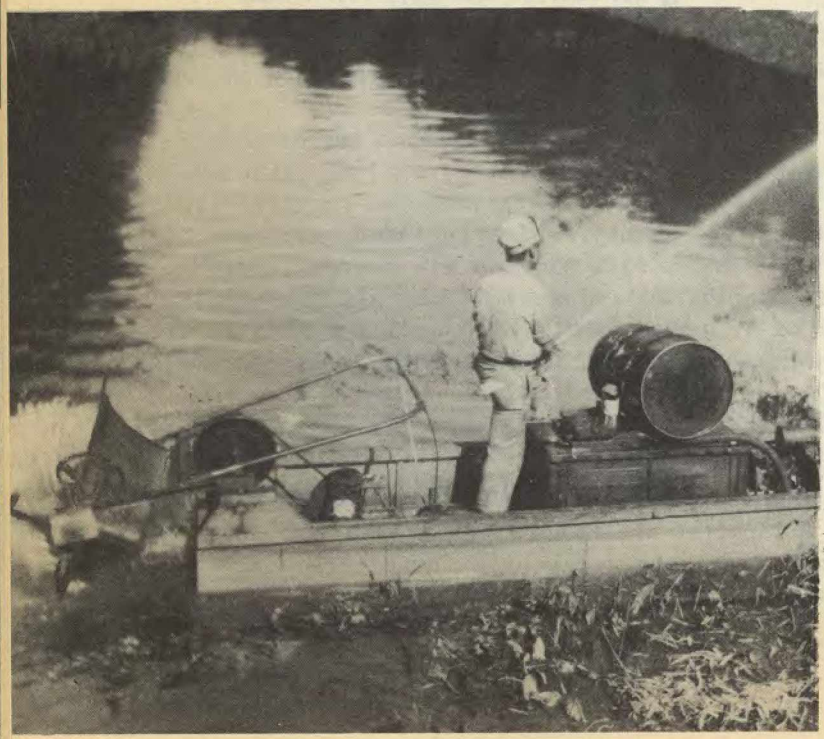
During 1945 the Terre Haute zone in Vigo County, which included two towns, an ordnance plant, an airport, and several industrial plants, was reorganized. Many new larval and adult stations were established and many of the old ones discontinued. A more adequate indication of *A. quadrimaculatus* breeding places in the zone was thus secured. Control operations were begun in June, when counts in adult stations reached significant numbers. The major breeding places in the Terre Haute zone were roughly classified as: (1) the Wabash bottom area, (2) the ornamental ponds, and (3) the old excavations.

WABASH BOTTOM AREAS. The most important mosquito-breeding places in the Terre Haute zone lie in the bottom areas. A flood at the end of June filled the low areas and depressions and provided optimum conditions for heavy "quad" breeding. Conover Marsh, the most favorable breeding habitat, is a low-lying area of about 15

Courtesy of the David J. Sencer CDC Museum



(above) Conover Marsh, looking toward the Wabash River, during July 1945. The levee, extending from the hill in the left background to the right background of the picture, is obscured by heavy vegetation. (lower left) Spraying breeding areas on Indian Lake by means of the paddle-wheel-propelled boat. The paddle wheel may be raised or lowered in the water thus regulating the speed of the boat. It is steered by manipulating a sweep in the bow. (lower right) Power spraying in one of the steep-banked borrow pits. These could not be treated by hand because of the great difficulty in coming within range of the breeding areas.





Courtesy of the David J. Sencer CDC Museum

acres, separated from the river bottom proper by a levee. This extensive breeding area, overgrown with vegetation, could be controlled effectively only by pumping all the water over the levee with a six-inch centrifugal pump. The Ellis Pond area between Taylorville and West Terre Haute was another source of extensive "quad" breeding. This area is filled when the river bottom rises and then dries up during the summer. In the late summer the area was surveyed for possible drainage routes to the river. Dynamite was used with good effect to regrade an old 850-foot slough, providing for quick drainage of this extensive swamp when the Wabash River fell to low stages.

ORNAMENTAL PONDS. In 1934, the Isaac Walton League constructed a series of fish-breeding ponds in Deming Park at the east edge of Terre Haute. The ponds form a good "quad" larvae habitat. Breeding was well controlled by hand and power larviciding.

THE EXCAVATIONS. Numerous old strip-mine, gravel, and shale pits are distributed throughout the control zone, mostly west of the Wabash River. Conditions in these pits vary considerably but entomological data indicated that moderate breeding occurred in some of them during the summer months. The 600-gallon Bean power sprayer was used effectively to larvicide the steep-banked pits and small ponds. Substituting a ¾-inch hose for the ½-inch hose on the sprayer resulted in an effective spraying distance of about 125-150 feet from the nozzle tip.

FORT HARRISON

On the basis of past entomological records and reconnaissance during 1945, it appeared that the only significant breeding place around a war establishment in Marion County was Indian Lake, an impoundment of about 58 acres, one-half mile north of the Fort Harrison and Billings General Hospital zone. A thick mat of vegetation covered approximately 20 acres of the surface of the lake and formed an excellent habitat for "quad" breeding. Larvicide was applied by a 50-gallon Hardie power sprayer mounted in a boat. Good control was obtained with this equipment, but hand-paddling of the boat through the vegetation was slow and exhausting. To remedy this, a stern paddle-wheel powered by a small motor was mounted in the boat and successfully propelled it through the surface growth. The larvicide formula used consisted of 18.2 gallons of No. 2 Diesel oil, one gallon of two percent pyrethrum solution, 9.6 gallons of water, and 0.15 gallon of B-1956 emulsifier. This stock solution was diluted 1:10 and sprayed at the rate of 50 gallons per acre.

EVANSVILLE

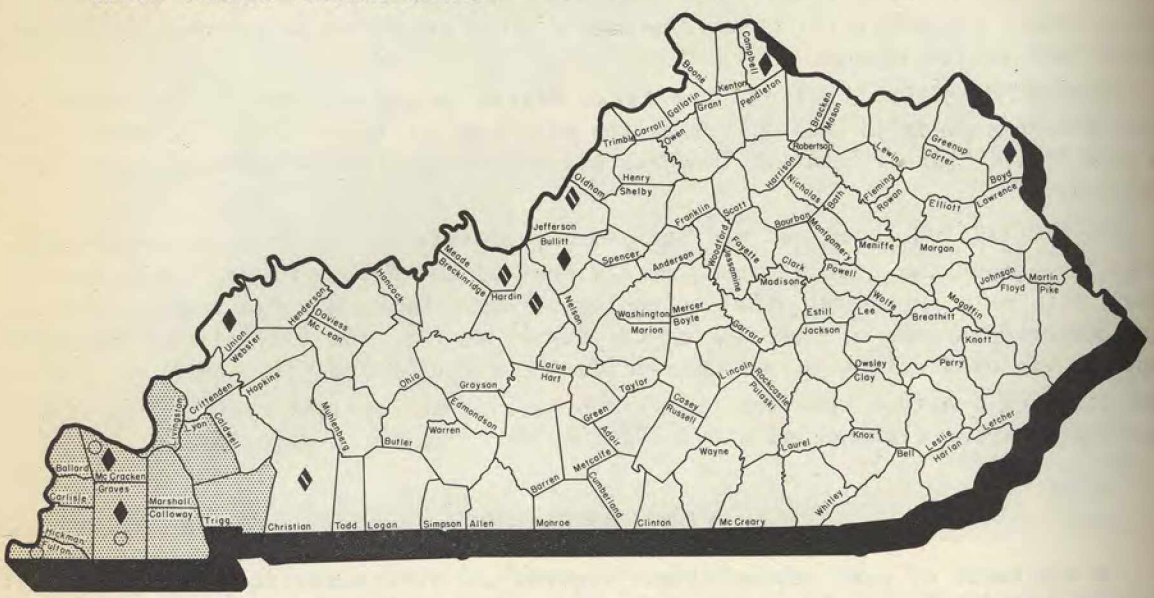
The most significant *A. quadrimaculatus* breeding places in and near Evansville in Vanderburgh County were two ponds in Garvin Park and a series of small ponds in the golf course. Under the existing favorable conditions, moderate numbers of mosquitoes developed in these places. At the beginning of August joint efforts with the city of Evansville resulted in a program of hand-larviciding with Diesel oil. Since the breeding places were limited in area and easily accessible, good control was obtained. An Army airfield and several industrial plants in this zone received routine entomological inspections in 1945. In light of the adult-mosquito and larvae counts, no further control was found to be necessary.

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Kentucky

PHILIP E. BLACKERBY, M. D.

State Health Commissioner



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage

MCWA activities in Kentucky were considerably modified during the second half of the fiscal year as a result of a thorough study of operations over the 1945 mosquito-breeding season. The war malaria program diminished in scope from ten counties to operations in four counties after the end of the war. The extended program was reorganized along more efficient and economical lines, based on the experience of the previous season's spraying operation. Over the course of the year, an average of 40 USPHS employees spent 68,321 man-hours on war malaria and extended program activities of various kinds.

WAR MALARIA

During the first half of the fiscal year 38 war establishments in 16 zones were protected by larviciding and four military installations in three zones were controlled by periodic entomological surveillance. In the course of this work, 14,667 gallons of oil were expended in oiling 683 mosquito-breeding acres and an additional 89 acres were dusted with 132 pounds of paris green. Supplementary work included clearing out 33 acres of vegetation and maintenance-cleaning of 5,383 linear feet of ditches. In 1946 only three military establishments remained active – Camp Campbell, Fort Knox, and the South Louisville Zone Medical Depot – and a modified malaria

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control system was put into effect. The necessary larviciding work was combined with entomological inspecting so that both operations were carried on by a combination sprayer-inspector. In addition, a new larvicide consisting of DDT-Diesel oil spray was used in place of the older larvicides. Results showed that this new larvicide was easier to apply and reduced the cost of application to about one-third the cost of the old method.

EXTENDED PROGRAM

During the first half of the fiscal year 16,838 house spray applications were completed in six counties, using a total of 6,956 pounds of DDT in the process. An average of 1.15 labor and foreman man-hours was necessary to carry out each house-spray application. The city of Fulton in Fulton County was given extended protection by larviciding as recommended for cities of more than 2,500 population. At the end of the 1945 mosquito-breeding season a thorough study was made of this first experience in residual house spraying in Kentucky. As a result of this study several improvements in procedure were incorporated into the following season's operations.

PUBLIC EDUCATION. Because of the intensive program of malaria education carried on during the previous season and the favorable public reaction arising as a result of the homes already sprayed, the educational phase of the extended program was considerably reduced in 1946. Local county health departments and other agencies were encouraged to carry on this work. The cooperation of home owners was obtained to a much greater extent during the 1946 season, and the furniture was more frequently covered before the spray crew arrived. It was learned from experience during the first season that various pieces of furniture in the homes were not damaged when left uncovered during spray operations and considerable time and effort were saved by covering only necessary pieces of furniture.

SPRAY CREWS. Since most of the men employed in the spray operations had previously received adequate training, they were left to operate with much less direct supervision. The area supervisor was thus left free to spend most of his time as advance or contact man for at least two spray crews, in addition to his other duties. After using both two-man and three-man crews, it was concluded that the two-man crew was more efficient. Also, it was found that one man, by properly planning the work, was adequate to perform the duties required at the central mixing plant. Two men had originally been assigned to this work.

PRIVATE ENTERPRISE SPRAYING. Various individuals requested information about residual DDT spraying of homes as a private enterprise. Since this presented an opportunity for a number of homes to be sprayed in addition to those included on the extended program, permission was given for these persons to obtain training in the proper spraying technics by working with spray crews on the extended program. Also, a limited amount of technical guidance was furnished to them. The result was the spraying of approximately 4,800 homes, a substantial contribution to the malaria control program in Kentucky.

MALARIA INCIDENCE RECORDS. The contact man, or spray foreman, secured information concerning malaria cases by asking the home owner a number of standard questions. The area office tabulated the information thus obtained and maintained a permanent record of malaria incidence throughout the counties sprayed. The Paducah office

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(top) Insect and rodent control demonstration unit. (center) Larviciding typical "quad" breeding place in Paducah area. (below) Paris green dusting from boat in Paducah area.

used this data to keep spot maps, showing malaria cases and deaths, up to date.

EXTENDED PROTECTION. During the second half of the fiscal year 9,206 house spray applications in 11 counties were accomplished on the extended program. Spray crew man-hours per application were reduced to 0.70 as a result of the experience gained during the previous season. Extended control larviciding operations in 1946 were continued in the environs of the city of Fulton, and also expanded to include the cities of Paducah and Mayfield. A total of 93,500 residents of Kentucky benefited from extended malaria control operations.

WORKSHOPS

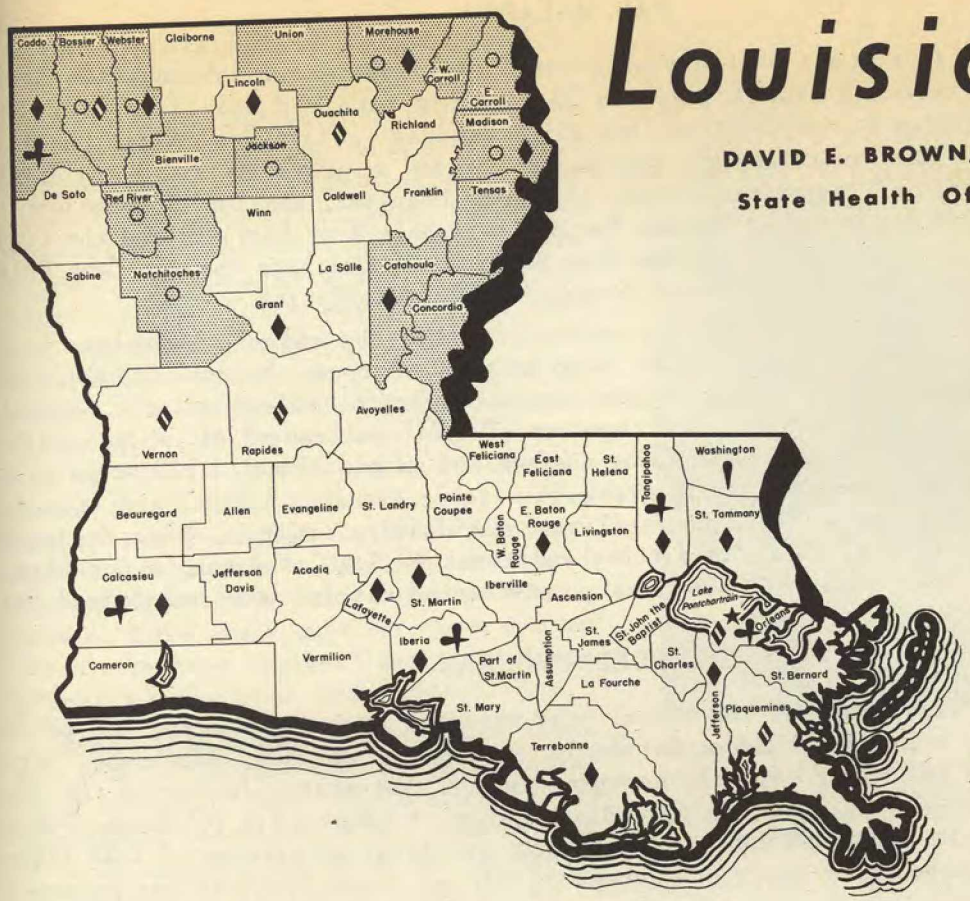
With the advent of DDT and new rodenticides, the Division of Sanitary Engineering received numerous requests for information relative to the proper use of these materials. In answer to these requests, district and state MCWA personnel conducted DDT and rodent workshops throughout the state for the benefit of city and county health departments as well as other groups interested in the promotion of public health work. To date there have been ten such workshops, with an attendance of approximately 450 people.



Courtesy of the David J. Sencer CDC Museum

Louisiana

DAVID E. BROWN, M. D.
State Health Officer



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Residual Dusting
- Typhus Control Ratproofing
- *Aedes aegypti* Control

At the beginning of this fiscal year the number of war establishments in Louisiana had already been reduced from that of the preceding year. By 1946 only a small fraction of the total number continued in operation and required malaria control operations. Coincident with the minimizing of war malaria activities, the extended control program grew more than fourfold according to the number of residual house spray applications. In the early fall of 1945 MCWA residual typhus dusting and ratproofing were inaugurated as a supplement to the extensive state rat eradication program which had been in operation for the preceding several years. *Aedes aegypti* control in New Orleans, begun in April 1943, was terminated at the end of 1945. Over the course of the year an average of 229 MCWA personnel worked a total of 340,364 man-hours on the various phases of control activities.

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WAR MALARIA

During the first part of the year a total of 71 war establishments (26 less than in the preceding fiscal year) in 23 parishes received malaria protection through surveillance, larviciding, and minor drainage activities. After the end of the war only nine installations remained active and required control – the Naval Ammunition Depot in Plaquemines Parish; the Naval Hospital, the USPHS Marine Hospital, and Jackson Barracks in Orleans Parish; Barksdale Army Airfield and the city of Bossier in Bossier Parish; Selman Army Airfield in Ouachita Parish; Camp Polk in Vernon Parish; and the Veterans' Hospital in Rapides Parish.

ACCOMPLISHMENTS. Louisiana lies entirely within the endemic malarious area along the Gulf Coast and has extensive swamp areas which cannot be drained. For this reason a tremendous larviciding program was necessary to effect malaria control – larger than in any other state. Altogether, 302,711 gallons of oil were used to spray 12,563 acres of mosquito-breeding surface and an additional 1,720 acres were dusted with 1,780 pounds of paris green. A sizable amount of brush and aquatic growth, 143 acres, was cleared to facilitate larviciding control. Minor drainage totalled 8,805 feet of hand-dug ditches and about 40 feet of dynamite ditching. Approximately 310,800 feet of previously constructed ditches were maintained and cleaned.

EXTENDED PROGRAM

During the first part of the fiscal year residual spraying was carried on in eight parishes – Bossier, Caddo, Catahonla, Concordia, Madison, Morehouse, Natchitoches, and Red River – in the northern part of the state, including the six parishes which were sprayed the preceding season. A total of 9,761 house spray applications were completed during this period, requiring an average of 1.38 labor and foreman man-hours to apply 0.60 pound of DDT per house application. Extended larviciding protection was accorded the cities of Tallulah in Madison Parish, Bastrop and Mer Rouge in Morehouse Parish, Natchitooches and Campti in Natchitooches Parish, Benton in Bossier Parish, and Conshatta in Red River Parish. In 1946 the residual house-spraying program was enlarged to embrace seven other parishes – Bienville, East Carrol, West Carroll, Jackson, Tensas, Union, and Webster – in addition to the original eight. From January through June a total of 36,141 house spray applications was accomplished. Spray crew efficiency increased as evidenced by the considerably less average time required for each house spraying – 0.98 man-hour. The amount of DDT per application remained about the same as in the preceding season. Extended larviciding control was discontinued in Mer Rouge, Campti, Benton, and Conshatta, and was begun in Minden (Webster Parish), Lake Providence (East Carroll Parish), and the Jonesboro-Hodge Zone (Jackson Parish). Approximately



Inspecting for mosquito larvae in swampy area.

Courtesy of the David J. Sencer CDC Museum

301,000 residents of Louisiana benefited from extended malaria control.

SPRAY CREW COMPOSITION. Two or three men were employed in the actual house spraying operations, depending upon local conditions. In several places the local authorities furnished one or more men to contact the occupants and prepare the houses ahead of the spray crews. This very materially facilitated the work and resulted in increased spray crew efficiency. Between mosquito-breeding seasons, skeleton field forces were employed in making field surveys and locating all houses in the areas to be included in the 1946 spraying program. To facilitate this work and to provide a permanent record of the character, size, and location of the houses, large scale maps were prepared on which were also included essential topographical features and roads.



Spray-clarifying tanks of 590 and 1,000 gallon capacities were used to settle out nozzle-clogging sediment.

SPRAY CLARIFYING TANKS. Since house spraying activities were begun in Louisiana in April 1945, field spray crews experienced considerable lost time because of spray nozzles clogging up due to insoluble impurities in the DDT concentrate. To obviate this difficulty, a 500-gallon, steel, oil storage tank was modified for use as a settling tank. An 18-inch manhole was cut in one end and fitted with a wooden weather-cover. A two-inch outlet was welded into the center of the other end of the tank, which was to be the bottom. Then a one-inch outlet was welded into the side of the tank six inches above the bottom. The tank was set on end, with the pipe outlets on the bottom, on a pedestal raised high enough to get gravity-flow from the one-inch outlet into drums via a hose. The two-inch bottom outlet was used to draw off the lighter sludge which settled to the bottom. A cloth strainer, attached to a pulley above the tank, was placed inside the tank covering the bottom. This strainer prevented the bottom outlet from being clogged and was used to lift out the heavy sludge-sediment before filling the tank again. A 1,000-gallon tank was similarly modified.

JEEP-TRAILER COMBINATION. A combination of jeep, for motive power and personnel carrier, and a trailer, for a spray and equipment carrier, was tried out during the past year to ascertain if it had any actual superiority over a single vehicle such as a weapons carrier. The trailer carried a standard oil drum fitted with a lock-type faucet for the spray mixture. A standard box with compartments contained two five-gallon "GI" cans of concentrate, four spray cans, rags, pails, etc. Another box, on the other side of the trailer, contained cover cloths, tools, repair parts, etc. The whole trailer was protected with a canvas cover. The jeep-trailer combination showed decreased cost of operation, a lower center of gravity for safety, better traction, and greater mobility. The jeep could be used by the

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advance man, while the crew worked out of the trailer. This combination proved more efficient than any vehicles previously used.



A combination of jeep, for motive power and personnel carrier, and a trailer, for a spray and equipment carrier, was tried out.

MOBILE POWER-SPRAY UNITS. During house spray work in the summer of 1945 it was noted that mechanical pumps were of economical use only when the houses were thickly grouped. To make most efficient use of the three 50-gallon and two 100-gallon Dobbin spray pumps on hand, each was mounted on a jeep trailer as a mobile unit. The units could be assigned to any crew when they were spraying in a thickly-populated neighborhood, and then, when ordinary conditions prevailed, could be assigned to another crew. This arrangement worked out most advantageously; each power sprayer could be operated by a regular crew, and was kept busy at maximum efficiency.

TYPHUS CONTROL

In the past several years state and local funds had supported on extensive rat poisoning program in cooperation with the Fish and Wildlife Service of the U. S. Department of Interior. At the beginning of the 1946 fiscal year an MCWA typhus control program was inaugurated in Louisiana as a supplement to, and in cooperation with, state typhus control activities. The combined program consisted of parish-wide, rural and urban, residual dusting in the four parishes of Orleans, Caddo, Calcasieu, and Iberia, and "spot" dusting wherever typhus cases appeared in Tangepahoa and Washington parishes. Infested business establishments in five cities were ratproofed, and poisoning activities were carried on both independently and as an adjunct to dusting and proofing. Approximately 907,000 residents of Louisiana benefited directly as a result of MCWA and state typhus control activities. In addition to an extensive dusting, proofing, and poisoning program carried on with state and local funds, 24 cities were included in the MCWA-state residual dusting program. Of these, four cities – New Orleans, Shreveport, Lake Charles, and New Iberia – also had ratproofing programs. In the city of Hammond, ratproofing alone was the means of combating the typhus menace.

EPIDEMIOLOGY. There were 425 cases of typhus fever in the state in the year 1945, which was an increase of approximately 100 percent over 1944. In 1945, through September, there were 305 cases in the state, 60 of which occurred in New Orleans. Over the same period in 1946 there were 213 cases, 76 of which were in New Orleans. This was a decrease of approximately 30 percent over last year, disregarding the better reporting of the disease by physicians. The typhus complement-fixation blood tests showed a reduction from approximately 68 percent positive to 34 percent positive for rat bloods on a state-wide basis.

SQUILL MIXING PLANT. In the latter part of April a central squill-bait mixing plant was put into operation to furnish mixed bulk and wrapped bait to the state projects. This plant was able to furnish materials to the cities and parishes more

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cheaply than the cost of their buying ingredients and mixing bait themselves. Also, as a result of this plant's operation, the amount of time the supervisor spent in an area was reduced considerably. By the use of Red Squill "torpedoes," the poisoning and dusting crew was able to do two operations at once, obviating the necessity of a return trip to each place dusted. After the dust had settled, Red Squill torpedoes were placed in rat "runs." Squill, being a slow-acting poison, allowed the rats to carry the DDT into their burrows and other inaccessible places before causing the death of rats.

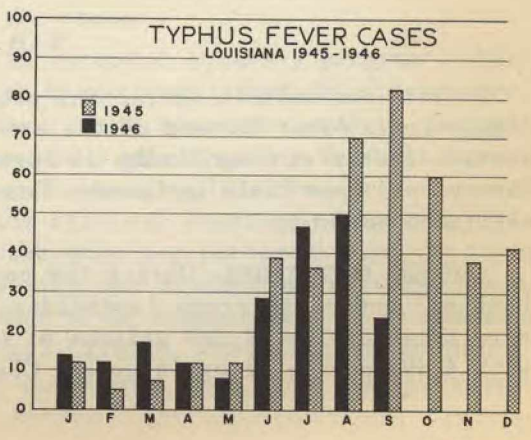
DUSTING INNOVATIONS. In dusting restaurants, the ten percent DDT was mixed with flour, which not only killed rat fleas but also did a very good job of exterminating roaches. To obtain a sufficient amount of DDT dust without expending considerable effort, the dust-outlet holes in the hand-dust gun between the dust chamber and the delivery spout were punched out. A program of theater dusting and poisoning was carried on quarterly, by local parish health units, in 39 parishes that had typhus cases.

