PROCEEDINGS AND PAPERS

OF THE

FIFTEENTH ANNUAL CONFERENCE

OF THE

CALIFORNIA MOSQUITO CONTROL ASSOCIATION

****

HELD AT AGRICULTURE HALL

UNIVERSITY OF CALIFORNIA

BERKELEY, CALIFORNIA

DECEMBER 13-14, 1946

Transcription by Margaret A. Prefontaine
Edited by Harold Farnsworth Gray

Richard F. Peters, Secretary-Treasurer
15 Shattuck Square
Berkeley 4, California

Note: On account of war conditions, the annual conferences in 1942 and 1943 were omitted. The Thirteenth Annual Conference was held February 28-29, 1944; the Fourteenth Annual Conference was held February 25-26, 1946.

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The Fifteenth Annual Meeting of the California Mosquito Control Association was called to order at 1:15 p.m., Friday, December 13, 1946, in Room 113, Agriculture Hall, University of California, Berkeley, California, by President E. Chester Robinson.

Mr. Robinson: The meeting of the 15th Annual Conference of the California Mosquito Control Association will now come to order. Mr. Peters wishes to make an announcement about the dinner tonight.

Mr. Peters: On the register is a column which is intended to furnish information as to those who expect to attend the dinner meeting at the Hotel Claremont at 7:30 tonight. Unless we have accurate information well in advance, the Association will have to pay for any deficiencies in estimated attendance.

Mr. Robinson: At this time greetings to the conference will be given by Professor Freeborn who has been associated with our work for a long time -- in fact he is so famous that they named a mosquito for him.

Dr. Freeborn: It is fifteen years that we have been holding these meetings, yet, as I look around, though it seems a short time to me, I know it is quite a while for there are some heads that have grown bald and some whose hair has grown white in the service. This makes me appreciate it really must have been fifteen years. We are particularly happy in the College of Agriculture to welcome you. As a matter of fact, when we call up at the booking office each year they say "Oh yes; the mosquito men" and take it as a matter of course that you are going to be here. Our relationship is indeed very cordial. I think it is particularly appropriate that you should come back here and renew your faith in research and mosquito lore at least once a year. It was forty years ago this year that the first experiment station publication on mosquitoes dealing with the problem of control in California was issued from this station. Dr. Quale published it. It was one of the very earliest in the nation. His bulletin was largely concerned with the work he did on the San Mateo Peninsula in response to requests for control of salt marsh mosquitoes. Due to the work he was able to do there, the advisability of mosquito control was so well shown that negotiations were started which led to the mosquito abatement act. Despite the efforts of those in the present audience who work in the valley and are largely interested in the disease carriers, the strongest force brought to bear on the Legislature came from the people whose life was made unbearable by the pest mosquitoes.

We are also very proud that not only did we contribute to this phase of the problem, but also that this institution furthered and sponsored the first anti-mosquito-anti-malaria control project in the United States, so far as we can discover. That was due to Professor Herms who started in the very early days and shortly after 1908-09. with the able help of a young

squirt by the name of Harold Gray, attempted malaria control in the foothill towns. I could go on down pointing out the interest the University of California has had. Malaria control in California promises to be of historical value only, but it seems that in all research we no sooner have one problem solved than another rears its head. Now it is encephalitis. We have been criticized at the Agricultural Experiment Station because they say we never finish any research. I am glad we don't. My reply is that I would be very much ashamed if we did. The minute you solve one problem you create at least half a dozen more that are urgent.

As we have gone on down through the years we have always had one, two, three or four and now we have a galaxy of those who have become mosquito experts. Some of them have been sort of dragged into it at first, but almost in spite of themselves there they were, and they became interested until now they have become mosquito experts. Now we old timers feel free to walk out and leave the ball with them. Without any further remarks, I welcome you sincerely. I bid you welcome and trust that your stay here will be of real value to you. If there are any other things we can do for you during your stay, make it known to any one of the staff who will be glad to help in any way they can.

Mr. Robinson: I might add that when we were planning for this conference I got in touch with Professor Freeborn and it was hard to crowd this program in but, through his assistance, we were able to get the room. We do appreciate it. For a while it looked as though we might have to meet on Saturday afternoon and all day Sunday.

At this time I would like to review a little history of mosquito abatement in California and what it means. Many of us have had to write speeches so they can be incorporated in the proceedings, and that is what I have done.

President's Message: "Members of the California Mosquito Control Association and guests:

"I wish to welcome all of you to this very instructive conference and hope when the occasion arises that you will participate. To the speakers who have traveled across the continent to be with us, we offer our sincere appreciation for your sacrifice, particularly in this holiday season.

"For all of us, it is well to renew the progress of mosquito control in California, as I think it is one of the outstanding accomplishments of this great state of ours.