PROOFING AND POISONING PRACTICES. For each establishment ratproofed, metal or concrete garbage stands were constructed. New garbage cans, if required, were figured in with the cost of ratproofing. Permanent "1080" poisoning stations were used wherever safe in food-outlet places. These stations were completely protected as a safety precaution. Clean-up campaigns were carried on routinely on each rat eradication project.

ACCOMPLISHMENTS. In the MCWA-state typhus program, a total of 25,667 premises were inspected during the year for rat infestations and 23,588 premise dustings were completed. Each dusting treatment required an average of 0.42 labor man-hour to dust 1.7 pounds of ten percent DDT. Approximately 270 buildings were ratproofed, each of which required 51.3 man-hours of labor. Some 23,172 premise poisonings were completed, requiring an average of 0.29 man-hour of labor to spread 0.23 pounds of bait per premise treatment. Use was also made of "1080" poisoned water as a supplement to the bait; 548 pints were consumed during the year.

AEDES AEGYPTI CONTROL

The control of the yellow fever and dengue mosquito had been in effect in New Orleans since April 1943. In the 1945 fiscal year *Aedes aegypti* control was combined with general sanitation activities. This integrated program, under which *aegypti* control was supervised by USPHS personnel, continued until the end of 1945. In 1946 further MCWA participation was considered unnecessary because effective control was being maintained by the local health unit. During the year 24,667 premises were inspected and 1,794 were found to contain *aegypti* breeding places, an index of 8.51. The 540,000 residents of the city benefited not only by these control measures but also by the general sanitation improvement throughout the city.

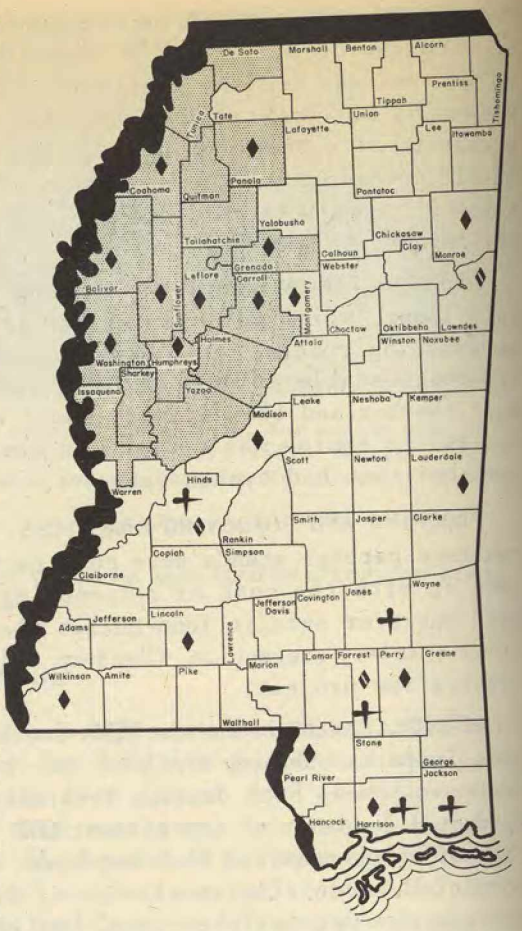


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Mississippi

FELIX J. UNDERWOOD, M. D.

Secretary and Executive Officer



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Typhus Control Residual Dusting
- Typhus Control Ratproofing

During 1945 a maximum number of MCWA zones were in operation in Mississippi. After the end of the war rapid curtailment of war establishments relegated the war malaria phase of control to a relatively minor activity, while the extended malaria program expanded to major proportions. Typhus control activities were inaugurated and carried out in four approved areas in the southern part of the state. An average of 214 USPHS employees participated in MCWA activities of various kinds during the year. All control operations of both malaria and typhus were conducted under the supervision of the State Division of Sanitary Engineering, with field work organized as an integral function of the county health departments. This form of organization resulted in wholehearted cooperation by county officials.

WAR MALARIA

In 1945 war malaria operations protected 59 war establishments in 40 zones in Mississippi. After the end of the war only three military installations – the separation center at Camp Shelby in Forrest County, the Veterans' Hospital in Hinds County, and Kaye Field in Lowndes County – received control and entomological surveillance measures.

CONTROL OPERATIONS. During the course of the year wide-spread use was made of both oil and paris green larvicides. Approximately 2,760 acres of water surface were treated with 68,219 gallons of oil and an additional 2,621 acres were dusted with 4,492 pounds of paris green. Clearing of 488 acres of aquatic and land vege-

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Power dusting from a wagon at Lake Washington.

tation facilitated the larviciding work and rendered some areas unfavorable for *quadrimaculatus* breeding. Drainage operations included 1,000 feet of hand ditching and the cleaning of 254,145 feet of existing ditches.

EXTENDED CONTROL

Public interest and enthusiasm in the residual spraying program have been evident throughout the year. In the borderline counties of Yazoo, Holmes, Carroll, Tallahatchie, and Panola, which would normally be only partly included in the residual spray program, county-paid crews were placed at the disposal of the various area supervisors to assure complete coverage of these counties. Full-time malaria educators assisted in the public relations phases of the extended program which offered protection to more than 459,000 residents of the state.

ACCOMPLISHMENTS. Since the beginning of the extended spraying program in Mississippi, 201,369 house spray applications have been accomplished. Of this number, 61,949 in 13 counties were achieved by a maximum of 48 crews during July, August, and September 1945. The average number of man-hours per spraying for this period was 1.07, and 0.47 pound of DDT was used for each house application. It was necessary to employ a 2½ percent spray due to the critical shortage of xylene, DDT, and Triton emulsifier. During the winter months only key personnel were retained for making maps, numbering houses, and preparing for renewed activities in the spring. From March through June of 1946 a maximum of 60 crews worked in 17 counties to perform an additional 104,041 house spray applications. The man-hours per house-spraying dropped to 1.00 because of increased spray-crew experience and the amount of DDT per application was increased to 0.70 pound.

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SPRAY CREWS. The work crew used in Mississippi consisted of one sprayer-foreman and three laborers. The use of the four-man crew was begun early in 1945 and has been continued in the belief that it is an efficient operational unit in view of the shortage of vehicles. Under conditions existing in this state, it has been observed that a four-man crew usually sprayed 15 to 20 percent more houses per day than a three-man crew could accomplish without using extra equipment.

MATERIALS AND EQUIPMENT. The Greenwood warehouse served as the distribution center for all materials and equipment. All kinds of major and minor repair work on automotive and sprayer equipment, as well as DDT mixing, was done at this warehouse. A mixing procedure was developed at the warehouse which doubled the output of concentrate from a single mixer. To each of 30 empty 55-gallon drums of the removable-head type (originally used for Triton emulsifier), 125 pounds of DDT and 31.5 gallons of xylene were added, the covers replaced, and the drums allowed to stand overnight. By morning most of the DDT was dissolved and what remained was more or less in suspension. The "mix" was then pumped into the mixer, became clear in about two or three minutes, emulsifier was added, and the mixing was complete.

A more versatile spray can was the result of installing a valve stem on the filler cap of the Lofstrand sprayer and on the cover plate of the Hudson sprayer. The pumps on both cans were left in place so that pressure could be obtained from either a compressor or the hand pump. Twenty-five compressors were used during the year to provide air pressure for the spray cans. Each compressor tank was fitted with a valve so that air could be delivered from a filling-station air supply in the event of breakdown of the compressing unit. The use of a faucet-equipped, 55-gallon drum on each truck for carrying diluted five percent spray was continued this year. Some areas constructed large, overhead tanks for mixing the diluted spray in order to facilitate the filling of the drums on the spray trucks each morning. The tank at Cleveland had a 500-gallon capacity and the one in the Clarksdale area held 420 gallons. A general utility man mixed the five percent spray in the tank each morning and had the drum in each truck filled by the time the crews reported for work. The movement of the truck kept the spray in the drum agitated during the day.

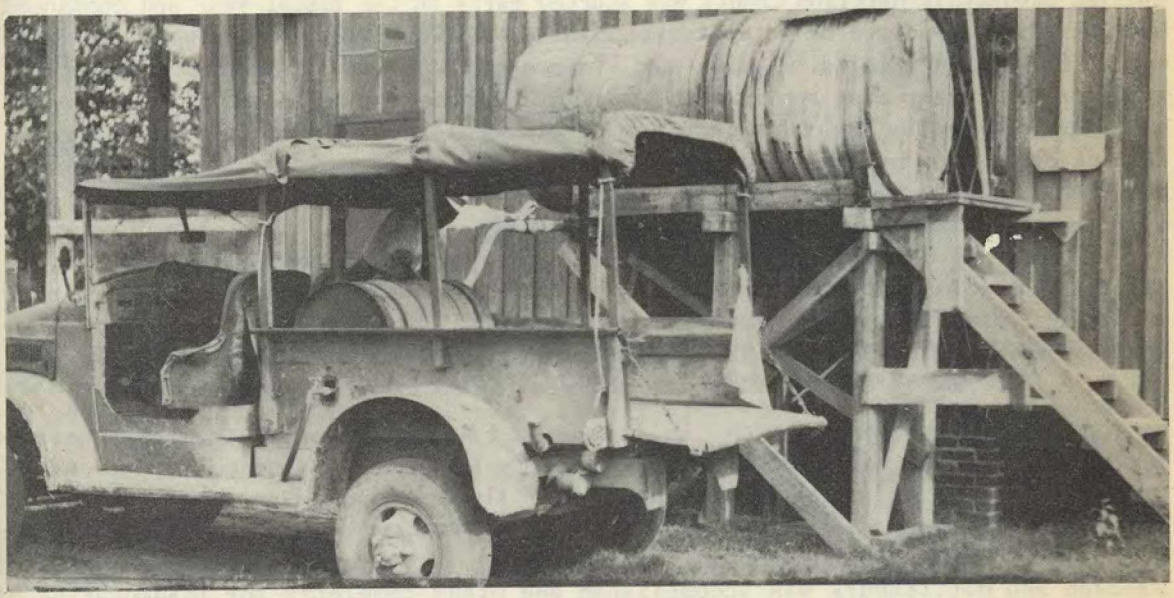
ENTOMOLOGICAL INSPECTION. All of the inspection work was accomplished by four full-time inspectors and one part-time inspector, who also acted as an assistant supervisor. In 1945, when a 2½ percent spray was used, 4.1 percent of the sprayed houses inspected were found positive for "quads" as compared with 87.2 percent positive for unsprayed houses. In 1946 only 2.1 percent of sprayed houses were found positive. This lower figure might have resulted from the use of a five percent spray since there was some indication that the greatest proportion of positives among the sprayed houses occurred in counties which had used the smallest amount of DDT per house application. Observations in houses sprayed in late summer and fall of 1945 indicated that some degree of control of flies and mosquitoes was attained during the early summer of 1946.

TYPHUS CONTROL

The policy of the Mississippi State Board of Health regarding the control of typhus has been to embody some permanency of organization in each county health unit where the disease is of public health importance. To this end, five sanitarians were placed in county units, permitting typhus responsibilities to become an integral part of the routine sanitation program.

Courtesy of the David J. Sencer CDC Museum







(top) Central mixing plant. DDT and xylene were placed in drums to stand overnight before being run through mixer. Hose leads to outdoor mixer. (center) Filling drum in truck with five percent DDT spray from overhead mixing tank. Spray cans were filled from drum through faucet in the side of the truck. (left) Valve stems installed in Lofstrand and Hudson spray cans. Air pressure could be obtained from compressor or regular hand pump.

Courtesy of the David J. Sencer CDC Museum

State-wide eradication work was carried on by a full-time, state board of health-paid employee working with the State Plant Board and assisted by members of the State Division of Sanitary Engineering. Poisoning operations in connection with ratproofing were the responsibility of local project personnel, who also cooperated with campaigns conducted by the State Plant Board. Such cooperative, county-wide poisoning campaigns were carried out in several counties where vent-stoppage and residual dusting were employed as control measures in urban communities. Over the course of the year, in addition to 12,254 local labor man-hours, a monthly average of 11 MCWA employees worked a total of 19,712 man-hours to offer protection against typhus fever to approximately 196,650 residents of Mississippi.

RESIDUAL DUSTING. In Jackson County residual dusting in areas of concentrated populations throughout the county continued through USPHS assistance during the year. A dusting project in Harrison County was started early in the fiscal year and continued with excellent evidence of ectoparasite control. Analysis of results showed approximately 89 percent control of fleas and 77 percent control of total ectoparasites in some ten days after dust application. In Laurel, Jones County, a ratproofing project was supplemented by residual dusting. After completion of the initially-planned dusting cycle, the incidence of typhus in rats, based on 33 samples, was approximately 12 percent. During the last half of the fiscal year, 3,250 applications of DDT dust were reported from this area. Residual dusting operations were begun also in the cities of Hattiesburg, Forrest County, and Jackson, Hinds County, in 1946. In general, the scope of the residual dusting operations extended along the coastal highway strip, including the cities of Bioloxi, Gulfport, Pass Christian, Mississippi City, Pascagoula, and Laurel. A total of 15,383 premise dustings was accomplished during the year, and 0.75 labor and foreman man-hour was expended for each dusting application.

RATPROOFING AND ERADICATION. In Jackson and Marion Counties, cooperative ratproofing and rat eradication projects were completed for this fiscal year. A ratproofing project in Laurel was organized with the services of an experienced USPHS supervisor and continued, after the initial organizational period, without further assistance. Promotional work on two additional large projects in the cities of Jackson and Hattiesburg was accomplished and plans completed for inauguration of ratproofing work to begin about July 1946. The "1080" poisoning campaigns in business districts in Jackson and Harrison counties were so effective that originally proposed evaluation procedures for DDT dusting were found to be impracticable because of inadequate samples of rats obtainable by trapping. One-half man-hour of labor was required to place 0.36 pound of bait in each of the 2,065 premise poisonings accomplished. A total of 172 establishments in the cities of Gulfport, Pascagoula, Laurel, and Columbia were ratproofed, requiring 46.3 labor and foreman man-hours for each job. For buildings of a temporary nature, ratproofing was made possible by using treated metal lathes as a substitute for concrete chain walls. The lathe was placed 18 inches in the ground and had a shelf of from eight to 12 inches.



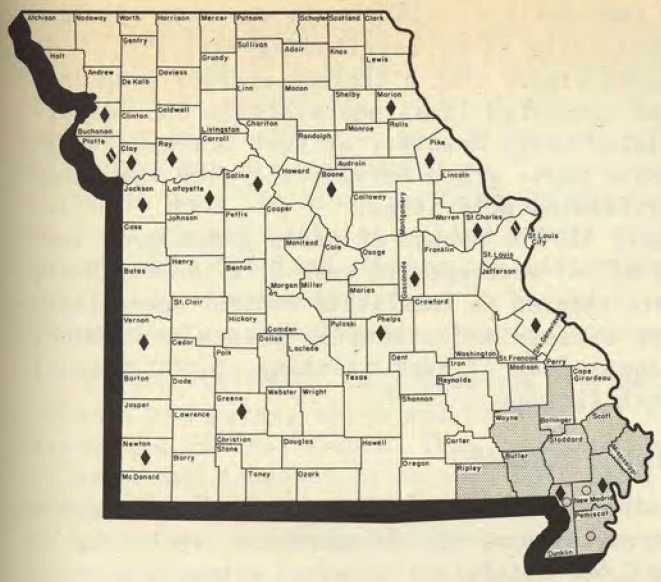
Metal laths were used as a substitute for concrete chain walls on temporary buildings.

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Missouri

R. M. JAMES, M. D.

State Health Commissioner



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage

The extent of war malaria operations in Missouri decreased sharply after the war's end; only three war establishments out of a total of 26 remained active during the last half of the fiscal year. Conversely, the Extended Malaria Control Program increased in scope from three counties to ten during the course of the year as emphasis shifted to the protection of the civilian population against the possible introduction of foreign malarias. During the course of the year an average monthly total of 103 MCWA employees worked some 171,000 man-hours on war malaria and extended program operations.

WAR MALARIA

At the beginning of the fiscal year 26 war establishments in 20 counties were protected by larviciding, minor drainage, and surveillance. No major drainage projects were found necessary this year, since vertical drainage of the "Frisco Ponds," the LeMay Sink Hole, and the sinkholes around Jefferson Barracks in previous years had eliminated or brought under control many of the serious "quad" breeding areas. During 1946 only three war establishments – Lambert Field and Jefferson Barracks in the St. Louis area, and the Fort Leavenworth reservation in the Fort Leavenworth area – remained active and required malaria control. At Lambert Field, entomological surveillance indicated no need for control operations, while at the other two installations larviciding was necessary to effect control.

LARVICIDING. Based on last year's DDT-larvicide experiments at Duck Lake in the Fort Leavenworth area, routine DDT larviciding of small ponded areas, ditches, and streams was inaugurated this year in the Jefferson Barracks zone and the Fort Leavenworth Zone on the Missouri side of the river. A mixture of DDT, No. 2 Diesel oil, and a spreading agent was sprayed through an atomizing nozzle at the rate

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of 0.05 pound DDT per acre. DDT larviciding saved a great deal of time when small ponds, ditches, and streams constituted the principal water areas treated. It took about the same amount of time to treat an area with DDT as with oil, except that it was not necessary to obtain refills constantly with DDT as it was with oil larviciding. Inspectors reported very good kills after larviciding with DDT. From the results of work performed, it appeared likely that a trained sprayer-inspector could provide adequate control over the scattered limestone sinks in the Jefferson Barracks area without additional labor help. However, at Fort Leavenworth it was still necessary to continue extensive paris green larviciding over the large water areas in addition to the DDT larviciding activities.

During the course of the fiscal year, 15,864 pounds of paris green were used to dust 7,482 acres, and 36,115 gallons of oil were sprayed over 2,127 acres. Sixty acres of land and aquatic vegetation were cleared to facilitate control operations, and 14,240 linear feet of ditches were cleaned and otherwise maintained. Minor drainage activities included 2,000 linear feet of hand ditching, 6,600 feet of dynamite ditching, and 600 feet of ditch linings.

EXTENDED PROGRAM

During the 1945 season three counties – Dunklin, Pemiscot, and New Madrid – were included in the residual house spraying program. In addition, according to recommended practice, 16 towns of over 2,500 population received extended protection through larviciding. A total of 19,760 house spray applications were accomplished, requiring an average of 0.97 man-hour to apply 0.56 pound DDT per spray application. In the second half of the fiscal year the 39,000 house spray applications accomplished extended over ten counties – the three sprayed in 1945, and Mississippi, Butler, Wayne, Bollinger, Ripley, Scott, and Stoddard. Man-hours per application decreased to 0.78 because of increased efficiency of crew operation, and the amount of DDT per house spraying was increased to 0.77 pound to obtain greater residual effectiveness. Over the course of the year approximately 459,000 residents of Missouri benefited from the extended program.

SURFACE SPRAY RATES. When smoothly-painted surfaces were sprayed it was necessary to increase the spraying rate to approximately 400 square feet per minute



When smoothly painted surfaces were sprayed it was necessary to decrease the spraying rate to prevent run-off.

Courtesy of the David J. Sencer CDC Museum

to prevent run-off. When very rough, course surfaces were sprayed the rate was reduced to about 100 square feet per minute in order to secure a surface residuum of 200 mg. of DDT per square foot and still allow for losses due to absorption.

SPRAY CREW COMPOSITION. In order to obtain a better man-hour ratio per house spray application, two-man crews were inaugurated insofar as automotive vehicles permitted. An operational unit of three two-man crews headed by a contact-man supervisor was found to be most economical and efficient. For the sake of economy, the contact man was utilized as an "operations individual" during the active spray months. He made the house spraying arrangements for three crews so that crew time was not consumed with contacting houses where the owner was away or refused to have the spray applied. During the winter months the contact man was assigned to malaria education activities. By having first-hand spray operations experience his value as an educator was greatly increased.

SPRAYING EQUIPMENT. Each crew was provided with a 55-gallon drum of mixed concentrate and water, which was prepared at the warehouse or storage area before leaving for the day's work. This system proved far superior to measuring and adding water and concentrate to each individual spray can as it was needed. Continuous agitation of the mix was effected by the jostling of the truck over the road. The use of air compressor units proved more satisfactory than the old hand pumping method not only in saving energy but in saving spray can maintenance. Much difficulty was experienced with the hand-spraying units due to inferior construction and the corrosive effect of the spraying materials. Considerable time was spent in preparing large scale maps of residual spray areas showing exact house locations and spraying progress. It is believed that the extra work entailed in the preparation of these maps has paid dividends in facilitating operations and insuring a high standard of accuracy of spray records.

AUTOMOTIVE EQUIPMENT. Although certain definite stations were designated as area headquarters, there were times when all trucks but one were based at an auxiliary station and the crews were transported there in one truck from the main base. This practice saved considerable wear on automotive equipment, particularly when the spraying area was far from the regular base. Governors were installed on tactical vehicles at the beginning of the 1946 spraying season and have resulted in a considerable reduction of accidents. A practice was instituted in the garage of keeping a rotating motor pool so that each vehicle was completely checked before it was released from the central garage. As a result of experience gained from the operation of mobile-units engaged in DDT spraying of poliomyelitis endemic areas, an additional truck carrying extra concentrate, repair parts, and supplies was added to each unit of contact man and three spray crews. This truck also served as a conveyance for the contact man in the area to be sprayed.

INSECT CONTROL

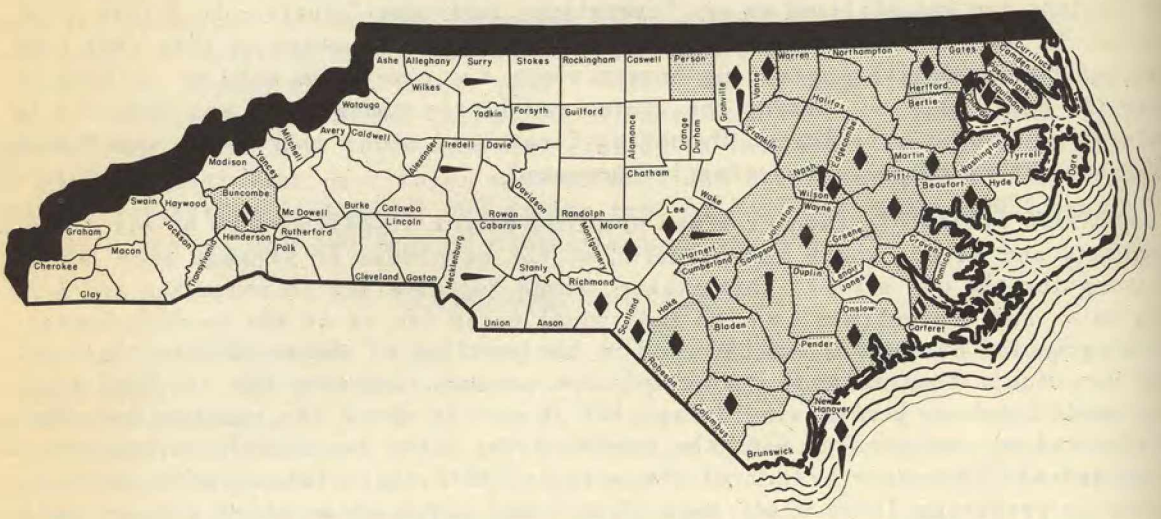
As a result of the extensive use of DDT, health authorities in Missouri have begun to think more and more in terms of the use of DDT for general sanitation rather than malaria control alone. While it is understood that DDT will not replace good municipal housekeeping or general sanitation, nevertheless the tremendous reduction in flies, bed bugs, and mosquitoes on a countywide scope has emphasized that DDT spraying is extremely effective as a sanitation device.

Courtesy of the David J. Sencer CDC Museum

North Carolina

CARL V. REYNOLDS, M. D.

State Health Officer



The malaria control program underwent drastic changes during the course of the fiscal year as a result of the ending of the war and the consequent inactivation of 71 out of the total of 77 war establishments previously protected. War malaria activities were diminished almost to the vanishing point, while residual spraying operations were greatly expanded. Typhus control was incorporated as part of MCWA activities at the beginning of the fiscal year and the program was considerably expanded by the introduction of residual dusting operation. The number of MCWA personnel employed on malaria control decreased from 188 in July 1945 to 67 in June 1946 due mainly to the virtual termination of war malaria projects and the increasing amount of local participation in the extended control program. Approximately 160,000 man-hours were expended on all types of MCWA activities during the year.

LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Residual Dusting
- Typhus Control Ratproofing

WAR MALARIA

During the first half of the fiscal year 58 war establishments in 30 zones were protected by larviciding, minor drainage, and major drainage operations, while conditions around an additional 19 war establishments in 11 zones necessitated only periodic entomological inspections. After the end of the war only six projects – the city of Fayetteville, Fort Bragg and the Veterans' Hospital in the Fort

Courtesy of the David J. Sencer CDC Museum

Bragg area of Cumberland County, the Cherry Point Marine Base and the Pollocksville Marine Air Base in the Newburn area of Craven County, and Moore General Hospital in the Asheville area of Buncombe County — remained active and malaria protection was continued in all of these areas by surveillance, larviciding, and drainage activities.

LARVICIDING. Oil was the larvicide of choice in North Carolina during the past fiscal year; 27,862 gallons were sprayed over 1,382 mosquito-breeding acres. An additional 71 acres were dusted with 270 pounds of paris green. Supplementary extensive clearing was accomplished by the removal of 167 acres of aquatic vegetation and 378 acres of land growths.

DRAINAGE. Major drainage was carried on in four zones during the first half of the fiscal year. In Buncombe County, a project to drain abandoned gravel pits in the vicinity of Moore General Hospital was initiated early in 1945 and was completed at the end of March 1946. Although the hospital was in the mountains and not near any endemic malaria section, it had special significance in that a great number of malaria and other tropical disease cases were being cared for and considerable "quad" breeding was found in the gravel pits. Since the hospital was a permanent installation it was felt that permanent drainage was the preferable malaria control method. In the Jacksonville zone of Onslow County a large swamp in the vicinity of the city of Jacksonville, Camp Lejeune and the Marine tent-camp area, the Naval Hospital, and the Midway Housing Project was drained by ditching operations. Three swamps in the vicinity of the Oak Grove Marine Airfield barracks area in Jones County were drained by dynamite ditching. Ditching was also required around the Cherry Point Marine Base and the adjacent war housing project in Craven County because the average elevation above the Neuse River was only 18 feet and numerous swamps had developed through lack of proper drainage outlets. Altogether a total of 69,194 linear feet of hand ditching, 27,280 feet of dynamite ditching, and 1,597 feet of underground ditching was necessary to accomplish major and minor drainage projects in 1945. Approximately 1,206,000 linear feet of existing ditches were cleaned and 7,839 cubic yards of earth were filled in to eliminate, in all, a total of 50 acres of water surface.



Major drainage was carried on in four zones during the first half of the fiscal year.

EXTENDED PROGRAM

During the first half of the fiscal year 2,488 residual house sprayings were performed in 13 counties, including 24 towns. In 1946 residual spraying was extended to 36 counties, including 92 towns, and a total of 20,605 house spray applications were completed. Spray crew efficiency increased, as shown by the average of 0.86 man-hour per application required in 1946 as compared to 1.08 during

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the previous season. To obtain increased residual effectiveness the amount of DDT per house application was increased from 0.38 pound to 0.65 pound in 1946. One extended program major drainage project was begun in February 1946 and continued to the end of the fiscal year. In Craven County, just outside the city of Newburn, a series of ponds around the Washington Fork community were eliminated by hand-dug ditches.

HOUSE SPRAYING PRIORITY. In determining the homes to be sprayed with DDT, top priority was given to veterans with malaria histories. The order of priority after infected veterans was: homes of individuals with current positive blood smears, communities in which a high incidence of malaria had been established by blood-slide surveys, and lastly, communities in which malaria was established by other epidemiological data. All homes of individuals found to be positive for malaria on current blood slide surveys were sprayed as well as those homes in the immediate vicinity.

LOCATING VETERANS' HOMES. In some cases it was very difficult to locate discharged servicemen with malaria histories and to ascertain their desires to have their homes sprayed. The cooperation of the local health officers was enlisted in this project. A circular letter was mailed to health officers explaining the program for spraying veterans' homes and asking that they submit lists of infected veterans in their counties who wanted their homes sprayed. The industry of the health officers in compiling these lists contributed materially to the success of the programs; in one county alone 175 homes of veterans with malaria histories were located and sprayed.

ENTOMOLOGIST-EDUCATORS. Due to the scattered nature of the program in North Carolina no one area had sufficient work either for a full-time entomologist or a full-time educator. As the personnel on these two activities were capable of performing the dual function, education and entomology were combined and placed under the supervision of the state entomologist, thus saving in personnel and travel expenses. This system worked out very satisfactorily.

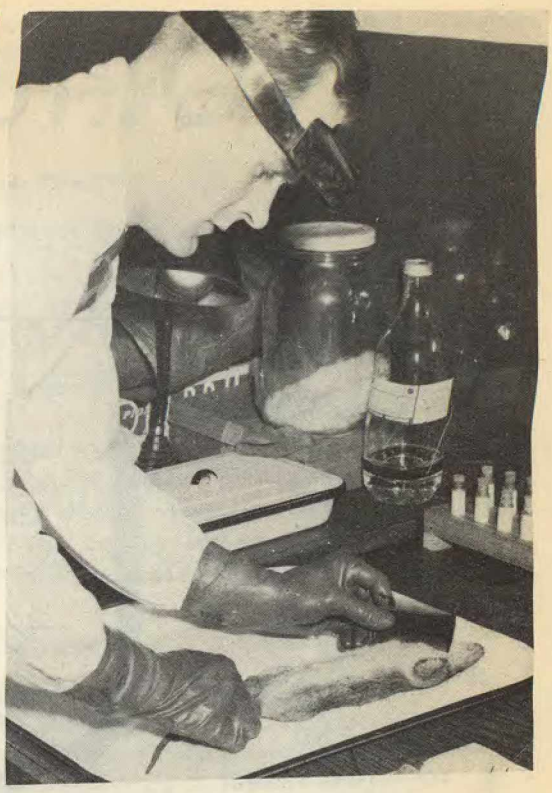
FISH POND BREEDING CONTROL. Under a program sponsored by the U. S. Soil Conservation Service a large number of fish ponds were built on farms in the state. The State Board of Health required a permit before construction was allowed. Embodied in the application for the permit was an agreement to maintain the pond in such a manner that it would not breed malaria mosquitoes, thus becoming a nuisance dangerous to the public health. County soil conservationists cooperated with the health department by helping the farmers to fill out the applications, obtain the permits, and plan and construct the ponds, thus assuring conformance with required regulations. During May and June of 1946, 107 and 101 proposed ponds, respectively, were inspected.



Ponds had to be maintained to prevent mosquito breeding.

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(above) Distributing 1080 water in "souffle" cups. (right) Combing a rat for ectoparasite counts.

TYPHUS CONTROL

In September of 1945 typhus control activities in North Carolina were incorporated into the MCWA program and operations were considerably expanded by the inauguration of residual DDT dusting. Besides 46,424 man-hours of local labor, a monthly average of 19 MCWA employees spent a total of 33,239 man-hours on various types of typhus control during the year, offering protection to some 371,400 residents of the state.

RESIDUAL DUSTING. Eighteen cities in the counties of New Hanover, Craven, Granville, Wilson, and Sampson had residual dusting programs. About two-thirds of the 36,176 premise dustings were in residences, and the other third were in businees establishments. An average of 0.60 labor and foreman man-hour was required to spread 1.5 pounds of 10 percent DDT for each premise application.

RATPROOFING. Ratproofing campaigns were carried out in the cities of Mooresville in Iredell County, Charlotte in Mecklinburg County, Winston-Salem in Forsyth County, Elkin in Surrey County, and Dunn in Harnett County. In all, 601 business establishments were treated requiring 53.3 labor and foreman man-hours for each establishment.

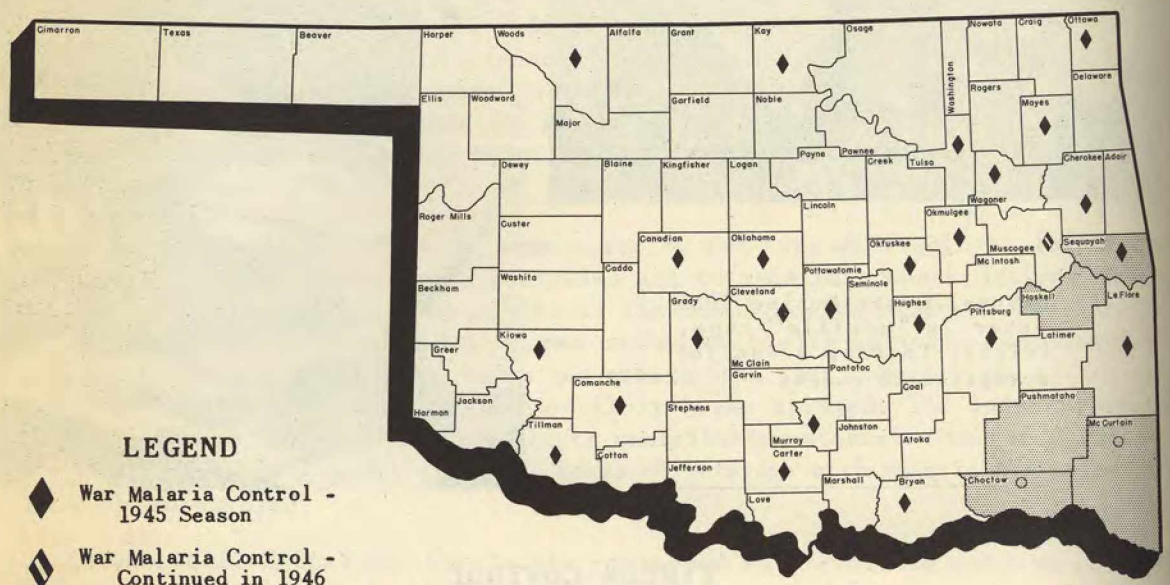
RAT POISONING. Poisoned bait was spread around premises as a supplementary activity to both residual dusting and ratproofing, since it required little more time and effected additional rat control. A total of 2,079 premise poisonings were completed, requiring 0.36 pound of bait and 1.20 labor and foreman man-hours for each premise treatment.

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Oklahoma

GRADY F. MATHEWS, M. D.

Commissioner of Public Health



LEGEND

War Malaria Control - 1945 Season

War Malaria Control - Continued in 1946

Extended Program Residual Spraying

Extended Program Larviciding, Surveillance, and/or Drainage

Malaria control activities in Oklahoma, as in other states, were transitional in character during this fiscal year, with gradual reduction of war malaria control to a minimum and coincidental expansion of the DDT residual spray program. The extended program in this state was unique in that the scope of spraying operations was dependent directly on the amount of local participation furnished by each county.

ENTOMOLOGICAL RECORDS

Routine entomological inspections were supplemented by a flexible system of light trap locations, shifted so as to eventually complete the collection records in every county in the state. So far seven new locations were operated in 1945, and 27 were added in April 1946. The method of operation of the light traps required cartons of sufficient size (one-half pint) for one night's "run". Collections were handled by local cooperators at each station. The cartons were picked up during monthly service visits to each light trap, and specimens were stored for winter study.

Entomological inspection indicated that 1945 was the most serious malaria mosquito-breeding season yet recorded in Oklahoma. Collections commonly included more

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than 100 *Anopheles quadrimaculatus* at representative stations, and the species was widely distributed throughout the state. High catches along the Red River exceeded 1,000. Adult collections in some few stations continued from past seasons reached 25 to 50 times any previous records.

WAR MALARIA

During the first part of the fiscal year 69 military establishments in 25 counties were protected by malaria control activities. Entomological inspection of 41 installations indicated no need for further ministrations, while 28 required larviciding and minor drainage to effect control of mosquito breeding. In 1946 only one military establishment, the Veterans' Hospital in Muskogee County, was functioning during the malaria mosquito season.

LARVICIDING. Most of the larviciding was done with oil; 86,740 gallons were sprayed over 5,054 acres of water surface. An additional 966 acres were dusted with 1,500 pounds of paris green. Approximately 21,000 linear feet of existing ditches were cleaned out, and 35 acres of brush and vegetation were cleared. Minor drainage activities consisted of hand-digging 18,000 linear feet of ditches.

EXTENDED PROGRAM

During the 1945 season the residual spraying program operated in Choctaw, McCurtain, and Pushmataha counties. The cities of Hugo and Bowell in Choctaw County, and Idabel and Broken Bow in McCurtain County received extended protection through larviciding, since they had populations exceeding 2,500.

LOCAL PARTICIPATION PLAN. In the early part of 1946 a proposition was placed before civic leaders and organizations in 19 communities of 100 houses or more,



Larviciding small, swampy pond.



Applying DDT residual spray to house interior.

Courtesy of the David J. Sencer CDC Museum

and before the commissioners of five counties, outlining the possibility of greatly extending the residual spraying program with locally contributed funds and labor. The desired pro-rated contributions from the communities to the state malaria control fund were computed at $1.00 per house - approximately one-half of the actual field costs or one-third of the total over-all costs. The counties were urged to contribute an equivalent amount of labor. The response to this proposal for local participation was, in most cases, favorable and enthusiastic. Of the 19 communities approached, 16 subscribed to the first 1946 spray period (March - June 1946) and guaranteed the second spray period on the same basis. The counties contributed less labor than requested due to impending end of the fiscal year budget, but all guaranteed action during the second spray period. The local participation program will mean expansion during the next fiscal year into at least three additional, malarious counties. The plan furnished a striking example of neighborly effort in public health.

PUBLIC RELATIONS. Two field educators and state office personnel promoted the local participation plan by utilizing to full advantage the printed and projection materials supplied by MCWA headquarters. Meetings were held in almost every schoolhouse before and during the inauguration of the program. Meeting with civic organizations several nights each week was a regular part of the weekly field schedule. The significance of DDT in household sanitation was thoroughly emphasized throughout the state. A county demonstration program was inaugurated following a general meeting of health unit personnel in Tulsa on December 3 - 4, 1945. Stations were established for issuance of DDT to county sanitarians and other authorized individuals for demonstration purposes, and report forms were devised to keep the state office informed of the progress and effectiveness of this work. Over 60 demonstrations, with more than 1,300 attendance, have been reported so far.

ACCOMPLISHMENTS. From July through December 1945, 9,735 house spray applications were performed in the three counties covered by the program. Spray crews worked a total of 9,283 man-hours to spray 4,127 pounds of DDT. In 1946 as a result of the local participation plan, residual spraying was extended to cover five counties - the three previously sprayed, plus Haskell and Sequoyah counties. The number of spray applications increased to 17,060 during the second half of the fiscal year, requiring 14,554 labor and foreman man-hours to spray 14,911 pounds of DDT. Spray crew efficiency increased; only 0.85 man-hour was required to spray a house in 1946 as compared to 0.95 in 1945. The amount of DDT per house was more than doubled during the second half of the fiscal year to obtain greater residual effectiveness. In all, some 102,000 residents of Oklahoma received extended control protection.

SPECIAL RECONNAISSANCE SURVEYS

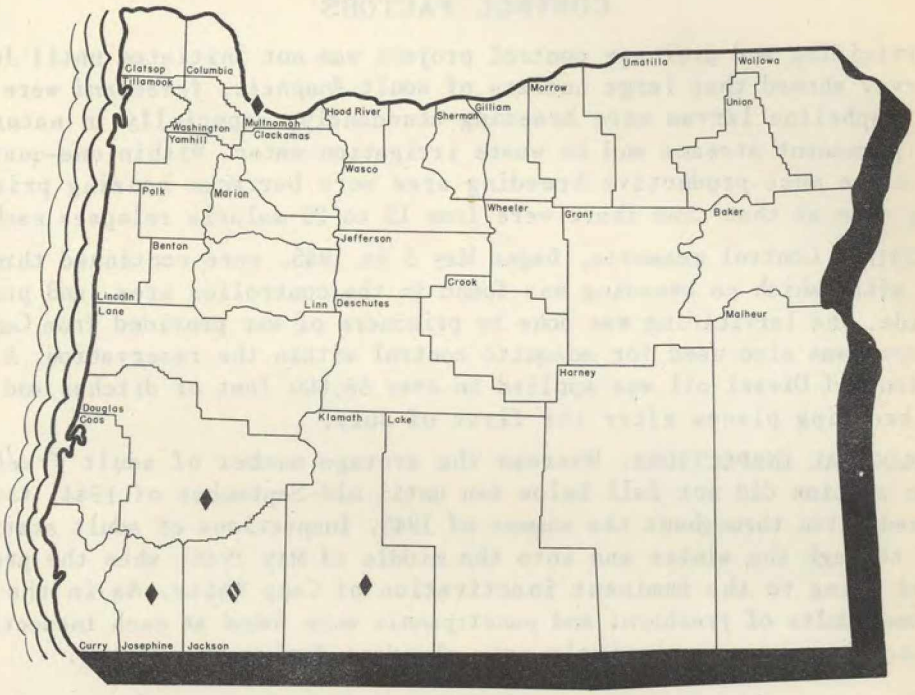
The state office cooperated extensively with the U. S. Engineer Corps and the USPHS Impounded Water Section in organizing and carrying out reservoir survey work. At Tishomingo, on Lake Texoma, the state also furnished supervision and inspection for the U. S. Engineer control project. Other reconnaissance responsibilities at the many POW camps and military hospitals were continued through the 1945 season, utilizing the services of an entomologist from the staff of the University of Oklahoma, who could thus become available to the state as an experienced worker in field malaria control.

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Oregon

H. M. ERICKSON, M. D.

State Health Officer



LEGEND

◆ War Malaria Control - 1945 Season

◇ War Malaria Control - Continued in 1946

In the summer of 1945 only one larviciding and minor drainage project was conducted in Oregon. Located in the valley of the Rogue River near Medford, this project included one zone surrounding Camp White and another zone enclosing Medford Army Airfield. In addition, several entomological surveys were completed in the western part of the state. In 1946 entomological inspections were carried on around Camp White and Medford Airfield until the middle of May, when the project was terminated owing to the imminent closing of the installations.

SPECIES DIFFERENTIATION

Although most of the malaria in Oregon has occurred in the Willamette River Valley where *punctipennis* is the predominant *Anopheles*, the situation is reversed near Medford where *freeborni* has been found to be the most abundant species. In

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July, August, and September of 1944, *freeborni* constituted 95 percent of the adult anophelines found near Medford. During the same period of 1945, this species made up 93.6 percent of the total. In contrast to the preceding year, however, *punctipennis* was more common (4.0 percent) than *pseudopunctipennis franciscanus* (2.3 percent). This past year was the second in which the occurrence of *franciscanus* was confirmed north of California on the West Coast.

CONTROL FACTORS

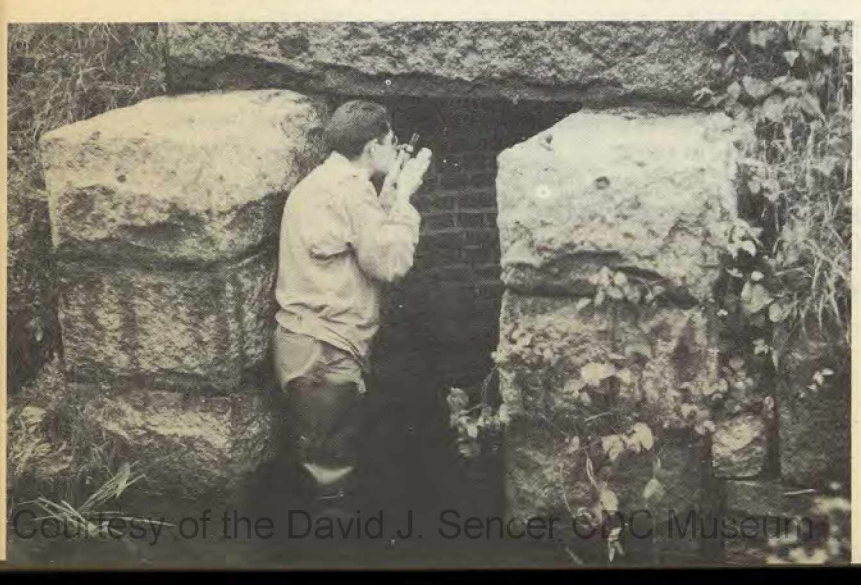
The larviciding and drainage control project was not initiated until July 1944, when a survey showed that large numbers of adult *Anopheles freeborni* were present, and that anopheline larvae were breeding abundantly, especially in natural pools along the permanent streams and in waste irrigation water. Within one-quarter mile of perhaps the most productive breeding area were barracks housing prisoners of war, among whom at that time there were from 15 to 20 malaria relapses each week.

LARVICIDING. Control measures, begun May 5 in 1945, were continued through September 6, after which no breeding was found in the controlled area, and practically none outside. The larviciding was done by prisoners of war provided from Camp White. The same crew was also used for mosquito control within the reservation. A total of 1,635 gallons of Diesel oil was applied to over 66,000 feet of ditches and 30 acres of other breeding places after the first of July.

ENTOMOLOGICAL INSPECTIONS. Whereas the average number of adult *freeborni* per inspection station did not fall below ten until mid-September of 1944, this number never exceeded ten throughout the summer of 1945. Inspections of adult stations were continued through the winter and into the middle of May 1946, when the project was terminated owing to the imminent inactivation of Camp White. As in the previous winter, some adults of *freeborni* and *punctipennis* were found at each inspection until April; *punctipennis* was relatively more abundant during the winter.

RECONNAISANCE SURVEYS

In the latter part of 1945 several surveys were made in the western part of the state. One survey was made near Grant's Pass in Josephine County, where there were two proven cases of malaria transmission the preceding year from a returned soldier having malaria. Another survey was an investigation of the mosquito situation in Roseburg, Douglas County. The vicinity of Klamath Falls and zones around the nearby Marine Barracks and Naval Air Station were inspected in July, but no extra-cantonment malaria control was deemed necessary. In the vicinity of Portland, no adults of *freeborni* were collected or reared, and in view of these and other factors no special emphasis on the control of anophelines was recommended for this area.



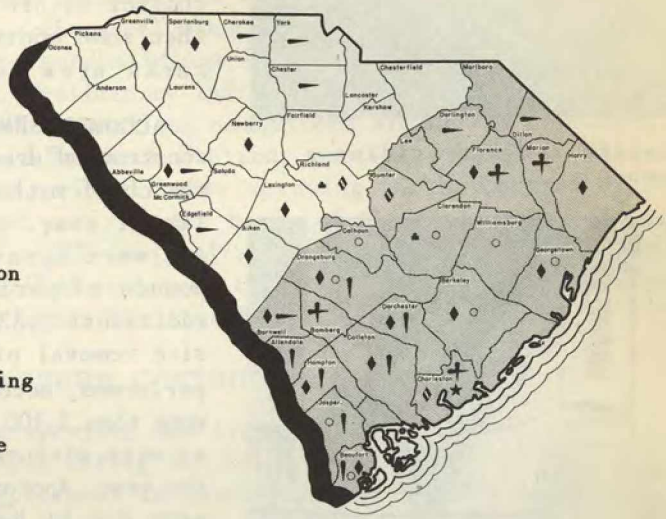
Several entomological surveys were made in the western part of the state.

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South Carolina

BEN F. WYMAN, M. D.

State Health Officer



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Residual Dusting
- Typhus Control Ratproofing
- *Aedes aegypti* Control
- NIH Malaria Field Research Laboratory, Manning (Clarendon County)
- NIH Imported Malaria Studies Laboratory, Columbia (Richland County)

Significant features of the MCWA program in South Carolina during the past fiscal year were the combined supervision of typhus control dusting and residual house spraying in seven counties and the addition of typhus dusting to the activities of the *Aedes aegypti* unit in Charleston. As in the preceding year, *aegypti* control was integrated with general sanitation work. Malaria control activities were diminished markedly immediately after the end of the war in order to permit the financing of residual spraying operations, which were almost doubled in scope in 1946. During the year an average of 295 MCWA employees worked a total of 415,746 man-hours to provide health protection of various kinds to more than half a million residents of the state.

WAR MALARIA

During the first part of the fiscal year 109 war establishments in 19 counties received protection against malaria by a combination of entomological surveillance, larviciding, and drainage operations. In 1946 the malaria control unit in the Charleston area confined its activities mostly to anopheline mosquito control around the

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Clearing and larviciding a swamp.



DDT residual spray crew preparing to power spray a house interior.



Oiling an old cistern for *Aedes aegypti* control.

Port of Embarkation Hospital, which was used as a temporary camp for laborers imported from the Caribbean islands for redistribution to various parts of the country. Small crews were continued around Fort Jackson in the vicinity of the city of Columbia in Richland County and Shaw Army Airfield in Sumter County because these two permanent installations were maintaining mosquito control within the respective bases and desired that some control be carried on around the barracks area outside the base.

ACCOMPLISHMENTS: Maintenance of previously constructed drainage ditches and larviciding were the chief methods of war malaria control of this fiscal year. Approximately 54,000 gallons of oil were sprayed over 2,750 acres, and 1,733 pounds of paris green were used to control an additional 1,337 mosquito-breeding acres. Extensive removal of aquatic and land vegetation was performed, accounting for some 700 acres cleared. More than 2,100,000 linear feet of drainage ditches were cleaned and otherwise maintained during the year. Approximately 42,110 feet of new ditches were dug by hand and 78 feet of ditch linings were installed. A small amount of underground drainage, 1,000 feet, was also completed. In all, a total of 42 acres of water surface were eliminated by the foregoing operations and approximately 6,200 cubic yards of fill.

EXTENDED PROGRAM. During the first part of the fiscal year 34,918 house spray applications were completed in 12 counties, requiring 1.40 labor and foreman man-hours to spray 0.46 pound of DDT per house application. Extended larviciding protection was offered to 11 towns in eight counties, as recommended for communities having more than 2,500 population. In 1946 the program was expanded to include 23 counties, in which 55,582 house spray applications were completed. More efficient spray crew operation decreased the man-hours required for each spraying to 1.21. The average amount of DDT per application increased during this period to 0.59 pound. Larviciding on the extended program was not considered necessary in 1946.