"Mosquito abatement began in California at Burlingame in 1905, which was only a few years after the discovery that mosquitoes were the vectors of malaria. Professor Herms and Harold Gray performed the first malaria-mosquito control work in the United States at Penryn, California, in 1910. This

successful demonstration was followed by similar work at roville and Bakersfield in the same year. In 1912, Thomas H. Means of Los Molinos, California, was the first to do malaria-mosquito control work in an irrigation district in the United States.

"The first mosquito districts to be formed in California were the Three Cities District in San Mateo County, and the Marin County Mosquito Abatement District in 1915. These districts' primary purpose was the control of Aedes mosquitoes breeding in the salt marshes, which moved in on the residents in great swarms.

"Because of the success of these districts, in the next ten years, fifteen districts were formed. Most of them started out as small districts, abating specific species of mosquitoes. The next ten years, seven more districts were formed; these also were fairly small in area.

"In the ensuing ten year period, from 1931 to the present time, expansion of existing districts, and the formation of new ones, has been very rapid. Eleven have been added, making a total of thirty-six districts in all.

"We, in California, are all interested in these trends because they affect us individually and collectively. Let me now cite several examples of this. The Merced Mosquito Abatement District, formed in 1923, had 19 square miles, expanded in 1942 to 90 square miles, and in 1945 to a county-wide district with 1,995 square miles, and a total budget of $137,500.00.

"Dr. Morris Mosquito Abatement was formed in 1916, with 48 square miles under abatement. It now has 770 square miles, with a proposed annexation of 50 square miles, and a budget for the fiscal year 1946-47 of $139,917.00.

"The East Side Mosquito Abatement District was formed in 1939 with 33 square miles. By three separate annexations, it now has 250 square miles, and a yearly budget of $73,000.00

"At the present time in California there are 10,993 square miles in mosquito abatement districts. This is an area larger than the states of New Jersey and Delaware. This is a growth of 6,353 square miles in this past year. In addition, there is in the process of formation or annexation, 3,156 square miles. These districts will expend over $1,200,000.00 in the fiscal year 1946-47.

"This tremendous growth in mosquito abatement in California in the past year can partially be attributed to the peoples' realization of the potential hazards of infiltration of carriers of malaria and Japanese B encephalitis.

"The State Legislature, at a special session, appropriated $600,000.00 to assist the State Department of

Public Health in their studies of mosquitoes and mosquito-borne diseases. $400,000.00 of this money was allocated to assist mosquito abatement districts in their control work in malaria and encephalitis endemic areas.

"What does all this mean? It means, first, that we as organizations represented here, and as individuals, have a great responsibility to the two million residents of California living under mosquito abatement districts. They gladly pay in their share toward the support of these districts that they may live in a community free from the health hazards of mosquito-borne diseases, and enjoy their recreation and relaxation in sunny California without the annoyance of mosquitoes.

"Mosquito control must further expand to keep pace with the development of California. The completion in the next few years of the great Central Valleys' water project will put hundreds of thousand acres of land under irrigation, and irrigation means mosquitoes.

"With the scientific research now being carried on; with the new materials and equipment now available, and the promise of better ones to come, I am confident that we, as mosquito control personnel, will keep pace with, and assist in, the development of California."

Mr. Robinson: We will now have the report of our Secretary-Treasurer, Dick Peters.

Mr. Peters:

FINANCIAL STATEMENT

Amount on hand, date of assumption of Office (February 26, 1946): $535.01

INCOME

1946		
4-4	Contra Costa Co. #1 M.A.D.	$10.50
4-4	Tulare M.A.D.	14.00
5-16	Turlock M.A.D.	15.00
	8-Copies Proceedings	12.00
		$51.50

EXPENDITURES

1946		
4-1	Regents U. C. (Projector Rental)	$ 7.50
4-15	Gift, Prof. W. B. Herms, Emeritus	41.67
4-15	Comm. Printing, Modesto	13.33
5-27	Stamps	5.00
7-3	Tulare Daily Times (Mats)	56.33
7-3	Hatfield Stationery (Stencils)	12.30
7-18	Palmer Multigraphing	234.87
7-22	Stamps	15.00
7-29	Huebbe (Covering & Binding)	12.81
8-5	Stamps	15.00
10-1	Margaret A. Prefontaine	15.00
		$429.36

Amount on Hand ($535.01) Plus Income ($51.50)		$586.51
Expenditures	-	429.36
Amount on Hand, December 13, 1946		$157.15

We must consider another means of financing this Association, a better way of financing if all of the desired activities are to be paid for. In the latter period of discussion, tomorrow, this matter is expected to be gone into more thoroughly.

Mr. Robinson: We have on sale here the annual proceedings of last year's conference at a price of $1.50. I notice that some of our guests have come in recently and I want to call their attention to the register. Please be sure to register and also specify whether you will be at the dinner at the Hotel Claremont tonight. We hope you will be, but we must know in advance.

I will appoint a Nomination-Resolutions Committee to consist of:

Gray
Peters
Washburn
Raley
Henderson

We have another distinguished gentleman with us today who has done a lot for mosquito abatement work in California and who has been a great help to us in the State Legislature. I refer to Dr. Halverson, our State Director of Public Health. We appreciate his fine work and are glad to hear now a paper he has prepared for us.