EQUIPMENT. Power-spray units were used in 17 of the total 23 counties operated during

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the year. These units proved very efficient and economical when used in areas in which houses were close together, but were not well-suited for use in isolated, large farm houses or in very small tenant houses. Trucks equipped with pneumatic pressure tanks for furnishing air pressure to the hand sprayers saved considerable labor in those areas in which power sprayers were not suitable.

INVESTIGATIONAL PROJECTS. A special study was organized in Calhoun County to determine the effectiveness of DDT premise spraying as compared to house spraying alone as a means of controlling anopheline mosquitoes. The area chosen for this study had had relatively high mosquito densities in previous years. In one-half of the area residences were sprayed in the usual manner with DDT emulsion. In the other half all out-buildings or parts of out-buildings in which animals were housed were sprayed as well as the residences. Preliminary indications pointed to premise spraying as the more effective means of controlling mosquitoes around the homestead. In conjunction with the Malaria Field Research Station, special studies in Clarendon County to ascertain the worth of residual house spraying in the control of human malaria was continued for a second year. On the basis of the analyses of the parasitemia data it was indicated that DDT residual spray was capable of reducing the incidence of human malaria. A detailed report of the study appears in the "Investigations" section of this volume, under "Malaria Field Research, Manning, S. C."

TYPHUS CONTROL

Supervision of residual house spraying and typhus control dusting was very effectively combined in seven counties during the year. Addition of typhus dusting to the activities of the *Aedes aegypti* unit in Charleston furnished a very efficient service without undue duplication since a great many of the premises inspected by the "*aegypti*" men also needed dusting for rat-flea control.

ACCOMPLISHMENTS: Sixty-nine cities in 11 counties had residual dusting activities during the past year, in which 14,222 premise treatments were made. Each dusting treatment required 1.59 labor and foreman man-hours, and 3.6 pounds of ten percent DDT dust. Ratproofing was completed in 654 buildings in 13 cities in 12 counties, of which four—the cities of Charleston, Florence, Bamberg, and Mullins—also had residual dusting programs. The working time required to ratproof each establishment averaged 35.8 man-hours. Rat poisoning was carried on in conjunction with proofing to eliminate those rats already on the premises. In all, a total of 953 premise poisonings were carried out, in which 2.92 labor man-hours were required to place an average of one pound of bait for each treatment. Due to the intermittent and scattered nature of operations in some sections of the state, dusting and other control measures in these sections were carried on by mobile units, each of which circulated in an area of several counties.

AEDES AEGYPTI CONTROL

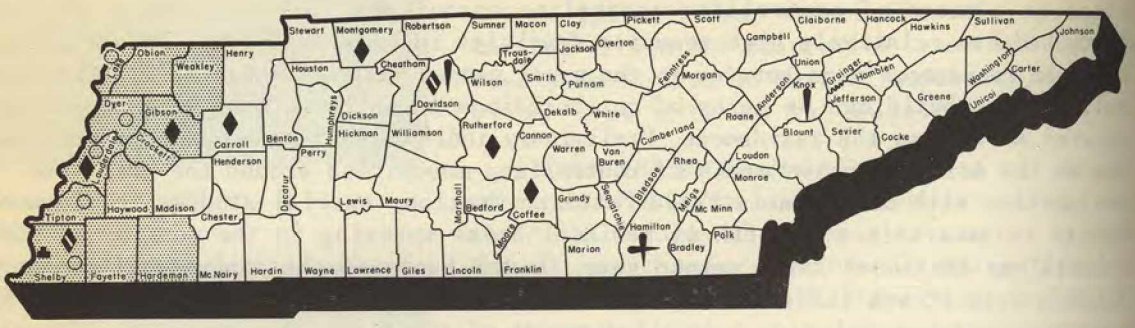
Aedes aegypti control in Charleston continued throughout this entire fiscal year as an integral part of the general sanitation program. The new feature of this year's activities was the addition of typhus dusting to the combined *aegypti*–sanitation program. This integration of activities provided a more complete service to the 145,000 residents of the city and proved very satisfactory and economical. Of the 26,281 premises inspected in Charleston during the year, *aegypti* breeding places were found in only 980, for an index of 3.73.

Courtesy of the David J. Sencer CDC Museum

Tennessee

R. H. HUTCHESON, M. D.

Commissioner of Public Health



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Extended Program Larviciding, Surveillance, and/or Drainage
- Typhus Control Residual Dusting
- Typhus Control Ratproofing

The MCWA program in Tennessee was continued during this fiscal year as a function of the State Department of Public Health, Division of Preventable Diseases. Activities were concentrated in the western part of the state where topographic and climatic conditions were very favorable for mosquito production. War establishment zones were protected by an intensive program of larviciding, while other sections having high mortality rates received DDT residual spraying treatment aimed at killing adult mosquitoes. Typhus control activities under the MCWA program began late in the year when residual dusting programs were started in three counties. During the year an average of 101 USPHS employees worked an aggregate of 152,216 man-hours on all types of MCWA activities and afforded protection to approximately 420,000 residents of the State.

WAR MALARIA

A total of 134 war establishments in eight counties received malaria protection during the first part of the fiscal year, of which 124 required larviciding and minor drainage operations and ten required only surveillance. In 1945 an unusually late flood on the Mississippi River inundated a large section of the delta, creating vast areas of slow-flowing, floatage-covered water in which "quads" bred so prolifically as to render the usual larvicidal methods entirely ineffective. To prevent a possible outbreak of malaria, several war industry plants in Memphis and the Thayer General Hospital in Nashville were sprayed with DDT. In 1946 only four military installations—the Kennedy General Hospital, the Naval Reserve Base, and the Ferry Command Base in Shelby County, and the Thayer General Hospital in Davidson

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County—remained active and required malaria protection. The mosquito-breeding season was not accompanied by more than the usual amount of precipitation. Breeding started late, but prolifically. The new larvicide, consisting of 2.5 pounds of DDT per 50 gallons of No. 2 Diesel oil, was applied by hand sprayers through a mist nozzle at the rate of one to two gallons per acre with amazing results. Consequently, "quad" counts were kept well within the "safety" limits of under ten adults per station.

LARVICIDING. The larviciding system employed, known as the "blanket" system, consisted of treating all *Anopheles* breeding places of ordinary size routinely every eight to ten days. Larger breeding areas involving more than one-half acre were inspected routinely and treated only when the need was indicated. During the year a total of 43,981 gallons of oil were used to spray 1,787 acres and 552 pounds of paris green were dusted over 207 acres. Supplementary clearing effected the removal of vegetation and brush from 27 acres.

INSPECTION ACTIVITIES. The inspection force worked in close cooperation with larviciding crews. Usually a team of three inspectors was used, one inspector being assigned specifically to adult mosquito collection. The two "larval" inspectors were used primarily as "trouble shooters" for investigating unusually high adult counts whenever they occurred, in addition to routine checking following larvicidal treatment. Larvae and adult mosquito reports were analyzed each day in order that prompt action could be taken where indicated. Inspectors were equipped with small hand-sprayers charged with a DDT and oil solution to enable them to treat small, miscellaneous breeding places at the time of their discovery, thus saving the larviciding crews the necessity of making special trips.

DRAINAGE No war malaria drainage work was undertaken during the active control season. During the winter, or "off season" months, larviciding crews were diverted to drainage activities. Entomological records were used as a basis in planning all drainage projects. During the year 18,368 linear feet of ditches were dug by hand and 16,743 feet of ditch linings were installed. Approximately 3,000 cubic yards of earth were used as fill and 59,317 feet of existing ditches were cleaned and otherwise maintained.



DDT oil-mist larviciding.

AUTOMATIC LARVICIDING DEVICES

In Shelby County experimental larviciding work was carried on as a supplementary duty of the inspection force. One project involved the charging of 50 leaching cans of one-gallon capacity with one percent solution of DDT in oil, and placing them along low, bottom areas in anticipation of their being picked up and providing treatment for flood water conditions. In the areas so treated good results were

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obtained for one entire high water period which persisted for approximately three weeks. Another experimental project was begun in a large drainage creek five miles long and containing approximately ten acres of breeding surface. The possibility of the automatic treatment of this canal was investigated in cooperation with the Office of Malaria Investigations, National Institute of Health. A pellet consisting of 100 grams of DDT (100 percent technical grade), 200 grams of para-dichloro-benzine, and 20 cc. of oleic acid was submerged in the creek at 1,000-foot intervals and anchored by means of wires. These pellets dissipated very slowly when submerged in water at temperatures below 110 degrees F. and it was anticipated that control could be maintained for three to four months in the channel of the creek. Side pockets, however, had to be located and treated individually.

EXTENDED PROGRAM

Six counties—Dyer, Lake, Lauderdale, Obion, Shelby, and Tipton—were included in the residual spraying program during the first half of the fiscal year. During this period 12,162 residual house sprayings were completed, using three-man spray crews. In 1946 the program was expanded to include the additional counties of Crockett, Fayette, Gibson, Hardeman, Haywood, and Weakley, and 21,578 house applications were performed in the 12 counties, using two-man spray crews. Comparison of the efficiency of the three-man versus the two-man spray crews revealed startling results. The three-man crews averaged 5.8 houses per man-day and 1.02 man-hours per house application, while the two-man crews averaged 11.5 houses per man-day and 0.77 man-hour per house application. The amount of DDT per application was increased from 0.42 pound in 1945 to 0.75 pound in 1946 in light of the studies on increased residual effectiveness with heavier deposits of DDT. A short-time investigation of one-man spray crews revealed the even more unexpected results of an average of 16.7 houses per man-day. Detailed studies of the efficiency of one-man crews will be undertaken in the next fiscal year.

EQUIPMENT. Each crew was provided with a one-half ton truck equipped with a small air compressor unit and hand sprayers or power spraying apparatus. DDT emulsion was mixed and transported in 50-gallon drums fitted with a lock-type faucet. The



Filling hand sprayers with DDT emulsion from 50-gallon drum equipped with a lock-type faucet.

Courtesy of the David J. Sencer CDC Museum

movement of the truck kept the emulsion agitated. DDT concentrate for the entire state program was mixed in a central warehouse. The conventional 50-gallon, barrel-type, mechanical mixer was modified so as to permit the mixing of DDT isomers, DDT-oil solutions, and pyrethrum emulsion larvicides.

INSPECTION CHECK. In order to determine the efficiency of the residual spraying program, one to two percent of the DDT-treated houses were inspected monthly for three months after spraying. The data collected indicated the number of "quads" in sprayed houses as compared to adjacent, unsprayed natural resting places. Engorged specimens were collected for feeding preference studies. Other data gathered included the distribution of DDT crystals on sprayed surfaces, the number of houseflies present, and the general reaction of the public toward the spraying program.

LARVICIDING AND DRAINAGE. In 1945 extended malaria control protection through larviciding was accorded the cities of Memphis and Collierville in Shelby County, Newbern and Dyersburg in Dyer County, Tiptonville and Ridgely in Lake County, Ripley in Lauderdale County, and Covington in Tipton County. During the second half of the fiscal year larviciding was continued only in Memphis and its environs, Collierville, Ripley, Covington, and Dyersburg. Three extended major drainage projects were carried on during the year. Operations consisted of installing ditch linings and supplementary grading and sodding around the outskirts of the city of Memphis, in Dyersburg, and in Halls.

TYPHUS CONTROL

The MCWA typhus control program in Tennessee started late in 1945. Residual dusting activities were inaugurated in the cities of Chattanooga in Hamilton County, Nashville in Davidson County, and Knoxville in Knox County and were continued throughout the fiscal year. Chattanooga also has an MCWA ratproofing campaign as well as local ratproofing under the city ordinance. Typhus control in Memphis was operated entirely with local supervision, funds, and labor. Of the 16,450 premises inspected for rats and ectoparasites, 15,336 were found to be infested and were treated with DDT dust. An average of 0.45 labor and foreman man-hour was required to spread 2.4 pounds of ten percent DDT dust per premise application.



Drainage ditch in Memphis lined with salvaged masonry.

Courtesy of the David J. Sencer CDC Museum

Texas

GEORGE W. COX, M. D.
State Health Officer



The over-all magnitude of MCWA activities in Texas during this fiscal year exceeded that of any other state in the country. During the course of the year, war malaria operations were relegated to a minor role, while extended control activities were expanded to include more than five times the number of counties previously sprayed. Extensive typhus control activities continued unabated during the year. *Aedes aegypti* control, in addition to being integrated with general sanitation work as in the preceding year, was also combined this year with residual typhus dusting in several cities. A monthly average of 312 USPHS employees worked a total of 511,075 man-hours during the year on all types of MCWA control projects.

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LIGHT TRAPS. The program for obtaining information on the distribution and abundance of individual mosquito species in the state, inaugurated during the previous fiscal year, was continued this year. Mosquito light traps were operated in non-MCWA counties through the cooperation of the Division of Entomology of the state health department. Information obtained from this program will further augment existing data on mosquito-borne diseases.

WAR MALARIA

During the first half of the fiscal year, 130 war establishments located in 15 areas in 39 counties received malaria protection. Of these, 97 required larviciding and minor drainage control measures and 33 were kept under surveillance. A special airplane larviciding project was completed on the small river separating the Arkansas and Texas portions of the city of Texarkana. In 1946, after the end of the war, only four war malaria areas remained in operation, all of which required some larviciding and minor drainage control. These included the Brownsville International Airport in Cameron County, the city of Marshall in Harrison County, Texarkana in Bowie County, Fort Worth Army Airfield in Tarrant County, and the Love Army Airfield, the Naval Air Station, and Hensley Field in Dallas County.

LARVICIDING. A total of 69,659 gallons of oil were sprayed over 3,140 acres, and 1,896 pounds of paris green were dusted over 1,458 acres of mosquito breeding areas by hand and power spraying and dusting equipment. To facilitate larviciding, and to eliminate favorable mosquito breeding conditions, 391 acres of aquatic vegetation and 88 acres of land growths were cleared out.

DRAINAGE. One major drainage project was completed in 1945 in the outskirts of the city of Tyler in Smith County, where a railroad embankment has caused the formation of a 40 acre marsh in the Caddo Lake area. Two thousand feet of dynamite ditching, supplemented by 100 feet of hand digging, created proper drainage facilities. Including minor drainage operations throughout the state, a total of 31,543 linear feet of hand ditching, 26,656 feet of machine ditching, and 2,080 feet of dynamite ditching was accomplished. These activities, combined with the cleaning and maintenance of 1,028,461 feet of previously constructed ditches, eliminated 136 acres of water surface.

(left) Aquatic vegetation being removed from shore line after having been pushed there by an outboard-powered barge. (right) Adult collecting station near Brownsville. Animal sheds make good *albimanus* catching stations.





Courtesy of the David J. Sencer CDC Museum

EXTENDED PROGRAM

During the latter part of 1945, six counties - Bowie, Cameron, Hidalgo, Lamar, Red River, and Willacy - had county-wide residual house spraying programs. Approximately 75,850 residual applications were completed, requiring an average of 0.42 pound of DDT per house spraying. In 1946, the program was extended to offer residual protection to 33 counties which had potential malaria problems. To effectively handle this more than five-fold increase in scope of activities, spraying operations in each county were confined as far as possible to those areas where protection was indicated on the basis of available entomological, epidemiological, and topographical data. In keeping with this policy, 46,184 house spray applications were accomplished during the second half of the fiscal year. The amount of DDT per house application was increased to 0.58 pound in order to comply with the latest knowledge on increasing residual effectiveness. Extended malaria control by larviciding was carried on in nine cities in Hidalgo County — Mercedes, Donna, Weslaco, Alamo, San Juan, Pharr, McAllen, Mission, and Edinburg — throughout the entire fiscal year.



Spraying trash and garbage with 5 percent DDT emulsion at Pharr, Texas.

SPRAY CREW EFFICIENCY. In 1945 an average of 1.25 labor man-hours were required for each house spray application. This was decreased to 1.12 man-hours in 1946 mainly by having the house occupants cover their own furniture and furnishings while the spray crew was preparing to spray the house. This resulted in saving time in each residence which otherwise would have been wasted on extra-spraying activities. Operational time was also saved by means of installing on each vehicle a tank or barrel of sufficient size to furnish an immediate and continuous supply of water for an entire day's spraying needs. The maintenance of automotive and spraying equipment was greatly facilitated in at least one area by the employment of personnel with mechanical knowledge, who were able to do minor repairs in addition to performing their regular spraying duties.

TYPHUS CONTROL

During the past fiscal year, recommended procedures in regard to dusting, poisoning, and ratproofing programs were maintained in order to continue or initiate typhus control operations in as many counties as possible. However, since it was noted in several counties that there was a high number of typhus cases among the rural population, and also in certain residential areas of several cities, the decision was made that a residential and farm program of typhus control should also

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be inaugurated. These rural and residential projects represented a departure from the accepted practice of treating mostly business establishments in the larger cities. Due to the intermittent and scattered nature of operations, especially in rural sections, dusting and other control activities in 38 of the 49 counties operated were carried on by eight mobile units, each of which circulated in an area of several counties. Another feature of this year's typhus control program was the integration of residual dusting, and in some cases rat poisoning, with *Aedes aegypti* and general sanitation work, wherever applicable. During inspections for *aegypti* breeding places, it required little additional effort to search for rat "signs" and to dust and drop poisoned bait in appropriate places.

RURAL AND RESIDENTIAL PROJECTS. Thirteen counties participated in the farm typhus control program, and seven cities were included in the residential program. The first requirement was the passage of resolutions by the counties or cities involved, stating that they would adhere to the general features of the program outlined by the state health department. Secondly, a local supervisor, employed and paid by local funds, was assigned for training with one of the mobile dusting and poisoning units. When the local supervisor finished his training, a supply of DDT was furnished to the city or county involved. After an extensive publicity campaign, outlined by the state health department, the local supervisor was authorized to conduct either a rural or residential program, whichever the case might be. A small charge was required of each premise treated by the city or county in order to defray the cost of the labor and materials used in dusting and eradication. Complete monthly reports were submitted by the local supervisor to the state health department, where they were reviewed and checked.



Mobile typhus crew ratproofing buildings.

ACCOMPLISHMENTS. Of the 169,964 premises in 49 counties inspected for rats and ectoparasites, 90,300 in 181 cities received residual dusting treatments. Each premise treatment required an average of 0.56 labor and foreman man-hour to dust 1.2 pounds of 10 percent DDT. Ratproofing programs were carried out in 20 cities in 16 counties, and 1,254 business establishments were rendered impervious to rat invasions. Modifications in each building required an average of 31.2 labor and foreman man-hours. Rat poisoning operations were carried out as an adjunct to both dusting and proofing activities. In all, 37,516 premise poisonings were accomplished, each of which required an average of 0.50 man-hour to spread 0.32 pound of bait. Supplementary eradication with "1080" poisoned water accounted for a total of 1,888 pints during the year. In addition to 146,972 man-hours of local

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labor, a monthly average of 62 USPHS personnel worked a total of 82,009 man-hours to offer typhus protection to more than 2,500,000 residents of the state.

AEDES AEGYPTI CONTROL

Aedes aegypti control operations continued as an integral part of the general sanitation program, which included also rat poisoning, pest control, and fly control. During this fiscal year, residual typhus dusting was likewise incorporated into the general sanitation-*aegypti* control program. In addition to local labor, 23 USPHS inspectors participated in *aegypti* control, which benefited more than 1,200,000 residents of the state. The cities of Mercedes, Weslaco, Donna, Alamo, San Juan, Pharr, McAllen, Mission, and Edinburg in Hidalgo County averaged the lowest percentage of mosquito-breeding places to premises inspected in the state. Of the more than 24,280 premises inspected only 220 were infested, for an index of 0.89. On the other hand, San Antonio in Bexar County had the highest index – 5.77. Approximately 2,000 premises of the 34,550 inspected were infested. Laredo in Webb County, where control measures were not begun until the second half of the fiscal year, ran a close second with an index of 5.4. Between these extremes were Houston in Harris County, 2.61; Galveston in Galveston County, 1.58, Brownsville in Cameron County, 1.33; and Corpus Christi in Neuces County, 1.15. Throughout the entire state 8,919 of the 350,153 premises inspected had *aegypti* breeding places, for an average index of 3.06. *Aegypti* – sanitation inspection activities were expanded this year to include surburban towns in the environs of the larger cities mentioned above. This expansion represented an increase in surveillance rather than an aggravated *aegypti* problem. The city of Kingsville in Kleberg County was also accorded surveillance this year.



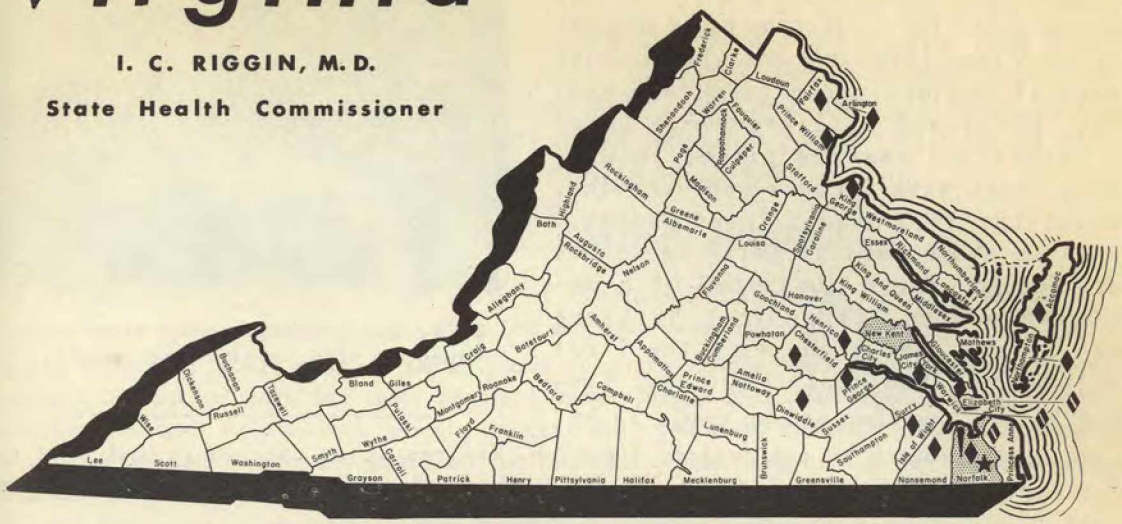
Inspector dusting empty battery cases with paris green to prevent *aegypti* breeding.

Courtesy of the David J. Sencer CDC Museum

Virginia

I. C. RIGGIN, M. D.

State Health Commissioner



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Typhus Control Residual Dusting
- *Aedes aegypti* Control

During the first half of this fiscal year the MCWA program in Virginia continued on the same scale as in the preceding year since no one knew how much longer the war would last. Malaria control emphasis was placed on prisoner of war camps and installations where returning military personnel were stationed. With the end of the war all activities around military installations began to be curtailed. Only key men were retained to carry on malaria control during the 1946 season, to conduct the typhus control dusting program, and to man a demonstration DDT residual spraying project. The number of MCWA employees decreased steadily from 137 in July 1945 to 30 in June 1946. Over the year a total of 105,423 man-hours were expended on the various phases of the program.

WAR MALARIA

Of the 107 war establishments in 18 counties which were protected by surveillance, larviciding, and minor drainage during 1945, only seven — Oceana Navy Airfield, the Little Creek Zone, and the FPHA Housing Project in Princess Anne County; Langley Field, Fort Monroe, and the Copeland Park FPHA Housing Project in Elizabeth City County; and Fort Eustis in Warwick County — remained active and required malaria control after the end of the war. During the year 49,794 gallons of oil and 2,409 pounds of paris green were used to larvicide 1,493 and 1,347 acres respectively. A total of 184 acres of aquatic and land vegetation were cleared to facilitate larviciding and to discourage anopheline breeding. Minor drainage operations throughout the state totalled 160,131 linear feet of hand-dug ditches, 1,563 feet of ditch linings, and 3,806 cubic yards of fill. Approximately 414,370 feet of previously constructed ditches were cleaned and repaired.

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ARTIFICIAL RESTING PLACES. In evaluating malaria control activities experience had shown that a good natural resting place for collecting adult *Anopheles quadrimaculatus* did not always exist where it was desirable to obtain samples. Boxes and nail kegs were tried as artificial resting places in previous years with inconsistent results. During the 1945 season "quad houses," based on those used in North Carolina, were built. These consisted of a demountable shed, three feet by three feet by six feet high, with the front enclosed to about half way down. They were bolted together and so could be set up in a few minutes in any desired location. The resulting catches proved this type of collecting station more dependable than the smaller boxes or kegs and gave very satisfactory results in lieu of natural resting places.



Power larviciding a pond from a jeep equipped with pressure equipment.

LARVICIDING BOATS. Small boats were designed and built for paris green dusting of the shallow shoreline of municipal reservoirs. To meet the specialized requirements of this type of work the boats were constructed of juniper, with wide beams, and gradually-sloping, scow bows to veer off stumps and yet provide ample space for large forward loading decks. The boats were ideal for the purpose and required only two- or three-horsepower outboard motors to make sufficient headway.

PEST MOSQUITO CONTROL. At Fort Story, Princess Anne County, Army personnel were greatly annoyed by the presence of pest mosquitoes. The Army therefore arranged with the Virginia MCWA organization to ditch the salt marsh for an area of five miles around the Fort. In addition an entomological survey of the Seashore State Park was made to ascertain how great a mosquito problem this area presented to the Army activities. Work was done with prisoner-of-war labor under the direction of USPHS personnel.

Privy-type artificial resting place used as an adult collecting station.



CONTRACT SERVICES. The U. S. Public Health Service contracted with the Federal Public Housing Authority, on a reimbursable basis, to do complete mosquito control work around six of their major housing developments in the Hampton Roads area in Norfolk County. This contract was extended into the 1946 season. At Riverdale, Norfolk County, the main ditches around the FHA housing development were lined with concrete, on a contractual bases. This work was completed during the fiscal year.

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POND IMPOUNDMENTS. It has become common practice in Virginia for owners of larger farms to impound streams, thus creating small ponds for irrigation purposes. At one such pond, located about one-quarter mile from a Navy Airfield, *quadrimaculatus* were found to be breeding quite heavily. Although the state board of health had regulations concerning impoundments it was felt that a demonstration pond would aid farmers in developing their proposed ponds. Therefore the above-mentioned pond was modified at the property-owner's expense with a spillway and regulating baffle boards for raising and lowering the water elevation. This project will be of permanent benefit to future malaria control work in the state.

PERMANENT MOSQUITO CONTROL PROGRAM

One of the main objectives in the state of Virginia's activities was to conduct the MCWA program in such a fashion that when the war was over the local authorities, realizing the benefits, would provide local funds to carry on the work. During World War I much mosquito-control work was done in the Hampton Roads area, but when the war ended no efforts were made to continue and the initial work was soon wasted. Virginia authorities were determined that such would not be the case again. After "V-J Day" direct work was started to promote local programs. Three new mosquito-control districts were established and four other communities made substantial appropriations to initiate work. In addition to local funds the 1946 State Legislature appropriated a portion of the state's funds to be used as contributions to local districts. Several other local jurisdictions were slated to inaugurate programs at an early date.

RESIDUAL SPRAYING

A limited amount of DDT residual house spraying was performed in New Kent and Norfolk counties during the 1945 mosquito season. However the feeling existed that there was a definite place, at least in public institutions, for the proper use

Crew cutting hand ditch from swampy pond to outlet drainage ditch.



Courtesy of the David J. Sencer CDC Museum

of DDT residual spray. For this reason as well as to clear up a great deal of confusing information released on the use of DDT, a state-wide project was inaugurated in 1946 for the purpose of spraying certain public buildings as a demonstration service. To accomplish these sprayings a crew was trained and equipped, thus making them available at any time to be dispatched to any section of the state in the event of a malaria outbreak. Thirty institutions throughout the state were sprayed including prisons, hospitals, jails, welfare homes, farms, etc., and from reports received this has been one of the most beneficial projects undertaken in the state.

TYPHUS

A review of the health records revealed that there had been 64 cases of typhus fever in the city of Norfolk since 1937 and that the number of cases reported each year was on the increase. Justified by these data a DDT dusting program was inaugurated in 1946 to control rat fleas and other ectoparasites. Rats, trapped before dusting, were combed and the ectoparasites counted. Also, blood samples were taken to determine incidence of typhus among the rats. After dusting similar samples were taken to check the efficiency and effectiveness of the program which affected 200,000 residents of the city. Approximately 450 premise dustings were completed, each of which required an average of 1.06 labor man-hours to spread 13.2 pounds of ten percent DDT dust.

AEDES AEGYPTI CONTROL

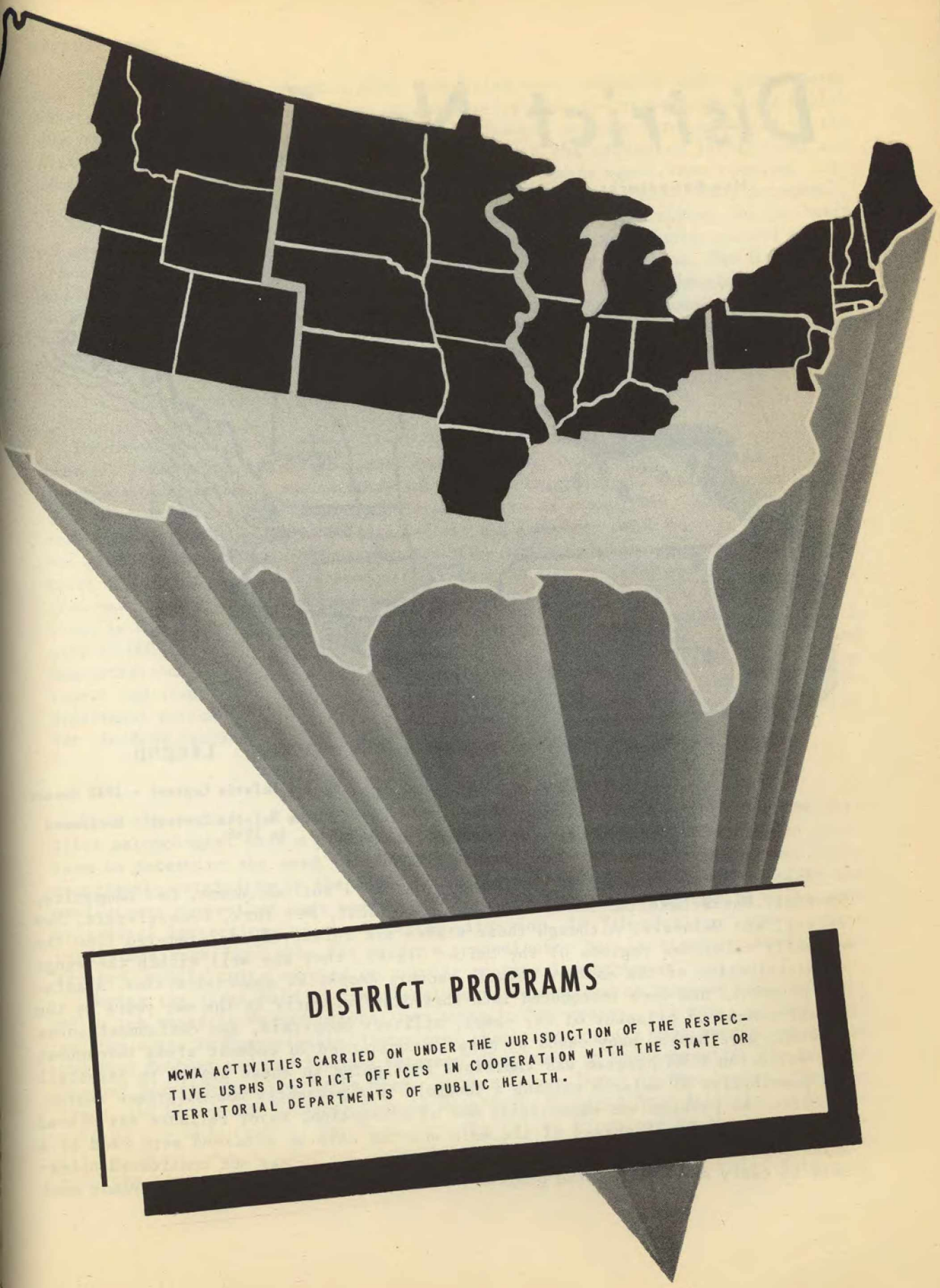
During the first part of the fiscal year a combination *aegypti* survey and control program was carried out in the cities of Norfolk and Portsmouth. Of the 3,673 premises inspected in Norfolk, 229 were found to be harboring breeding places, for an index of 6.31. In Portsmouth only 119 of the 3,034 inspected premises were infested, the index here being 3.92. No regular MCWA *aegypti* control program was undertaken in these two cities because existing local mosquito-abatement efforts were coping with this problem which affected some 195,000 residents of the state.



(left) Rats, trapped before dusting, were combed and the ectoparasites counted. (below) This boat served as an excellent *aegypti* breeding place.



Courtesy of the David J. Sencer CDC Museum



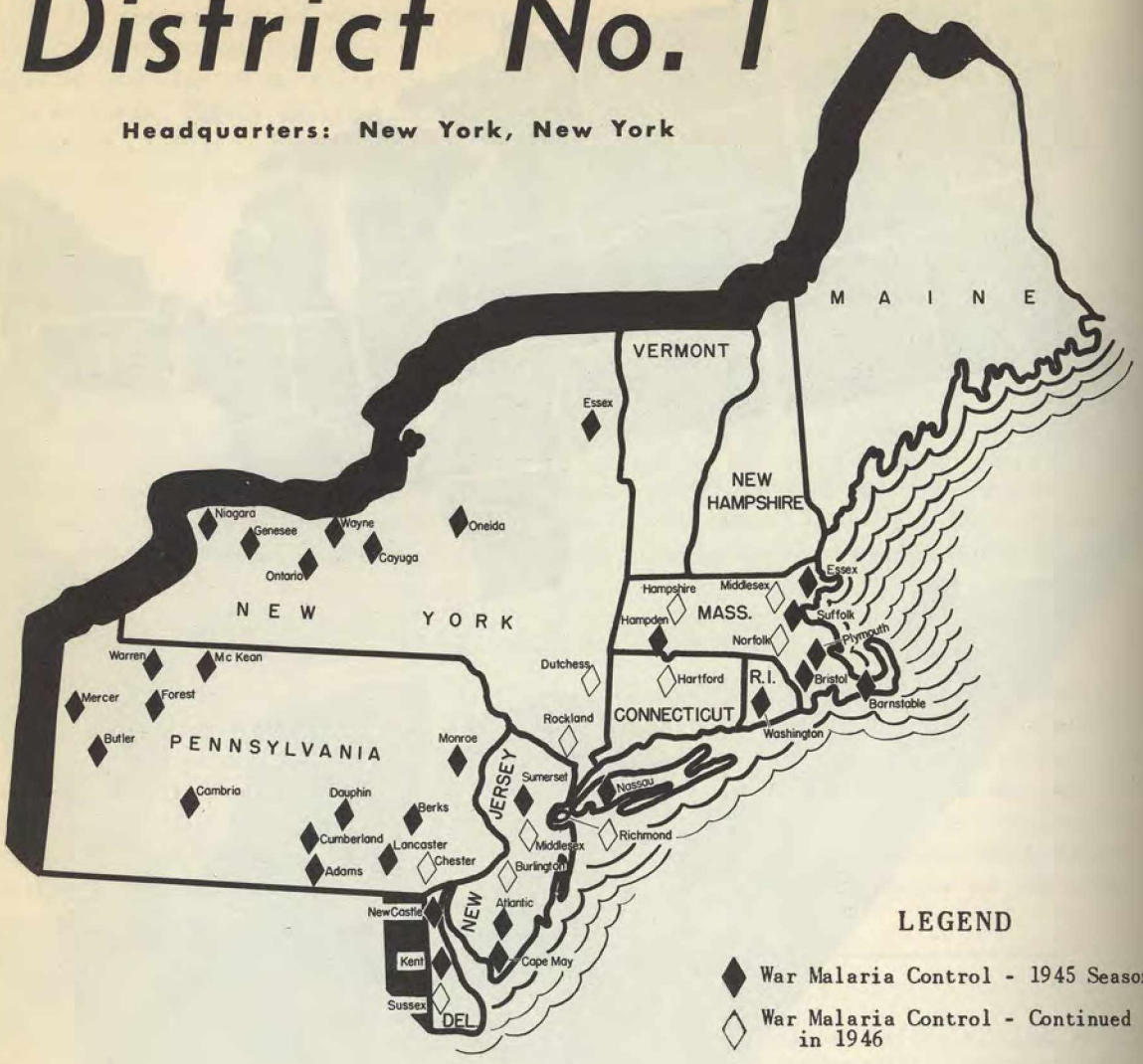
DISTRICT PROGRAMS

MCWA ACTIVITIES CARRIED ON UNDER THE JURISDICTION OF THE RESPECTIVE USPHS DISTRICT OFFICES IN COOPERATION WITH THE STATE OR TERRITORIAL DEPARTMENTS OF PUBLIC HEALTH.

Courtesy of the David J. Sencer CDC Museum

District No. 1

Headquarters: New York, New York



The states encompassed by USPHS District No. 1 include Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, and Delaware. Although these states are relatively far-removed from the normally malarious regions of the United States, they are well within the range of distribution of the eastern malaria vector, *Anopheles quadrimaculatus*. A malaria potential had been introduced into this district early in the war years by the establishment of prisoner of war camps, military hospitals, and cantonment zones in which were housed many cases of malaria contracted in endemic areas throughout the world. An MCWA program was therefore instigated in these states to forestall the possibility of malaria gaining a foothold in a presently non-malarious region.

Since the problem was essentially one of prevention, major reliance was placed on the entomological phases of the work and the data so obtained were used as a guide to control operations and their effectiveness. It was not considered necessary to carry on an extensive program with actual control operations around each

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war establishment and therefore MCWA activities were conducted under the general supervision of the district office in cooperation with the respective state health departments and military authorities. Reconnaissance surveys were conducted by the district entomologist, and three mobile units did the necessary larviciding and minor drainage wherever indicated. In those zones where conditions required continued control, fixed units consisting of prisoner of war labor, Army personnel, or local laborers were established under general district supervision. On the basis of entomological surveys conducted in the previous year no malaria control activities were deemed necessary during the past fiscal year in Maine, New Hampshire, and Vermont. In the other seven states a total of 55 war establishments in 41 counties were accorded some type of military protection and four additional military posts had pest mosquito control projects. In 1946, after the war had ended, only 14 military establishments in six states remained active and required control measures.

DISTRICT OFFICE ACTIVITIES

The District No. 1 office, located in New York, N. Y., exercised general supervision over all field units in the ten states comprising the district in cooperation with the state health departments and military authorities. Entomological activities during the year included surveys to determine the prevalence of mosquitoes, identification to establish the presence of the malaria vector, and impounded water surveys to determine the possibilities of malaria hazards. All MCWA public relations material in the district originated from the district office. An extensive training and educational program was carried out including a course in mosquito identification for Army technicians in the Second Service Command, instruction and information on the public health uses of DDT for officers of the Second and Third Service Commands, conferences and demonstrations on DDT for health department personnel in the district, lectures on rodent and insect control for War Shipping Administration, state, and local health department personnel, and laboratory training and field methods in malaria control for the Army Specialized Training Program and Navy medical students.

ENTOMOLOGICAL SURVEYS

Upon the request of state health department or military authorities the district entomologist made a preliminary reconnaissance survey in the zone in question to determine the need for further control activities. In those zones where uncertainty existed as to the need for additional control measures even after the preliminary survey had been made, the district entomologist or mobile units made occasional inspections to check on the situation. In " borderline" zones, where conditions were favorable for malaria transmission but larviciding was not indicated, mobile units carried on regular routine inspections.

During the first half of the fiscal year reconnaissance surveys were conducted in ten zones in Massachusetts, two zones in New Jersey, six zones in New York, and ten zones in Pennsylvania. Occasional check inspections were carried on around the West Roxbury and Northampton Veterans' Hospitals in Massachusetts; the England General Hospital and the Belle Meade Service Forces Depot in New Jersey; Fort Niagara, the Rhoads and Halloran General Hospitals, Mitchell Army Airfield, and prisoner of war Side Camp in New York; and the Valley Forge and Deshon General Hospitals, Middletown Air Service Command, and Camp Reynolds in Pennsylvania. In 1946 only one reconnaissance survey was requested, around the Castle Point Veterans'

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Hospital in New York. Occasional check inspections were continued around the two Veterans' Hospitals in Massachusetts. Routine inspections were begun by mobile units around the Tilton General Hospital at Fort Dix in New Jersey and Camp Shanks in New York, both of which had required larviciding the previous season. The Valley Forge and Halloran General Hospitals were also put under routine inspections because previous surveys had classed them as "borderline" cases.



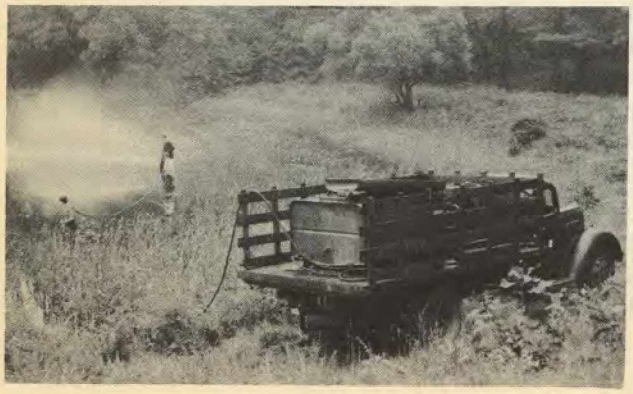
Entomologists made preliminary reconnaissance surveys to determine need for further control activities.

MOBILE UNITS

Three mobile units operated in District No. 1 during the past year. Mobile Unit 1, based in Cushing General Hospital, Framingham, Mass., operated in Massachusetts. Unit 2 was based in Camp Kilmer, New Jersey, and operated in Delaware, New Jersey, New York, and Pennsylvania. The third unit functioned mainly in Rhode Island from its headquarters in Davisville.

MOBILE UNIT 1. During the first half of the fiscal year this unit carried on larviciding and minor drainage projects around Camp Myles Standish Station Hospital in Bristol County and Waltham Regional Hospital, Cushing General Hospital, Fort Devens Station Hospital, Lovell General Hospital, and a prisoner of war camp in Middlesex County. Occasional inspections were conducted around the West Roxbury and Northampton Veterans' Hospitals in Norfolk and Hampshire Counties. In addition to these control activities this unit also carried on field training in malaria control for the Army Specialized Training Program, Navy medical students, and several communities in Massachusetts. A special study was also made of the hibernation of *A. quadrimaculatus* during the winter months. There was little change in the activities of Unit 1 in 1946 since most of the installations protected were hospitals which did not cease operations after the end of the war. Camp Myles Standish Station Hospital was the only establishment around which activities were discontinued in the second half of the fiscal year.

MOBILE UNIT 2. In 1945 larviciding was performed by this unit in New Jersey around Tilton General Hospital and Fort Dix in Burlington County, Princeton University Naval Station in Mercer County, and Camp Kilmer in Middlesex County. In New York, Camp Shanks in Rockland County and the Pawling AAF Rehibilitation and



Power larviciding from a mobile unit truck.

Courtesy of the David J. Sencer CDC Museum

Convalescent Center in Duchess County required larviciding control. During the winter months Unit 2 supervised pest mosquito control projects around Fort Miles in Delaware and the Carteret Ordnance Depot in New Jersey. These projects were conducted with Army funds and prisoner of war labor. Occasional check inspections were made in New Jersey around the AAF Redistribution Center and England General Hospital in Atlantic County and the Belle Meade Service Forces Depot in Somerset County. In New York, the Halloran General Hospital in Richmond County was the subject of check inspections, as was the Valley Forge Hospital in Chester County in Pennsylvania. This unit also gave demonstrations and training in the use of DDT residual spraying to interested communities and military installations. In 1946 larviciding was continued only around Camp Kilmer and the Pawling Convalescent Center. Tilton General Hospital at Fort Dix and Camp Shanks did not require continued larviciding but they were routinely inspected during the remainder of the fiscal year. Conditions around the Halloran and Valley Forge General Hospitals made it advisable to begin periodic, routine inspections instead of occasional checks but no larviciding was thought necessary up to the end of the fiscal year. A residual spraying project for fly control was begun by Unit 2 around Fort Miles in Delaware in the latter part of the year.

MOBILE UNIT 3. The third mobile unit carried out larviciding operations in Rhode Island around the Naval Construction Training Center and the Advance Base Depot in Davisville and the Naval Air Station in Quonset Point. In Connecticut, after July 17, this unit took over larviciding control from Unit 1 around the Old Farms Convalescent Hospital in Avon and continued the work for the remainder of the year. Unit 3 also assisted Unit 2 in providing larviciding control around the Pawling AAF Convalescent Center. One major drainage project was completed around the Naval Construction Training Center in the first half of the fiscal year. In 1946 Unit 3 was dissolved.

ACCOMPLISHMENTS. Over the course of the fiscal year mobile unit operations accomplished dusting over 557 acres with 1,488 pounds of paris green to control anopheline larvae and 349 acres larvicided with 2,930 gallons of oil where pest mosquito control was also desirable. Drainage included 230 feet of hand ditching, and 1,650 feet of machine-dug ditches. The greatest part of the 7,475 man-hours expended by the mobile units during the year was spent in entomological surveillance around war establishments, since the problem in District 1 was essentially one of prevention rather than actual control.

"FIXED" UNITS

Several zones in New Jersey and Delaware required more extensive control measures and it was considered advisable to establish " fixed" control projects in these zones rather than to tie up a mobile unit. These projects were set up under district supervision in cooperation with military authorities, and labor consisted of Army personnel, locally-hired workers, and prisoners of war. All but one of these " fixed" projects was terminated by the end of 1945.

In Cape May County, New Jersey, larviciding and major drainage operations were conducted around the Naval Air Station in Wildwood. Larviciding and DDT residual spraying projects were completed in the Fort Miles Coast Artillery Outpost and the Coast Guard Station on Cape May Point. A pest mosquito control project was

Courtesy of the David J. Sencer CDC Museum



Power spray equipment mounted on a "Weasel." Larviciding with water-oil emulsion at U. S. Naval Air Station, Wildwood, N. J.

carried out in the Carteret Ordnance Depot during the winter months in cooperation with Mobile Unit 2. Delaware had three pest mosquito control projects operated with prisoner of war labor furnished by the Army. These projects consisted of minor drainage work around the Dover Army Air Base, Fort Saulsbury and Fort Miles; the latter was conducted in cooperation with Mobile Unit 2. Airplane dusting with paris green, hand larviciding, and minor drainage were carried on around Fort DuPont in Delaware City and New Castle Army Air Base in New Castle. Field training in malaria control for the Army Specialized Training Program and Naval medical students was also given by personnel attached to the Delaware project. In 1946 a residual spray project for the control of flies was operated by prisoner of war labor under the supervision of Mobile Unit 2 personnel.

ACCOMPLISHMENTS. Larviciding with paris green was carried out wherever control of anopheline mosquitoes was necessary. Supplementary oiling was done around those installations where pest mosquito control was also desired. Over the course of the fiscal year fixed units used a total of 9,966 gallons of oil to larvicide 654 acres and 17,048 pounds of paris green to dust 8,645 acres of mosquito-producing surfaces. Eight acres of brush and aquatic vegetation were cleared, and 122,422 linear feet of previously constructed ditches were cleaned and otherwise maintained. Major and minor drainage accomplished by " fixed" projects included 45,856 feet of hand-dug ditches, 6,535 feet of machine ditching, and 310 feet of ditch linings installed. In all, a total of 490 acres of water surface were eliminated as sources of mosquito breeding, requiring an expenditure of 13,488 MCWA man-hours.

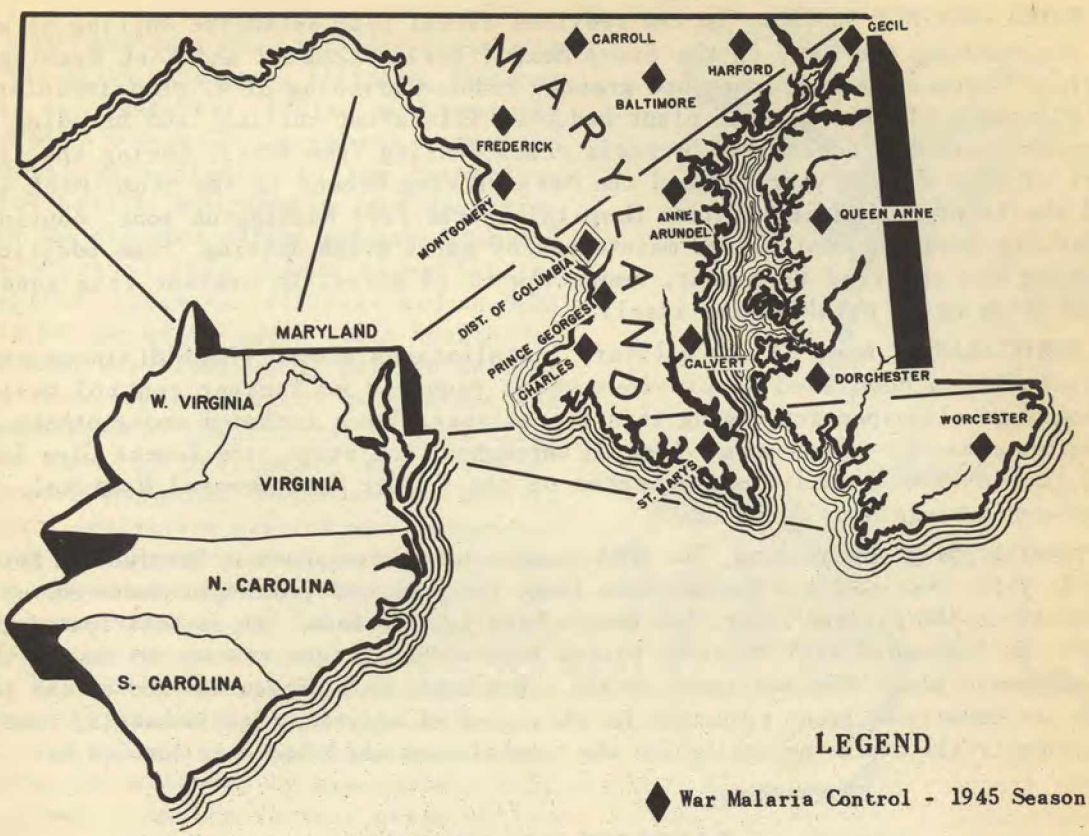


German prisoners of war cleaning and ditching near U. S. Naval Air Station, Wildwood, N.J.

Courtesy of the David M. Sencer CDC Museum

District No. 2

Headquarters: Richmond, Virginia



LEGEND

◆ War Malaria Control - 1945 Season

USPHS District No. 2 includes the states of South Carolina, North Carolina, Virginia, West Virginia, Maryland, and the District of Columbia. The first three states mentioned had MCWA programs operating under the general direction of their respective state health departments in cooperation with the district office and are discussed elsewhere in this volume under "state-operated" programs. West Virginia had no MCWA program operating during this fiscal year. In Maryland and the District of Columbia, both being on the border of the normally malarious region, it was not deemed necessary to carry on an extensive program with actual control operations around each war establishment. Major reliance was placed on the entomological phases of the work and the data obtained from inspections were used to guide control operations as well as to evaluate their effectiveness. This work was conducted under the general supervision of the District No. 2 office in cooperation with the respective state health departments. District entomologists and engineers performed the necessary inspection and supervision.

MARYLAND

During the first part of the fiscal year malaria control activities were conducted around 30 war establishments in Maryland. Of these 25 required only periodic

Courtesy of the David J. Sencer CDC Museum

entomological surveillance to check on mosquito production. Larviciding and ditching were required around the Navy Powder Factory, the Potomac Heights War Housing Development, and another war housing project in the Indian Head zone in Charles County. The ditching completed totalled 500 feet dug by hand and 1,068 feet blasted by dynamite. In addition approximately 1,000 feet of previously constructed ditches were cleaned to facilitate drainage.

WATER CHESTNUT CONTROL. In the previous fiscal year extensive cutting of water chestnut by the Navy in the Stump Neck (Charles County) and Fort Washington (Prince Georges County) zones had greatly reduced breeding of *A. quadrimaculatus*. Only fringes of this aquatic plant had been left after cutting, and breeding had been successfully controlled by paris green dusting from boats. During the first part of this fiscal year, around the Navy Proving Ground in the Stump Neck zone and the Veterans' Administration Hospital in the Fort Washington zone, continued effective breeding control was maintained by paris green dusting. Some additional cutting was required this year, amounting to 14 acres, to prevent this aquatic plant from again establishing itself.

SURVEILLANCE. Many of the military installations around which drainage projects had been completed in previous years required no further control besides entomological inspection during this fiscal year. These included among others the numerous prisoner-of-war camps located throughout the state, the Forest Glen Annex and the Advance Reconditioning Center of the Walter Reed General Hospital, and the Camp Springs Army Airfield.

TERMINATION OF THE PROGRAM. The MCWA program was discontinued in Maryland on December 1, 1945. This step was decided upon since the principal problem encountered, water chestnut in the Potomac River, had been virtually eliminated. It is anticipated that the U. S. Engineers will maintain patrol activities in future years to insure that this aquatic plant does not again obtain a foothold. In addition the end of the war, with the consequent great reduction in the number of military establishments, removed practically all of the necessity for the type of work which had been carried on.

DISTRICT OF COLUMBIA

As in previous years the MCWA program in the District of Columbia during the first half of this fiscal year consisted entirely of entomological surveillance since virtual elimination of significant mosquito production had been accomplished two years ago by the removal of water chestnut from the Oxon Run Zone.

SURVEILLANCE. Periodic inspections as a malaria control measure were maintained around 22 war establishments in ten zones during the first half of the fiscal year. Among the establishments protected were the Naval Research Laboratory in the Oxon Run zone, the Army War College in the North Anacostia zone, the Naval and Wave Barracks in the Lower Potomac zone, the Naval Observatory in the Zoo zone, Walter Reed Hospital in Rock Creek zone, Georgetown University in the Upper Potomac zone, and the Navy Yard, Marine Barracks in the South Anacostia zone. Other installations were located in the Benning, Kingman Lake, and Soldiers' Home zones.

D. C. HEALTH DEPARTMENT CONTROL. Inspectors from the Bureau of Sanitation of the District of Columbia Health Department had been operating in coordination with and under the supervision of USPHS personnel in the control of mosquitoes in non-military areas and it is anticipated that in the future anti-malaria and anti-mosquito work will be continued in the District of Columbia under the direction of the health department.

Courtesy of the David J. Sencer CDC Museum

District No. 3

Headquarters: Chicago, Illinois



LEGEND

◆ War Malaria Control - 1945 Season

USPHS District No. 3 includes the states of Wisconsin, Michigan, Illinois, Indiana, Ohio and Kentucky. Indiana and Kentucky had MCWA programs operating under the general jurisdiction of the respective state health departments in cooperation with the district office and are discussed elsewhere in this volume under "state-operated" programs. Illinois had an MCWA program operating under state health department direction until late in October and then supervision of activities was transferred to the district office. Illinois is also discussed under "state-operated" programs. There were no malaria control activities carried on in Wisconsin during this fiscal year. Consultant services were offered by the district office to the respective states and local communities, and a training course was given in Madison, Wisconsin late in November for state personnel on the use and application of DDT, and on rodent control measures. This course was attended by approximately 75 employees from the various state public welfare institutions.

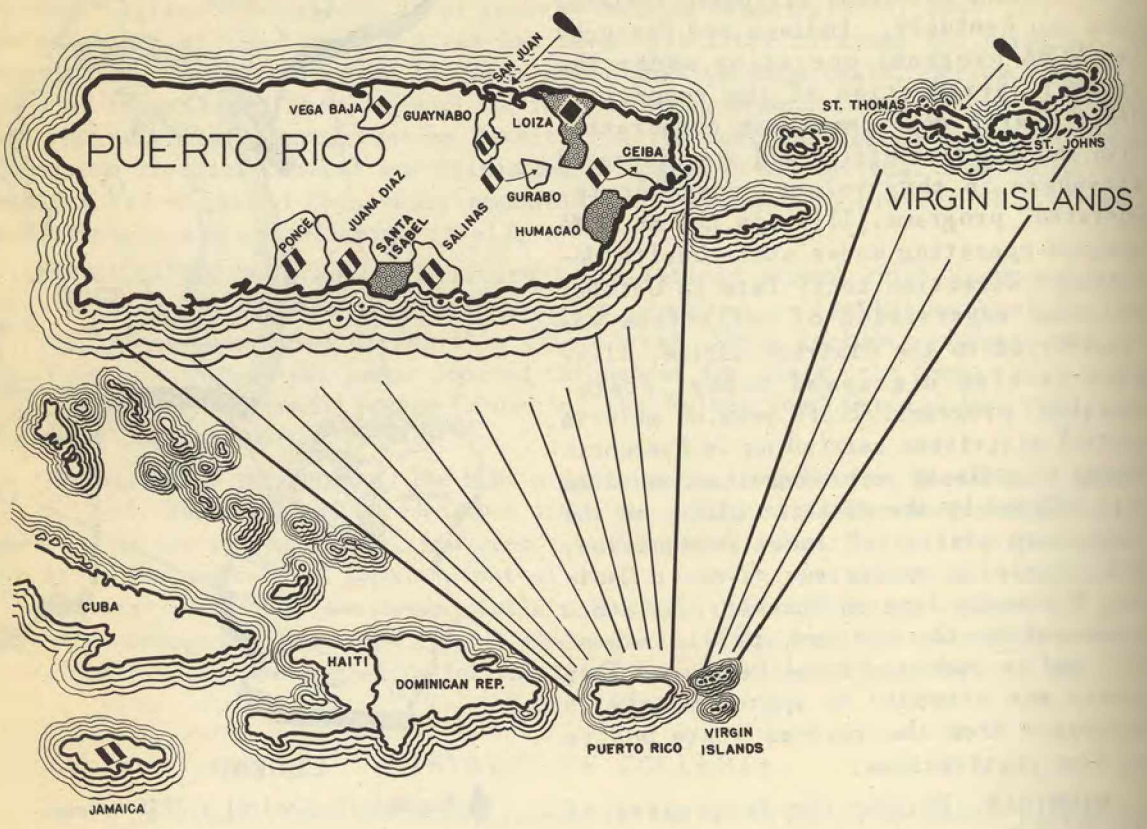
MICHIGAN. During the first part of the fiscal year, in addition to entomological surveillance in the Fort Custer area, district mobile unit personnel carried on larviciding around the Percy Jones General Hospital in Battle Creek, Calhoun County, and the Hospital Annex on Gull Lake in Kalamazoo County. A total of 845 pounds of paris green was used to dust 274 mosquito-producing acres. Four acres of aquatic vegetation were cleared to facilitate larviciding and to eliminate favorable breeding conditions. At the request of the state health department several mosquito surveys were made in communities in Macomb and Wayne counties.

OHIO. With the exception of entomological surveys in 1945 around Cule General Hospital in Cuyahoga County, Fletcher General Hospital in Guernsey County, Camp Perry in Ottawa County, and Lockbourne Army Air Base in Franklin County, there were no malaria control activities in Ohio during the year. Consultant services were offered by the district office to the state department of health and local agencies and several meetings were held with state and local officials in the interest of mosquito control.

Courtesy of the David J. Sencer CDC Museum

District No. 6

Headquarters: San Juan, Puerto Rico



LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946
- Extended Program Residual Spraying
- Typhus Control Ratproofing

The MCWA program in the three Caribbean islands was operated directly out of the USPHS District No. 6 office located at San Juan, Puerto Rico. Projects for the protection of military personnel were carried on in seven extra-cantonment areas in Puerto Rico, and one in Jamaica, British West Indies. In addition, surveillance programs in Puerto Rico were operated cooperatively with the Navy in two areas and with the Army in one area. Under the Extended Malaria Control Program three projects for the civilian population were carried out in cooperation with the Puerto Rico Insular Health Department. Typhus control activities became

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part of the general MCWA program on July 1, 1945. These activities were continued in Puerto Rico in cooperation with the Insular Health Department until December 1945, when practically the entire program was turned over to the Insular authorities. U. S. Public Health Service activities were then transferred to St. Thomas, Virgin Islands. During the fiscal year, an average of about 230 persons per month were employed on MCWA projects, representing an average monthly reduction of about 95 employees from the 1945 fiscal year. A total of 413,713 man-hours were expended on all types of control activities.

CARIBBEAN JOINT ARMY-NAVY-PHS MALARIA CONTROL COMMITTEE. On May 6, 1946 the Tenth Naval District Medical Officer called a meeting of Army, Navy and Public Health Service malaria control personnel to evaluate the then current malaria control problem and to develop measures for continuing adequate control activities with available appropriations and personnel. As a result of this meeting there was created an organization designated "Joint Army-Navy-Public Health Service Malaria Control Committee," approved by both the Antilles Department of the Army and the Tenth Naval District. Under provisions of the committee, the control of military malaria in the Caribbean area was considered a joint responsibility of the three agencies concerned. Based on appraisal of the over-all problem, each agency was allocated functions commensurate with available funds and materials. The areas where control operations were indicated were divided into those requiring "conventional" control measures, plane spraying with DDT, and experimental larviciding. These areas were then assigned to the respective agencies for control on the basis of location, extent, and type of control required. The committee was to begin functioning July 1, 1946.

PUERTO RICO

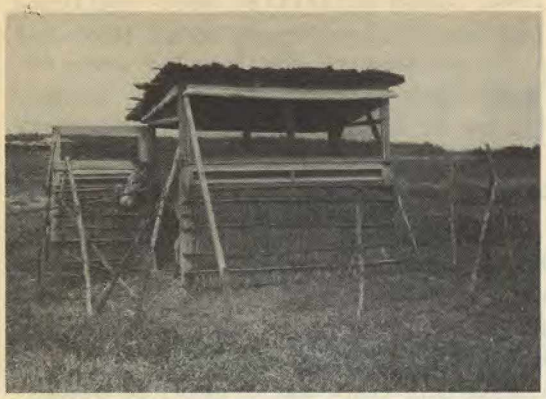
A. Fernos Isern, M. D.

Insular Commissioner of Health

The malaria rate among military personnel in Puerto Rico declined steadily during the period of MCWA activities, dropping from 21 per thousand per year in 1943 to five per thousand per year in 1945. During this time there was a substantial decrease in personnel engaged in larvicidal control, although the consumption of larvicide indicated a gradual rise in efficiency of operations. A great part of the increase in efficiency was attributable to drainage projects which not only permanently eliminated some breeding areas but also increased the accessibility of others not eliminated. Other contributing factors included the selection of better labor and the introduction of some mechanization.

ENTOMOLOGICAL FACTORS. Malaria control operations in Puerto Rico and Jamaica differ from those in the United States in that animal bait traps and light traps (and not the daytime resting places of *A. quadrimaculatus*, *A. freeborni*, or even *A. albimanus* in the low Rio Grande Valley) are the primary source of information as to the *A. albimanus* populations. Dipping records and adult population studies, based on weekly animal bait trap and nightly light trap collections, were used to locate breeding areas, to watch trends in mosquito populations, and to check on effectiveness of control operations. Frequently, entomological data furnished the reason and justification for extensive engineering operations. Surveillance programs were operated in collaboration with the Navy in two areas and with the Army in one area during the fiscal year. Navy installations included the Roosevelt

Courtesy of the David J. Sencer CDC Museum



Animal bait trap near Ft. Buchanan, P.R.

Roads Fleet Anchorage and the U. S. Navy Air Base in the Ceiba area and the U. S. Navy Radio Station in the Carolina area. The Army installations included the U. S. Army Auxiliary Air Base and the Coast Artillery encampments in the Ceiba area.

LARVICIDING. During the first part of the fiscal year, larvicidal and minor drainage activities were carried on in eight military areas, three of which also had major drainage operations. Later, two of the control areas were placed under surveillance and two other areas – Camp Tortuguerno and Camp O'Reilly – were reduced from full control to surveillance and subsequently closed.

DDT was first used as a larvicide in Puerto Rico as five percent DDT in kerosene at Fort Buchanan in December 1945. A blocked canal within the control area, with a larval population of about ten to 15 anopheline and ten to 15 culicine larvae per dip, was selected. Five gallons of the solution were applied to a section of the canal, comprising about three acres. On the day following treatment no anopheline larvae could be found although there was no apparent reduction in the culicine population. The treatment remained effective for almost three weeks; 21 days elapsed before anopheline larvae were again found. DDT isomer, 2.5 percent in kerosene with 0.5 percent B-1956 spreader, was first used as a larvicide in January 1946 at Camp O'Reilly. It was found that effective control could be obtained in a stream, even one with considerable flow, for about two weeks. When used on streams and rivers more than ten feet wide, a rate of 1.5 to 3.0 gallons of solution per acre was found effective. Field tests with a new larvicide containing 1.25 percent DDT and 0.5 percent spreader by weight in oil showed considerable promise. It gave excellent control and reduced costs of routine labor and materials. The efficiency of DDT larvicide was also expressed in the reduction of adult *A. albimanus* populations. During the four-month test period at Camp O'Reilly, animal bait trap catches in the inner zone showed a reduction from an average of 0.6 per night in December 1945 to 0.2 per night in March 1946.

AIRPLANE SPRAYING. At Fort Bundy the military population was not of sufficient size to warrant an MCWA control program. The only ground control measure in regular use was the oiling done by Post Engineer crews within the Post area. Animal bait traps and light traps were maintained and operated by MCWA, and as the trap catches indicated the need an Army C-47 plane sprayed the area, usually with ten percent DDT in Diesel oil. Adequate control was evidenced by a zero malaria rate among the military personnel. Near Fort Buchanan and the San Patricio Navy Housing Unit is a large swamp, locally termed the "Brugal" swamp. The area covers about 180 acres, most of which was economically inaccessible except by air. The area was first brought under control by airplane dusting with 33 percent paris green. Later the Navy furnished, equipped, and operated a light biplane for thermal-aerosol spraying. Excellent results were obtained against not only the anopheline larvae population but also against both anopheline and culicine adults as well. Treatments were made at intervals of from one week to ten days.

Courtesy of the David J. Sencer CDC Museum

DISTRICT NO. 6

DRAINAGE. An outstanding contribution in the field of civilian malaria control was made through a demonstration major drainage project at Ponce, Puerto Rico, inaugurated cooperatively by the Malaria Control Division of the Insular Department of Health and the U. S. Public Health Service. The primary purpose of the project was to demonstrate the feasibility of building malaria out of a large urban area by permanent elimination of breeding places. The town of Ponce, with a population of 105,116 and a high malaria rate, located on the south coast of Puerto Rico, was selected as the control area. The initial phase of planning and field surveys was started during the latter part of April 1945. Because of administrative delays, construction work was not started until late August. Considerable progress was made during the remainder of the fiscal year.

Near Losey Field, a breakwater composed of mangrove poles and rough oak planks was constructed to protect a gravity-flow sea outlet from one of the drainage systems. The breakwater has functioned in an excellent manner since it was installed in February of 1946. Previous to its installation, it was necessary at frequent intervals to assign a laborer to clear the sand from the mouth of the outlet. The breakwater protected the outlet from wave action and released the laborer for other tasks. More important, construction of the breakwater resulted in better drainage for the area served by the outlet. A mojor drainage project at Fort Buchanan, consisting of 2,600 feet of dynamite ditching, was completed in 1945.

RESIDUAL HOUSE SPRAYING. In collaboration with the Insular Health Department and the School of Tropical Medicine, an extensive residual spray program was carried out in the areas of Humacao Playa, Santa Isabel, and Loiza Aldea. Records to date indicated that in at least one area, Humacao Playa, considerable success was obtained by spraying 520 houses three times each over a period of a year. Malaria rates in this treated area were reduced from 6.3 percent before spraying to 0.91 percent after the



Replacing an open drainage ditch with 24-inch subsurface pipe. The open ditch was a convenient garbage disposal place.



(above) Construction of breakwater prevented formation of sandbar which blocked drainage ditch outlet to sea. (below) House to house survey prior to DDT residual spraying.



Courtesy of the David J. Sencer CDC Museum

third spraying. Rates in the " check" area, Loiza Aldea, were 4.7 percent and 3.8 percent respectively. Loiza Aldea was sprayed once at the end of the year, after having served as a " check" on operations in Humacao Playa.

It was found that for approximately $1.00 per capita per year in a moderate-sized Puerto Rican town, the malaria rate can be reduced substantially. The minimum effective rate of application in the coastal region of Puerto Rico was found to be 200 mg. DDT per square foot. The DDT-kerosene solution meets with much favor among the native population. However, the DDT-isomer-xylene emulsion was definitely not popular and many people refused to have their houses sprayed with it.

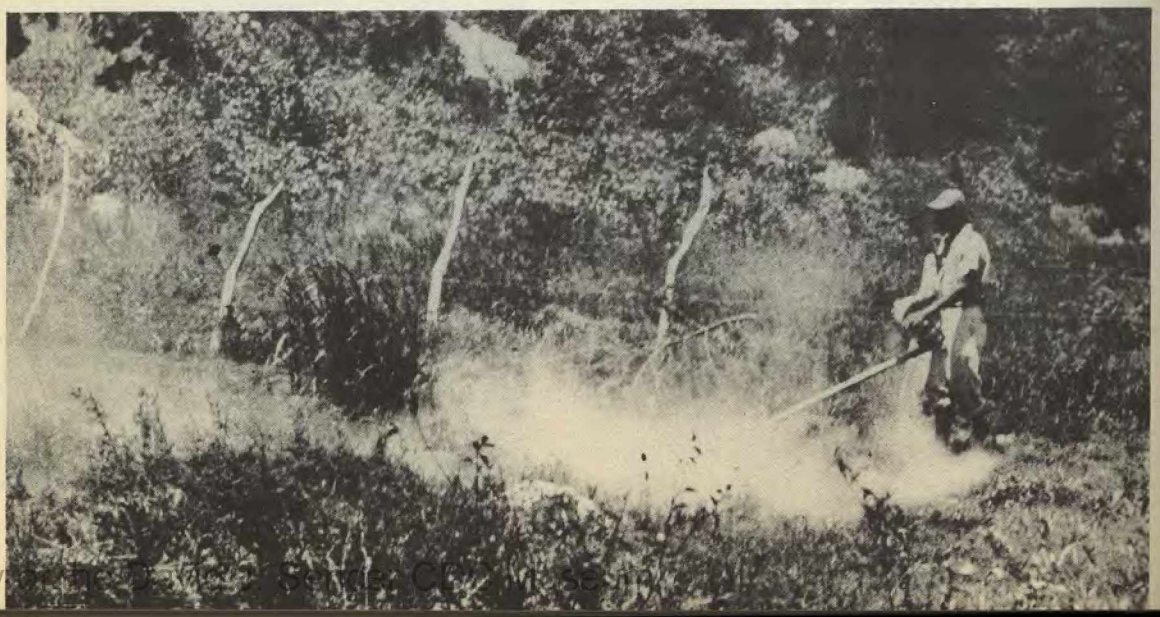
TYPHUS CONTROL. During the first part of the fiscal year a ratproofing project was inaugurated and carried on in San Juan directly under USPHS supervision, in cooperation with the Insular Health Department. By December 1945 the entire program, with the exception of supervision of the activities of one trap operator, was turned over to the Insular authorities. The catches made by this trap operator were delivered to the School of Tropical Medicine where an investigation was being conducted on the ectoparasites of rats.

JAMAICA, B. W. I.

The MCWA project at Fort Simonds, Jamaica Base Command, was unique in that it was the only project operating on foreign soil. The base was a lend-lease airfield entirely surrounded by British-owned or Jamaican-owned land. The area supervisor not only directed the regular off-Post MCWA activities but also, acting for the Post Engineer and Post Surgeon, directed on-Post control. Owing to the agricultural uses of the land in the off-Post zone, paris green dusting, cleaning, and clearing were the control measures in use. A residual spray program was maintained in the surrounding native villages.

The on-Post control program consisted of oiling for larvae control, minor drainage, inspection, residual spraying of all buildings, and the servicing of the C-47 spray plane which was used for general DDT spraying when the need was indicated. Owing to the rapid turn-over of military personnel it was often necessary for the resident officer to ride the spray mission to serve as a guide for the pilot. Hand-operated equipment was used generally on the project. Attempts to introduce mech-

Dusting *albimanus* breeding places in Jamaica, B.W.I., with paris green.



Courtesy



Concrete-products manufacturing plant which turned out approximately 35 miles of inverts, slabs, and pipes during the year.

anized equipment did not prove successful. This was partly due to the unfamiliarity of the available laborers with mechanical equipment and partly to the inaccessibility of much of the *A. albimanus* breeding area. One section of the control zone was an area of about seven square miles. Two sides were bordered on parts by paved roads and gravelled surface; one side had a partially gravelled road; the fourth side had a dirt road that was usable only in dry weather. Cattle trails provided the best routes within the area.

VIRGIN ISLANDS

Knud Knud-Hansen, M. D.
Commissioner of Health

The MCWA program in the Virgin Islands consisted mainly of USPHS promotion and supervision of a ratproofing campaign in the city of Charlotte Amalie on St. Thomas Island. Work on this project progressed slowly due to labor shortages. On the islands of St. Thomas and St. Croix, entomological and engineering surveys were made by MCWA personnel to combat filariasis and the *Aedes aegypti* vector. Recommendations were made for eliminating the *aegypti* breeding places and for DDT residual spraying of the islands.

DISTRICT NO. 6 SUMMARY

The malaria rate for military personnel continued to decrease in the protected areas. Many cases of malaria occurred on some posts among troops returning from combat zones, but this appeared to have no effect on permanent personnel.

Courtesy of the David J. Sencer CDC Museum

PLANNING. Approximately 7,300 acres were included in topographic surveys during the year. The design and preparation of detailed plans for two pumping stations, one combination office and warehouse, and 12 separate drainage and fill units were completed. Entomological studies were made to determine the significant breeding places, and to establish priority of construction units.

OPERATIONS. Paris green was the most extensively used larvicide during the past fiscal year. A total of 61,663 pounds were used to dust 38,891 acres. An additional 1,320 acres were covered with 18,702 gallons of oil. Approximately 100 acres of aquatic and land vegetation were cleared out supplementary to larvicidal work. Principal drainage items included approximately 45,000 cubic yards of hand excavation, 31,000 cubic yards by drag-line, 22,000 cubic yards sub-surface and back fill, and 22,000 cubic yards of fill material. Approximately five miles of inverts with side slabs, nine miles of four-inch side drain pipe, and four miles of six to 30 inch pipe were installed and 18 miles of open-earth ditching and two miles of earth dikes were constructed. A total of 1,670,000 linear feet of existing ditches were cleaned of silt and debris.

CONSTRUCTION. Items constructed by the close of the fiscal year included one temporary and one permanent combination office-warehouse and concrete-products manufacturing plant, one complete pumping station with inlet and discharge canals, and one under construction. Manufacture of concrete products included approximately eight miles of Panama inverts, ten miles of side slabs, nine miles of four-inch pipe, 1.5 miles of six-inch pipe, and one mile of eight-inch pipe, 2.5 miles of ten-inch pipe, and three miles of 12- to 30-inch pipe.

FUTURE ACTIVITIES. Operations for the 1947 fiscal year are expected to continue at about the same level as existed at the close of this year. It is probable that, for routine operation, more emphasis will be placed on DDT aerosols and the new DDT-oil larvicide.

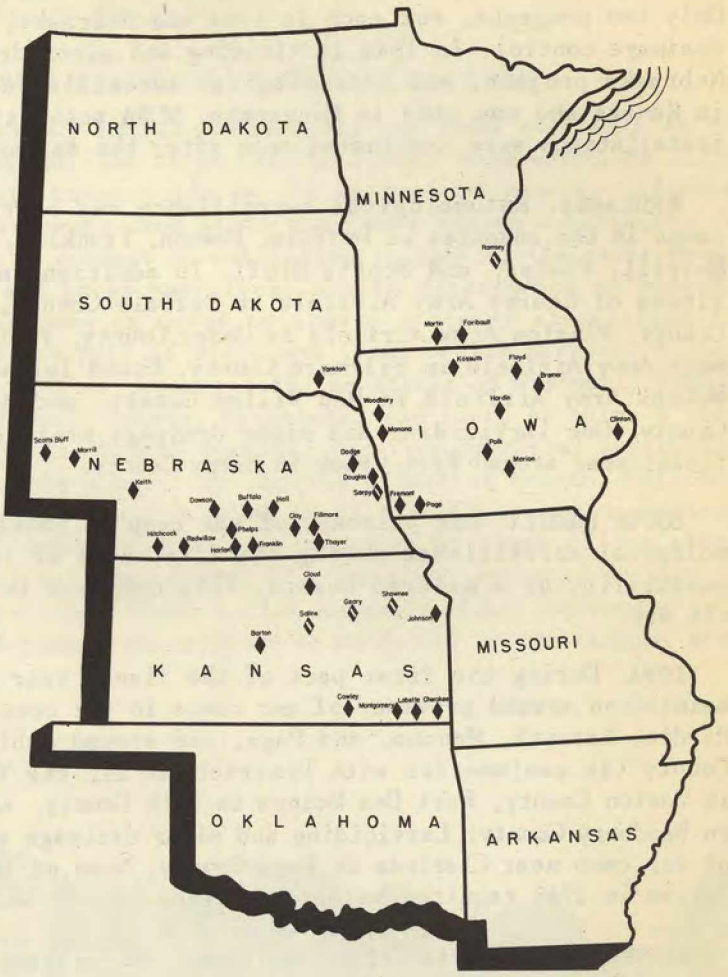
Discharge side of Losey Field USPHS pumping station. This station, which drains a 430 acre swamp, has a 30,000 gpm capacity.



Courtesy of the David J. Sencer CDC Museum

District No. 7

Headquarters: Kansas City, Missouri



Nine states comprise USPHS District No. 7—North and South Dakota, Minnesota, Nebraska, Iowa, Kansas, Missouri, Oklahoma, and Arkansas. Of these, Arkansas, Oklahoma, and Missouri had MCWA programs operating under the jurisdiction of the respective state health departments in cooperation with the district office and they are discussed separately under "state-operated" programs. North Dakota had no MCWA program in operation during the fiscal year. Activities in the other five states, supervised by the district office in cooperation with the respective state health departments, included the entomological surveillance and inspection of war areas in the marginal malaria states and malaria control projects in Clarinda, Iowa and Fort Crook, Nebraska. A total of 28 reconnaissance surveys were completed by the district entomologist around war areas to determine the need for further control activities, and 38 re-inspections of war establishments for malaria densities were made. Control efforts by the district mobile unit at the two projects mentioned above included considerable minor drainage work as well as larviciding. In 1946 only three states—Minnesota, Nebraska, and Kansas—had active war establishments which required surveillance or control.

Courtesy of the David J. Sencer CDC Museum

DISTRICT SUMMARY

During the first part of the fiscal year a total of 51 war establishments in 41 counties had malaria control activities. Most of these were branch prisoner of war camps which were established throughout the district in order to make prisoners of war available for harvesting work. The great majority of these installations were kept under entomological surveillance and required no further control measures. Only two projects, one each in Iowa and Nebraska, required larviciding and minor drainage control. In 1946 larviciding and minor drainage was continued around the Nebraska project, and entomological surveillance was maintained in three zones in Kansas and one zone in Minnesota. MCWA activities around the remainder of the installations were terminated soon after the war ended in 1945.

NEBRASKA. Entomological surveillance was carried out around prisoner of war camps in the counties of Buffalo, Dawson, Franklin, Hall, Harlan, Hitchcock, Keith, Morrill, Phelps, and Scotts Bluff. In addition inspections were made in the environs of Kearny Army Airfield in Buffalo County, Harvard Army Airfield in Clay County, Winslow Army Airfield in Dodge County, Fort Omaha in Douglas County, Fairmont Army Airfield in Fillmore County, Grand Island Army Airfield in Hall County, McCook Army Airfield in Red Willow County, and Braning Army Airfield in Thayer County. One larviciding and minor drainage project was carried on throughout the fiscal year around Fort Crook in Sarpy County.

SOUTH DAKOTA. One prisoner of war camp in Yankton County was kept under entomological surveillance during the first half of the fiscal year to check on the possibility of a malaria hazard. This camp was terminated soon after the end of the war.

IOWA. During the first part of the fiscal year entomological surveillance was maintained around prisoner of war camps in the counties of Bremer, Floyd, Fremont, Hardin, Kossuth, Monona, and Page, and around Schick General Hospital in Clinton County (in conjunction with District No. 3), the Veterans' Hospital in Knoxville in Marion County, Fort Des Moines in Polk County, and the Sioux City Army Airfield in Woodbury County. Larviciding and minor drainage was required around the prisoner of war camp near Clarinda in Page County. None of the installations which remained active in 1946 required malaria control.

MINNESOTA. Two prisoner of war camps, in Faribault and Martin counties, required surveillance during the first part of the fiscal year. These were terminated in 1946, and surveillance was begun around Fort Snelling in Ramsey County.

KANSAS. Only one prisoner of war camp, in Cloud County, was active and required surveillance during the latter part of 1945. However, entomological inspections were made around many other types of establishments including Great Bend City and the Army Air Base in Barton County, Jayhawk Ordnance Plant in Cherokee County, Arkansas City in Cowley County, Fort Riley in Geary County, the city of Gardner and the Naval Air Base in Johnson County, the Federal Housing Project and the Kansas Ordnance Plant in Labette County, the city of Coffeyville and the Coffeyville Army Air Base in Montgomery County, Camp Phelps in Saline County, and Winter General Hospital in Shawnee County. In 1946 surveillance was continued only around Fort Riley, Camp Phillips, and Winter General Hospital.

Courtesy of the David J. Sencer CDC Museum

MOSQUITO COLLECTIONS

In addition to the surveillance and inspections mentioned above the major entomological activities included intensive studies of the malaria mosquito breeding places in and around high "quad" producing areas in Kansas. Some of these studies were made by light trap operations in four previously unsampled areas in Kansas. Records from these trap catches were used in implementing distributional knowledge of various species of mosquitoes in the middle west.

INSECT CONTROL DEMONSTRATION ACTIVITIES

In the late summer of 1945 DDT-isomer concentrate was made available to the district office with the suggestion that it be used to conduct demonstrations illustrating the proper use of this insecticide in the control of insects affecting health. Because of the many requests from state and local health departments for demonstrations it was planned to conduct an exhibition in each of the state health departments in the district and in as many local health departments as possible before distributing the DDT-isomer in order to arouse a keener stimulation for demonstrational activities on the part of state and local health workers. A total of 109 showings were held by district personnel in the states of Missouri, Kansas, Oklahoma, Nebraska, North and South Dakota, Minnesota, and Iowa, at which a total of 2,723 individuals, mostly public health workers, received practical instruction in the proper uses of DDT for the control of insects affecting health. Following this series of demonstrations and the distribution of the DDT-isomer concentrate to the states a total of 372 demonstrations was reported by seven of the above-mentioned states, with a total attendance of 3,979. Complete reports have not yet been received from all of the states. These latter demonstrations required a total of 134 55-gallon drums of DDT-isomer concentrate distributed to the various state and local health departments.

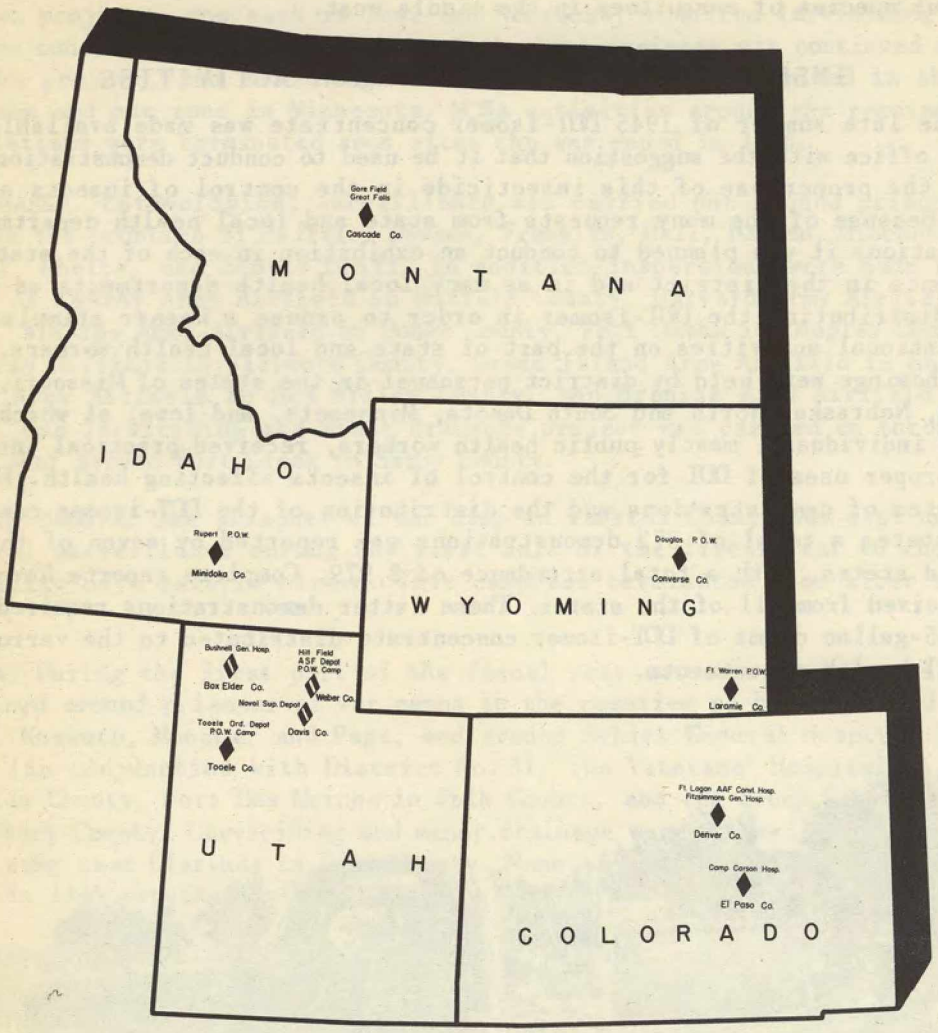


Mobile equipment for insect control demonstrations.

Courtesy of the David J. Sencer CDC Museum

District No. 8

Headquarters: Denver Colorado



The range of distribution of the western malaria vector, *Anopheles freeborni*, includes the northern tip of Montana, the southwestern corner of Wyoming, the western half of Colorado, and all of Idaho and Utah. However, these states, comprising USPHS District No. 8, are not within the normally malarious regions of the United

LEGEND

- War Malaria Control - 1945 Season
- War Malaria Control - Continued in 1946

Courtesy of the David J. Sencer CDC Museum

Courtesy of the David J. Sencer CDC Museum

States and it was considered unnecessary to maintain separate control projects around each of the war establishments in this district. Instead surveillance was maintained by the district entomologist in close cooperation with military authorities and state and local health departments, and district mobile unit personnel were dispatched to those areas where control measures were required.

UTAH. Two larviciding and minor drainage projects were carried on during the fiscal year in Utah, around Bushnell General Hospital in Brigham City, Box Elder County, and in the zone including the Army Service Forces Depot and a prisoner of war camp in Weber County. Entomological surveillance was maintained during the course of the year in the environs of the Naval Supply Depot in Davis County and Hill Army Airfield in Weber County. During the 1945 mosquito season periodic inspections were made of the Ordnance Depot and prisoner of war camp in Tooele County.

OTHER STATES. The Ruppert prisoner of war camp in Minidoka County of Idaho was inspected periodically and occasional spot larviciding was done by the inspector. This camp closed after the end of the war. In Cascade County of Montana, Gore Field and East Base in the Great Falls area were under surveillance during the first half of the fiscal year. Check inspections were also made during this period around the Fort Warren (Laramie County) and Douglas (Converse County) prisoner of war camps in Wyoming. In Denver, surveillance was carried on around the Fort Logan Convalescent Hospital and Fitzsimmons General Hospital in Denver County and Camp Carson Hospital in Colorado Springs, El Paso County. No actual MCWA program as such was continued in these states in 1946.

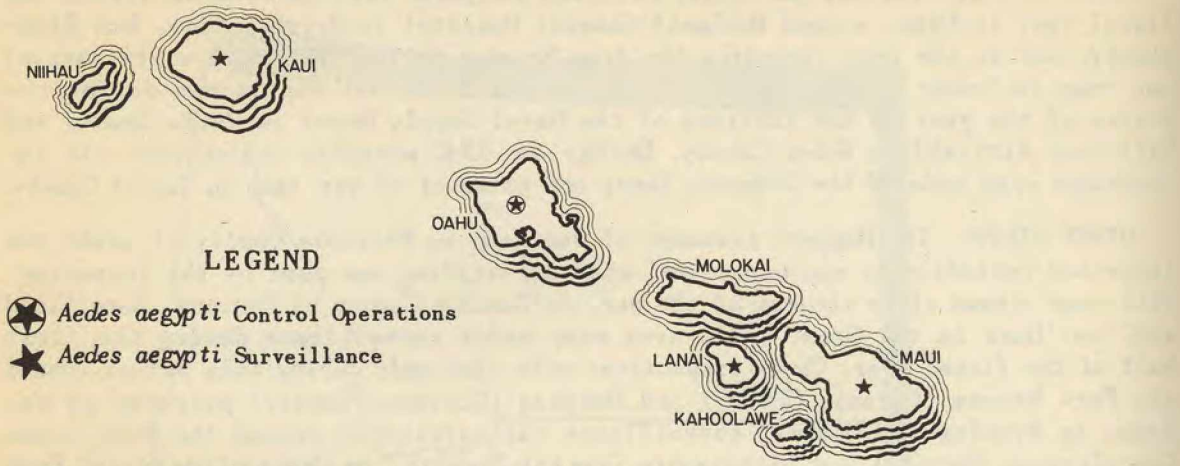
(below) District No. 8 mobile unit in operation. (right) Surveillance was maintained by the district entomologist.





District No. 10

Headquarters: Honolulu, Oahu



LEGEND

Aedes aegypti Control Operations

Aedes aegypti Surveillance

The control of *Aedes aegypti* and *albopictus* in the Hawaiian Islands continued during this fiscal year according to the basic plan of operation established in the fall of 1943 to cope with an outbreak of dengue fever. This plan stressed *inspection* of premises–*correction* of breeding–*education* of the householder. On October 31, 1945, all Army personnel assigned to the Mosquito Control Division were withdrawn and activities were continued with 22 federal civil service employees, supported by funds from the U. S. Public Health Service. Notification was received in March 1946 that USPHS funds would not be available beyond the end of May. On June 2, 1946 the Mosquito Control Division was completely transferred to the Bureau of Sanitation of the Board of Health, with 29 positions supported with territorial money from the Governor's contingent fund.

CONTROL OPERATIONS

One positive case of dengue fever was recorded in July 1945, although a number of suspected cases during the year were investigated and anti-mosquito precautions taken. Routine premise-to-premise inspections were carried on in Hilo, Honolulu, and rural Oahu, and surveys were made on the islands of Kauai, Maui, Lanai, and Hawaii as conditions indicated. An experimental, specially constructed DDT-smoke aerosol attachment to the exhaust of a motor vehicle was developed and proved valuable in the control of adult mosquitoes.

INSPECTING PROCEDURE. It was impossible with the reduced staff to maintain continuous inspection of all zones within cities at the same frequency as previously practiced. Although each zone was inspected, only those zones of high human population density and demonstrated hazard from the standpoint of re-introduction of

Courtesy of the David J. Sencer CDC Museum

dengue fever received treatment that approached the desired optimum of control. The use of DDT, with its high residual toxicity, aided in preventing some adverse effects resulting from the lengthening of the inspection cycle. The small, mobile crew of inspectors who had been functioning in Hilo proved invaluable as a nucleus for a fly-control problem subsequent to the tidal wave disaster of April 1, 1946. Routine inspections were made of 335,295 premises during the year, of which 7,268 were found to be breeding *Aedes* mosquitoes. Special emphasis was placed on permanent correction wherever possible. The use of DDT suspensions, applied to all potential and actual breeding containers with a special "squirt" oil-can applicator, increased the efficiency of the inspectors.

LARVICIDING AND FILLING. The borrowed military motorcycle larviciding units were replaced by a jeep (¼-ton truck) equipped with a pressure tank and spray equipment. This truck was used for larviciding storm drains, manholes, ground pools, swamp areas, ditches, and cesspools. During the year a source of breeding was completely eliminated by the removal of the bomb shelters erected during the war. The large swamp area adjacent to Kapiolani Boulevard was filled in, permanently removing one of the largest sources of *Culex* breeding within the city of Honolulu. A regular inspection cycle of known swamp and pond areas of mosquito breeding was established. When breeding was discovered, immediate treatment was made. This proved quite effective in reducing the numbers of *Culex* mosquitoes within Honolulu.

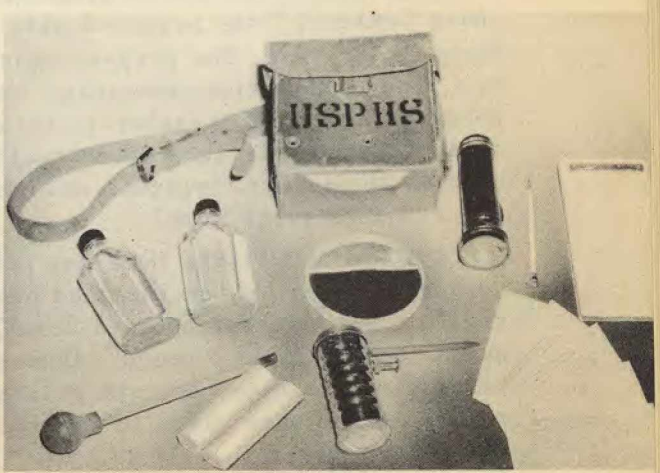
ACCOMPLISHMENTS. In the course of the year 7,425 catch basins and storm drains, 207 ground pools, 62 cesspools, 89 ditches and streams, and 13 swamps were oiled to eliminate mosquito breeding. In addition, 134 fish ponds were stocked with surface minnows, which fed on mosquito larvae. Phenothiazine strips became increasingly important as a means of controlling interior breeding. They have been readily accepted by the householder and are in constant demand. During the year approximately 85,000 packages, each containing 12 phenothiazine strips, were distributed in the Territory of Hawaii to schools, in cemeteries, and at public lectures.



Military motorcycle larviciding units were replaced by a jeep equipped with pressure tank and spray equipment.



(above) When breeding was discovered, inspectors provided immediate treatment. (below) Inspector's kit. Bottles contain an alcoholic suspension of DDT in water. "Oil-can" squirt gun in lower center.



Courtesy of the David J. Sencer CDC Museum

DDT-ALCOHOL LARVICIDE

An important phase of the program in Hawaii was the development of a method for using an alcoholic suspension of DDT in water, which could be used in all containers, replacing the variety of larvicides previously carried by each inspector. A conveniently handled oil-can "squirt" gun to apply the DDT suspension insured adequate treatment of all potential and actual breeding containers. Tests were conducted on the effectiveness of various DDT concentrations in ape plants, lily plants, bamboo stumps, tree holes, and a variety of artificial containers.

ENTOMOLOGICAL ACTIVITIES

The study of the life history and habits of mosquitoes was the basis for the development of effective control measures. The distribution, flight range, egg-laying habits, types of containers used as breeding places, effective larvicide concentrations, etc., were studied to obtain the necessary knowledge for adequate control measures.

AIRPLANE QUARANTINE. Close liaison was maintained with agencies concerned with insect quarantine and inspection of airplanes and other forms of transportation in order to prevent the introduction of medically or economically important insects. During the past fiscal year approximately one-fourth of all arriving and departing planes were inspected for insects and 133 aircraft were found to be carrying mosquitoes. A total of 364 mosquitoes of 19 different species were discovered. The species included five *Anopheles*, six *Aedes*, five *Culex*, and one each of *Mansonia*, *Psorophora* and *Culicidae*. Only four mosquitoes were found alive, none of them *Anopheles*. Intensive measures were taken by the agencies concerned to secure adequate disinsectization of the planes upon arrival and departure.

PUBLIC EDUCATION

In the course of the fiscal year 254 column-inches of news releases directly concerned with mosquito control activities appeared in the English-language newspapers. In addition, 108 column-inches appeared in the foreign language newspapers, including Japanese, Chinese, and Filipino.

HEALTH PROGRAMS. During the 1945-46 school year the Division of Health Education in the Department of Public Instruction of the Territory of Hawaii prepared a series of monthly health programs. The first program, entitled "Mosquitoes and their Control," was prepared with the assistance and review of the Division of Mosquito Control. The program consisted of a package of prepared articles, posters, and information concerning teaching aids, available films, references, etc., which assisted the teacher in presenting health subjects in an interesting and factual manner. By this means health subjects of local interest were included in courses in biology, hygiene, and home economics without departing too greatly from the standard curriculum.

LECTURES AND FILMS. Numerous public lectures and talks to schools were given during the year, which included presentations of the films, "*Aedes aegypti* Control", "Miss Keeter Goes to Town", "The Life History of the Yellow Fever Mosquito" and "Winged Scourge". Demonstrations of control techniques were also given using live exhibits wherever possible. Eighty-three showings of the film on mosquito control were given to a total estimated audience of 16,843.

Courtesy of the David J. Sencer CDC Museum

APPENDIX

Courtesy of the David J. Sencer CDC Museum

Table I
MCWA MALARIA CONTROL PERSONNEL ON DUTY
Fiscal Year 1946

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Monthly Average
Alabama	96	88	59	77	58	42	41	36	102	151	166	174	90
Arkansas	477	501	480	323	203	189	167	152	386	416	408	442	345
Dist. of Col.	2	6	2	2	1	1	1	1	1	1	—	—	2
California	26	29	28	27	21	17	16	11	11	16	17	14	20
Florida	300	317	307	307	120	111	106	86	95	193	189	184	193
Georgia	196	198	193	173	138	75	73	59	97	172	108	107	132
Illinois	32	25	14	10	3	8	3	1	—	—	—	—	12
Indiana	13	13	13	6	6	6	6	2	—	—	—	—	8
Kentucky	94	98	89	28	18	17	17	18	34	32	31	1	40
Louisiana	345	341	317	275	112	123	120	89	133	183	178	206	202
Maryland	15	15	13	5	3	8	1	—	—	—	—	—	9
Mississippi	335	349	255	131	81	59	66	70	258	277	290	261	203
Missouri	207	184	187	122	49	65	29	30	81	86	98	99	103
N. Carolina	188	185	165	97	87	79	58	72	73	68	68	67	100
Oklahoma	145	150	123	123	81	44	39	31	44	43	41	43	75
Oregon	1	1	1	1	1	1	1	1	1	1	1	—	1
S. Carolina	497	493	468	385	187	124	112	127	83	238	239	235	266
Tennessee	145	141	113	80	62	76	74	71	86	84	90	93	93
Texas	367	377	373	224	201	106	121	101	115	230	245	264	227
Virginia	137	135	122	103	76	32	30	29	29	28	30	30	65
Dist. 6	303	310	452	273	293	281	214	186	170	148	143	117	280
Dist. 10	32	36	35	34	34	39	37	34	33	31	30	27	34

Table II
MCWA *AEDES AEGYPTI* CONTROL PERSONNEL ON DUTY
Fiscal Year 1946

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Monthly Average
Alabama	10	6	6	6	8	6	5	6	4	6	6	6	6
Florida	25	28	24	24	24	23	23	23	22	22	20	15	23
Georgia	5	6	6	6	6	6	5	2	-	2	-	-	5
Louisiana	9	10	10	9	10	10	11	10	9	8	2	-	9
S. Carolina	8	8	8	8	7	7	7	7	7	7	6	6	7
Texas	36	37	39	34	24	14	15	16	16	15	14	14	23

Table III
MCWA TYPHUS CONTROL PERSONNEL ON DUTY
Fiscal Year 1946

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Monthly Average
Alabama	10	9	11	20	26	39	42	41	49	46	47	45	32
Arkansas				30	30	31	32	29	—	1	4	22	22
California	0	1	1	1	1	0	—	—	—	—	—	—	1
Florida	2	2	8	12	17	16	17	19	20	21	19	20	14
Georgia	1	2	1	22	24	42	48	72	61	92	76	70	43
Louisiana	1	1	5	12	7	20	20	17	23	31	35	40	18
Mississippi	2	2	2	7	4	18	19	20	19	19	2	15	11
N. Carolina	5	4	12	18	19	21	24	26	26	24	24	27	19
S. Carolina	7	7	14	21	22	20	21	26	31	33	33	34	22
Tennessee	1	0	—	—	6	6	11	11	17	19	16	11	8
Texas	18	25	48	47	77	81	73	73	78	74	89	62	62
Virginia					1	1	—	—	—	—	—	2	1
District 6	1	1	1	1	—	1	—	—	—	1	1	1	1

Courtesy of the David J. Sencer CDC Museum

Courtesy of the David J. Sencer CDC Museum

Table IV

" STATE-OPERATED" PROGRAM SUMMARY - FISCAL YEAR 1946

Total Counties, Areas, Zones, Establishments, and Towns for all MCWA Programs Operating in Each State

		1st Half F.Y.	2nd Half F.Y.	Total F.Y.	Man-Hours F.Y.
Alabama	Co's	25	28	36	181,852
	Areas	19	4	19	
	Zones	33	5	33	
	Est.	74	5	74	
	Towns			44	
Arkansas	Co's	29	35	39*	571,366
	Areas	20	3	20	
	Zones	53	7	53	
	Est.	57	7	57	
	Towns			35*	
California	Co's	14	5	15	22,454
	Areas	6	3	6	
	Zones	22	5	23	
	Est.	25	5	26	
Florida	Co's	45	37	55	244,136
	Areas	36	10	36	
	Zones	82	18	82	
	Est.	91	19	91	
	Towns			21	
Georgia	Co's	50	62	78	241,095
	Areas	15	3	15	
	Zones	53	3	53	
	Est.	85	3	85	
	Towns			169	
Illinois	Co's	10	-	10	10,366
	Areas	9	-	9	
	Zones	12	-	12	
	Est.	19	-	19	
Indiana	Co's	7	-	7	5,947
	Areas	7	-	7	
	Zones	9	-	9	
	Est.	19	-	19	
Kentucky	Co's	14	15	19	68,321
	Areas	6	4	6	
	Zones	19	4	19	
	Est.	42	3	42	
	Towns			3	
Louisiana	Co's	27	24	33	340,364
	Areas	8	5	8	
	Zones	44	8	44	
	Est.	71	9	71	
	Towns			36	
Mississippi	Co's	30	24	32	365,112
	Areas	23	3	23	
	Zones	40	4	40	
	Est.	59	4	59	
	Towns			13	
Missouri	Co's	21	12	28	170,979
	Areas	15	2	15	
	Zones	24	3	24	
	Est.	26	3	26	
	Towns			16	
North Carolina	Co's	39	41	48	160,042
	Areas	14	3	14	
	Zones	41	5	41	
	Est.	77	6	77	
	Towns			24	
Oklahoma	Co's	28	6	29	118,336
	Areas	15	1	15	
	Zones	38	1	38	
	Est.	69	1	69	
	Towns			4	
Oregon	Co's	5	1	5	344
	Areas	2	1	2	
	Zones	8	1	8	
	Est.	8	1	8	
South Carolina	Co's	30	29	34	415,746
	Areas	23	3	23	
	Zones	33	3	33	
	Est.	109	3	109	
	Towns			90	
Tennessee	Co's	13	15	19	152,216
	Areas	6	2	6	
	Zones	22	4	22	
	Est.	134	4	134	
	Towns			12	
Texas	Co's	72	77	95	511,075
	Areas	15	4	15	
	Zones	78	6	78	
	Est.	130	7	130	
	Towns			193	
Virginia	Co's	19	4	19	105,423
	Areas	6	3	6	
	Zones	30	6	30	
	Est.	107	7	107	
	Towns			3	

TOTAL

	1st Half F.Y.	2nd Half F.Y.	Total F.Y.	Man-Hours F.Y.
Co's	478	415	601*	3,685,174
Areas	245	54	245	
Zones	641	83	642	
Est.	1202	87	1203	
Towns			663*	

*Does not include 30 additional towns in 21 counties in Arkansas which had Typhus Surveys.

Courtesy of the David J. Sencer CDC Museum

Table V

" DISTRICT-OPERATED" PROGRAM SUMMARY - FISCAL YEAR 1946

Counties, Areas, Zones, Establishments, and Towns for all MCWA Programs Operating in Each District

		1st Half F.Y.	2nd Half F.Y.	Total F.Y.	Man-Hours F.Y.	INCLUDED STATES
District 1	Co's Zones Est.	43 59 60	11 14 14	43 59 60	20,963	Connecticut, Delaware, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island included in district totals. (No MCWA operations in Maine, New Hampshire or Vermont.)
District 2	Co's Areas Zones Est.	15 4 35 52	- - - -	15 4 35 52	3,120	Maryland and the District of Columbia included in district totals. (No MCWA operations in West Virginia. Virginia, North and South Carolina had " state-operated" MCWA programs.
District 3	Co's Areas Zones Est.	8 8 9 10	- - - -	8 8 9 10	2,441	Michigan and Ohio included in district totals. (No MCWA operations in Wisconsin, Illinois, Indiana, and Kentucky had " state-operated" MCWA programs.)
District 4						Alabama, Florida, Georgia, Louisiana, Mississippi, and Tennessee, all had " state-operated" MCWA programs.
District 5						Arizona, Nevada, and Washington had no MCWA operations. California and Oregon had " state-operated" MCWA programs.
District 6	Co's (islands) Areas Zones Est. Towns	12 9 11 20	12 7 11 11	13 9 11 20 2	413,713	Puerto Rico, Virgin Islands, and Jamaica, B.W.I. included in district totals.
District 7	Co's Areas Zones Est.	41 42 51 51	5 5 5 5	42 42 52 52		Iowa, Kansas, Minnesota, Nebraska, and South Dakota included in district totals. (No MCWA operations in North Dakota. Arkansas, Missouri, and Oklahoma had " state-operated" MCWA programs.)
District 8	Co's Areas Zones Est.	10 8 13 14	3 3 3 5	10 8 13 14	3,100	Colorado, Idaho, Montana, Utah, and Wyoming included in district totals.
District 9						No MCWA operations in New Mexico. Texas had a " state-operated" MCWA program.
District 10	Co's (islands)	5	5	5		Hawaiian Islands included in district totals.
District 11						No MCWA operations in Alaska.
TOTAL	Co's Areas Zones Est. Towns	134 71 178 207	36 15 31 35	136 71 179 208 2	443,337	

Table VI

SUMMARY OF " STATE-OPERATED" MCWA WAR MALARIA PROGRAMS

Table VI

SUMMARY OF " STATE-OPERATED" MCWA WAR MALARIA PROGRAMS

Fiscal Year 1946

		WAR MALARIA 1st Half F.Y.	WAR MALARIA 2nd Half F.Y.	WAR MALARIA Total F.Y.	AEDES AEGYPTI F.Y. 1946
Alabama	Co's	17	4	17	1
	Areas	19	4	19	
	Zones	33	5	33	
	Est.	74	5	74	
	Towns				1
Arkansas	Co's	22	3	22	
	Areas	20	3	20	
	Zones	53	7	53	
	Est.	57	7	57	
California	Co's	14	5	15	
	Areas	6	3	6	
	Zones	22	5	23	
	Est.	25	5	26	
Florida	Co's	37	9	37	3
	Areas	36	10	36	
	Zones	82	18	82	
	Est.	91	19	91	
	Towns				3
Georgia	Co's	23	3	23	1
	Areas	15	3	15	
	Zones	53	3	53	
	Est.	85	3	85	
	Towns				1
Illinois	Co's	10	-	10	
	Areas	9	-	9	
	Zones	12	-	12	
	Est.	19	-	19	
Indiana	Co's	7	-	7	
	Areas	7	-	7	
	Zones	9	-	9	
	Est.	19	-	19	
Kentucky	Co's	10	4	10	1
	Areas	6	4	6	
	Zones	19	4	19	
	Est.	42	3	42	
	Towns				1
Louisiana	Co's	23	6	23	
	Areas	8	5	8	
	Zones	44	8	44	
	Est.	71	9	71	
Mississippi	Co's	21	3	21	
	Areas	23	3	23	
	Zones	40	4	40	
	Est.	59	4	59	
Missouri	Co's	20	2	20	
	Areas	15	2	15	
	Zones	24	3	24	
	Est.	26	3	26	
N. Carolina	Co's	26	2	26	
	Areas	14	3	14	
	Zones	41	5	41	
	Est.	77	6	77	
Oklahoma	Co's	25	1	25	
	Areas	15	1	15	
	Zones	38	1	38	
	Est.	69	1	69	
Oregon	Co's	5	1	5	
	Areas	2	1	2	
	Zones	8	1	8	
	Est.	8	1	8	
S. Carolina	Co's	19	3	19	1
	Areas	23	3	23	
	Zones	33	3	33	
	Est.	109	3	109	
	Towns				1
Tennessee	Co's	8	2	8	
	Areas	6	2	6	
	Zones	22	4	22	
	Est.	134	4	134	
Texas	Co's	39	5	39	8
	Areas	15	4	15	
	Zones	78	6	78	
	Est.	130	7	130	
	Towns				30
Virginia	Co's	18	3	18	1
	Areas	6	3	6	
	Zones	30	6	30	
	Est.	107	7	107	
	Towns				2

TOTAL

	WAR MALARIA 1st Half F.Y.	WAR MALARIA 2nd Half F.Y.	WAR MALARIA Total F.Y.	AEDES AEGYPTI F.Y. 1946
Co's	344	56	345	16
Areas	245	54	245	
Zones	641	83	642	
Est.	1202	87	1203	
Towns				39

Courtesy of the David J. Sencer CDC Museum

Table VII

SUMMARY OF " DISTRICT-OPERATED" MCWA WAR MALARIA PROGRAMS

Fiscal Year 1946

		WAR MALARIA			AEDES AEGYPTI	INCLUDED STATES
		1st Half F.Y.	2nd Half F.Y.	Total F.Y.	F.Y. 1946	
District 1	Co's	43	11	43		Connecticut, Delaware, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island included in district totals. (No MCWA operations in Maine, New Hampshire and Vermont.)
	Areas	-	-	-		
	Zones	59	14	59		
	Est.	60	14	60		
District 2	Co's	15	-	15		Maryland and District of Columbia included in district totals. (No MCWA operations in West Virginia, Virginia, North and South Carolina had " state-operated" MCWA programs.
	Areas	4	-	4		
	Zones	35	-	35		
	Est.	52	-	52		
District 3	Co's	8	-	8		Michigan and Ohio included in district totals. (No MCWA operations in Wisconsin, Illinois, Indiana and Kentucky had " state-operated" MCWA programs.
	Areas	8	-	8		
	Zones	9	-	9		
	Est.	10	-	10		
District 4						Alabama, Florida, Georgia, Louisiana, Mississippi and Tennessee all had " state-operated"MCWA programs,
District 5						Arizona, Nevada and Washington had no MCWA operations. California and Oregon had " state-operated" MCWA programs.
District 6	Co's	9	7	9		Puerto Rico, Virgin Islands, and Jamaica, B.W.I., included in district totals.
	Areas	-	-	-		
	Zones	11	9	11		
	Est.	20	11	20		
District 7	Co's	41	5	42		Iowa, Kansas, Minnesota, Nebraska, and South Dakota included in district totals. (No MCWA operations in North Dakota, Arkansas, Missouri and Oklahoma had " state-operated" MCWA programs.
	Areas	42	5	42		
	Zones	51	5	52		
	Est.	51	5	52		
District 8	Co's	10	3	10		Colorado, Idaho, Montana, Utah, and Wyoming included in district totals.
	Areas	8	3	8		
	Zones	13	3	13		
	Est.	14	5	14		
District 9						No MCWA operations in New Mexico. Texas had a " state-operated" MCWA program.
District 10	Co's (islands)				5	Hawaiian Islands included in district totals.
District 11						No MCWA operations in Alaska.
TOTAL	Co(s	126	26	127	5	
	Areas	62	8	62		
	Zones	178	31	179		
	Est.	207	35	208		

Courtesy of the David J. Sencer CDC Museum

Courtesy of the David J. Sencer CDC Museum

Table VIII

MCWA LARVICIDAL AND DRAINAGE OPERATIONS

Fiscal Year 1946

	LARVICIDAL WORK						DRAINAGE OPERATIONS								
	LARVICIDE USED		*SURFACES TREATED*		*CLEARING*		*CLEANING*	*NEW DITCHING — LIN. FT.*				Ditch Lining Linear Feet	Under-Ground Drainage Lin. Ft.	Fill C.Y.	Water Surf. Eliminated Acres	TOTAL MAN HOURS
	Oil Gals.	Paris Green Lbs.	ACRES Oiled	ACRES Dusted	ACRES Aquat. Veg.	ACRES Land Veg.	Lin. Ft.	Hand	Mach.	Dynamite	Total					
Alabama	4,753	500	174	373	39	9	264,804	—	—	—	—	—	—	—	3	4,701
Arkansas	167,360	2,447	9,927	1,564	426	369	637,743	93,242	—	1,500	8,101	2,295	—	—	15	319,158
California	10,951	35	1,003	11	9	10	64,487	600	1,800	—	2,030	—	—	—	42	22,454
Florida	21,191	6,008	1,091	3,710	64	49	1,168,497	79,903	—	10,676	12,270	9,444	58	30,075	37	136,979
Georgia	2,182	9,802	241	7,553	60	83	158,335	6,229	113	—	823	—	—	23,062	24	41,263
Illinois	5,165	1,563	181	1,287	2	1	28,245	4,145	—	5,090	4,050	—	—	—	7	10,366
Indiana	4,621	52	333	65	—	—	3,400	—	—	850	900	—	—	—	—	5,947
Kentucky	14,667	132	683	89	25	8	5,383	—	—	—	—	—	—	—	—	43,479
Louisiana	302,711	1,780	12,563	1,720	56	87	310,812	8,805	—	40	1,388	—	—	293	—	247,382
Mississippi	68,219	4,492	2,761	2,621	205	283	254,145	1,000	—	—	23	—	—	—	1	162,253
Missouri	36,115	15,864	2,127	7,482	4	59	14,240	1,965	—	6,600	5,205	600	—	4	50	121,435
N. Carolina	27,862	270	1,382	71	167	378	1,205,888	69,194	—	27,280	36,133	—	1,597	7,839	50	59,908
Oklahoma	86,740	1,500	5,054	966	6	29	21,018	18,047	—	—	2,001	—	—	15	8	94,499
Oregon	1,635	—	30	—	—	—	—	—	—	—	—	—	—	—	—	344
S. Carolina	54,064	1,733	2,754	1,337	431	271	2,116,420	42,118	—	—	4,882	78	1,075	6,262	48	219,362
Tennessee	43,981	552	1,787	207	5	22	59,317	18,368	—	—	4,570	16,743	—	3,054	12	112,225
Texas	69,659	1,896	3,140	1,458	391	88	1,028,461	31,543	26,656	2,080	13,502	—	—	417	136	135,252
Virginia	49,794	2,409	1,493	1,347	62	122	414,370	160,131	—	—	12,511	1,563	—	3,806	—	104,635
District 1	12,896	18,536	1,003	9,202	5	5	122,422	46,086	8,185		36,914	310		700	490	20,963
District 2	—	—	—	—	14	—	1,000	500	—	1,068	900	—	—	382	10	3,120
District 3	—	845	—	274	4	—	—	—	—	—	—	—	—	—	—	2,441
District 6	18,702	61,663	1,320	38,891	34	57	1,668,868	53,380	11,286	3,263	24,819	—	—	1,045	91	413,713
District 8	250	195	54	569	—	—	—	695	—	—	18	—	—	—	—	3,100
TOTAL FISCAL YR.	1,003,518	132,274	49,101	80,797	2,008	1,930	9,547,855	635,951	48,040	58,447	173,040	31,033	2,730	76,954	1,024	2,284,979
SUB-TOTAL 1st HALF FISCAL YR.	900,973	116,329	43,858	70,132	3,457		7,269,718	478,088	37,962	36,214	122,009	20,203	2,210	58,028	418	
SUB-TOTAL 2nd HALF FISCAL YR.	102,545	15,945	5,243	10,665	482		2,278,137	157,863	10,078	22,233	51,031	10,830	520	18,926	606	

Courtesy of the David J. Sencer CDC Museum

Table IX

SUMMARY OF MCWA EXTENDED MALARIA CONTROL PROGRAMS

Fiscal Year 1946

		RESIDUAL SPRAYING					
		1st Half F. Y.	2nd Half F. Y.	Total F. Y.	2nd Half F. Y.	2nd Half F. Y.	Total F. Y.
Alabama	Co's	6	21	21	6	16	16
	Towns				6	19	19
Arkansas	Co's	23	31	32	11	16	17
	Towns				26	27	33
Florida	Co's	10	23	23	4	6	7
	Towns				4	6	7
Georgia	Co's	14	36	36	-	-	-
	Towns						
Kentucky	Co's	6	11	11	1	3	3
	Towns				1	3	3
Louisiana	Co's	8	15	15	5	6	8
	Towns				7	6	10
Mississippi	Co's	13	17	17	-	-	-
	Towns						

		LARVICIDING, DRAINAGE					
		1st Half F. Y.	2nd Half F. Y.	Total F. Y.	1st Half F. Y.	2nd Half F. Y.	Total F. Y.
Missouri	Co's	3	10	10	3	-	3
	Towns				16	-	16
N. Carolina	Co's	13	36	36	-	1	1
	Towns				-	1	1
Oklahoma	Co's	3	5	5	2	-	2
	Towns				4	-	4
S. Carolina	Co's	12	23	23	8	--	8
	Towns				11	-	11
Tennessee	Co's	6	12	12	5	4	5
	Towns				8	6	9
Texas	Co's	6	33	33	1	1	1
	Towns				9	9	9

TOTAL*

	RESIDUAL SPRAYING			LARVICIDING. DRAINAGE		
	1st Half F. Y.	2nd Half F. Y.	Total F. Y.	1st Half F. Y.	2nd Half F. Y.	Total F. Y.
Co's	123	273	274	46	53	71
Towns				92	77	122

*Does not include experimental residual spraying in 3 counties in Puerto Rico, or state-wide demonstration spraying in Virginia.

Courtesy of the David J. Sencer CDC Museum

Table X

SUMMARY OF RESIDUAL DDT HOUSE SPRAYING OPERATIONS

Fiscal Year 1946

	No. House Spray Applications	Lbs. DDT Used	Lbs. DDT per House Appl.	Man Hours	Man Hours per House Appl.	Man Hours per Pound DDT	No. House Spray Applications	Lbs. DDT Used	Lbs. DDT per House Appl.	Man Hours	Man Hours per House Appl.	Man Hours per Pound DDT
Alabama	21,964	16,658	0.76	30,848	1.40	1.85	45,711	36,772	0.80	52,654	1.15	1.43
Arkansas	88,915	34,524	0.39	96,683	1.09	2.51	135,327	88,453	0.65	142,508	1.05	1.61
Florida	24,113	19,393	0.80	39,164	1.62	2.02	27,516	23,701	0.86	32,405	1.18	1.37
Georgia	35,087	26,574	0.76	28,810	1.08	1.08	90,314	118,490	1.44	50,416	0.61	0.43
Kentucky	16,838	6,956	0.41	18,415	1.15	2.88	9,206	5,756	0.63	6,427	0.70	1.12
Louisiana	9,761	5,840	0.60	13,441	1.38	2.30	36,141	23,322	0.64	35,392	0.98	1.52
Mississippi	61,949	28,724	0.46	66,087	1.07	2.30	104,041	83,245	0.79	104,806	1.00	1.25
Missouri	19,760	11,133	0.56	19,090	0.97	1.72	39,001	30,006	0.77	30,454	0.78	1.01
N. Carolina	2,488	951	0.38	2,678	1.08	2.81	20,605	13,291	0.65	17,793	0.86	1.34
Oklahoma	9,735	4,127	0.42	9,283	0.95	2.24	17,060	14,911	0.87	14,554	0.85	0.98
S. Carolina	34,918	16,211	0.46	48,950	1.40	3.02	55,582	32,829	0.59	67,483	1.21	2.06
Tennessee	12,162	5,068	0.42	12,363	1.02	2.42	21,578	16,115	0.75	16,626	0.77	1.03
Texas	75,850	31,707	0.42	94,977	1.25	2.99	46,184	26,784	0.58	51,865	1.12	1.94
SUB-TOTAL	413,450	207,866	0.50	480,789	1.15	2.31	648,266	513,675	0.79	623,383	0.96	1.21

TOTAL — FISCAL YEAR

Number House Spray Applications	Lbs. DDT Used	Lbs. DTT per House Application	Man-Hours	Man-Hours per House Application	Man-Hours per Pound DDT
1,061,806	721,655	0.68	1,104,172	1.04	1.53

Table XI

SUMMARY OF MCWA TYPHUS CONTROL PROGRAMS

Fiscal Year 1946

		Residual Dusting	Ratproofing	Total Typhus	USPHS Man-Hours Worked #	Other Man-Hours Worked #	Total Man-Hours Worked #
Alabama	Co's	28	3	11	56,549	37,100	93,649
	Towns		3	28			
Arkansas	Co's	-	1	1 *	400	12,617	13,017
	Towns	-	2	2 *			
Florida	Co's	5	4	6	21,658	13,930	35,588
	Towns	9	5	11			
Georgia	Co's	54 ±	4	54 ±	65,338	55,268	120,606
	Towns	169	4	169			
Louisiana	Co's	6	5	6	19,540	24,609	44,149
	Towns	24	5	25			
Mississippi	Co's	5	6	6	19,712	12,254	31,966
	Towns	12	6	13			
N. Carolina	Co's	5	5	10	33,239	46,424	79,663
	Towns	18	5	23			
S. Carolina	Co's	11	12	19	34,277	45,674	79,951
	Towns	69	13	78			
Tennessee	Co's	3	1	3	10,945	57	11,002
	Towns	3	1	3			
Texas	Co's	49	16	50	82,009	146,972	228,981
	Towns	181	20	182			
Virginia	Co's	1	-	1	628	160	788
	Towns	1	-	1			
TOTAL	Co's	150	57	167 * ±	344,295	495,065	739,360
	Towns	514	64	535 *			

Includes supervision, travel, leave, sickness, miscellaneous, etc.
* Does not include 21 counties and 30 towns in Arkansas which had Typhus Surveys.
± Does not include Thomasville Typhus Investigational Program in Georgia, consisting of experimental residual dusting in three counties, rat eradication in one county, and one control county.

Table XII

SUMMARY OF RESIDUAL DUSTING TYPHUS CONTROL OPERATIONS

Fiscal Year 1946

	Premises Inspected	Premises Infested	Premises Treated	Lbs. 10% DDT Dust Used	Lbs. 10% DDT Dust Per Prem. Treat.	L and LF # Man-Hours	L and LF # Man-Hours per Prem. Treat.
Alabama	42,931	32,091	33,747	144,133·	4.3	29,084	0.86
Florida	31,097	22,729	29,408	51,129	1.7	16,383	0.56
Georgia	82,654	71,889	77,567	308,867	4.2	61,160	0.88
Louisiana	25,667	23,572	23,572	39,112	1.7	9,800	0.42
Mississippi	25,833	14,866	15,383	23,935	1.6	11,000	0.72
N. Carolina	39,312	34,637	36,176	53,110	1.5	21,530	0.60
S. Carolina	15,247	11,211	14,222	50,668	3.6	22,601	1.59
Tennessee	16,450	15,336	15,347	37,134	2.4	6,968	0.45
Texas	169,964	98,479	90,300	104,359	1.2	50,215	0.56
Virginia	512	455	453	5,985	13.2 *	---	1.06
TOTAL	449,667	325,265	336,161	818,432	2.4	228,741	0.68

L and LF - labor and labor foremen
* per premise (includes several treatments)

Table XIII

SUMMARY OF RATPROOFING AND POISONING TYPHUS CONTROL OPERATIONS

Fiscal Year 1946

	RATPROOFING			RAT POISONING					
	Estab. Treated	L and LF# Man-Hours	L and LF Man-Hours Per Treat.	Premise Poison-ings	Lbs. Bait Used	Lbs. Bait Per Prem. Poisoning	" 1080" Water Used	L and LF* Man-Hours	L and LF Man-Hours Per Prem. Poisoning
Alabama	120	2,696	22.5	24,936	29,555	1.19	---	10,671	0.43
Arkansas	189	5,511	29.2	408	5,356	13.12#	524	2,896	7.1 #
Florida	411	8,375	20.4	321	181	0.56	38	1,421	4.4
Georgia	325	14,405	58.3	23,675	17,441	0.86	298	18,216	0.88
Louisiana	272	13,955	51.3	23,172	5,379	0.23	548	6,779	0.29
Mississippi	172	7,970	46.3	2,065	742	0.36	150	1,025	0.50
N. Carolina	601	32,152	53.3	2,079	750	0.36	---	2,488	1.20
S. Carolina	654	23,413	35.8	953	993	1.04	219	2,778	2.92
Tennessee	---	---	---	4	---	---	---	80	---
Texas	1,254	39,158	31.2	37,516	12,168	0.32	1,888	18,790	0.50
TOTAL	3,998	147,635	36.9	115,129	72,565	0.63	3,665	65,144	0.56

per premise (several treatments to eliminate rats in premises ratproofed)
* L and LF - labor and labor foremen

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Courtesy of the David J. Sencer CDC Museum