Dr. Halverson: It is a real pleasure and honor for me to be here with you today. I want to express appreciation of the Director of the State Department of Public Health for all the work this Association has done in mosquito control and thereby helped so very materially to eliminate some real health hazards. I wish also to express appreciation to the University and particularly this department. The leadership they have given has extended its usefulness all over the world.

OUTLOOK FOR MOSQUITO CONTROL IN CALIFORNIA

By Wilton L. Halverson, M. D.
Director of Public Health

It is a pleasure to be here today and express the sincere appreciation that I and the State Department of Public Health have towards the activities of the Mosquito Control Association and all persons engaged in mosquito control in California. Our interest has been stimulated by war-time experiences and today we are more than ever impressed with the importance of arthropods as vectors of disease and recognize that the control of these arthropods is a science fundamental to the field of public health and preventive medicine. This

briefly is the key to our outlook for mosquito control in California.

We must recognize that we are all public servants serving the people of the State of California. Our public-health point of view limits our interest in mosquito control to those phases in which it relates to control of mosquito-borne diseases. Today in California there are two mosquito-borne diseases that occupy a place of importance; namely, malaria and virus encephalitis. However, other mosquito-borne diseases may appear in the future. Your responsibility on the other hand is one of not only protecting the health of the people within your district but also to provide them with physical relief from mosquitoes.

Before we can project our thoughts on the future outlook for mosquito control we must consider the program in which we are now so deeply engaged for it is a part of the immediate future. With service men returning from malarious areas around the world, deep concern was expressed by the state legislature in 1944 over the danger of violent new outbreaks of malaria, and Senate Concurrent Resolution #11 was passed requesting the State Department of Public Health to give a report on this hazard. Our report to the 1945 legislature entitled "Disease Bearing Mosquito Hazard in California" revealed that endemic virus encephalitis was as serious a threat to the people of California as malaria. During 1945 one localized outbreak of malaria occurred at Bryte in Yolo County that was quickly controlled. During the same period there were 290 cases and 48 deaths of human encephalitis.

In the Special legislative session this year the report on the State Mosquito-Borne Disease Hazard was reviewed with the realization that there was an immediate need for accelerated mosquito control measures to keep these diseases in check. Assembly Bill No. 28 was signed by the Governor in March 1946, providing $400,000.00 of state monies to be allocated on a matching basis to local mosquito control agencies in areas showing the presence of disease carried by mosquitoes, e.g., malaria or encephalitis. Its availability was to be contingent on the meeting of standards to be set by the State Department of Public Health to insure effective use of the funds. In addition $200,000.00 were provided for the use of the State Department of Public Health to administer the subvention program and make such studies and demonstrations as it considered essential to the successful development of the program. This fund was also to provide special training for supervisors and technical workers of local mosquito abatement districts, to provide a consultation and advisory service to local communities desiring to engage in mosquito control activities. Through this act our Department became intimately involved in the mosquito control problem throughout the state where previously it had maintained only an advisory service.

Let me assure you that this previous rather limited activity did not indicate any lack of interest on our part. It has been our plan for some time to establish a bureau for the

study and control of all vector borne diseases in California and the new legislation gave us that opportunity. To handle the field activities and subvention program we established within the "Division of Environmental Sanitation" a "Mosquito Control Section" providing for a staff of professionally trained entomologists and engineers to be classified as Mosquito Control Specialists, assisted by sanitarians and other field workers under the direction of a Senior Mosquito Control Specialist. It is our plan that this Section will become the professional nucleus of our proposed Bureau of Vector Control during the coming biennium.

To discharge sucessfully the responsibilities of Assembly Bill #23 vested in the Department of Public Health, an Advisory Committee of scientific experts and leaders in California was appointed to guide us. This Advisory Committee consists of:

Dr. Karl F. Meyer, Director, Hooper Foundation, University of California
Dr. W. McDowell Hammon, Hooper Foundation
Dr. William C. Reeves, Hooper Foundation
Dr. Stanley B. Freeborn, Ass't Dean, College of Agriculture, Unv. of California
Dr. William B. Herms, Professor Emeritus, University of California
Dr. Rudolph Harring, Professor of Veterinary Sciences, University of California
Dr. John J. Sippy, Health Officer, San Joaquin County Health Department
Mr. Harold F. Gray, Engineer, Alameda County Mosquito Abatement District
Mr. E. Chester Robinson, Superintendent, Eastside Mosquito Abatement District
Mr. Arthur F. Geib, Superintendent, Doctor Morris Mosquito Abatement District

In meetings with this committee our program was developed into two general phases:

I. Fundamental studies leading to a better knowledge of the diseases in question and the location of their endemic areas in the state.
II. Direct Control in the field by local agencies of the important mosquito vectors; this control to be partly financed by State subventions allocated through the Department of Public Health.

This plan has been energetically developed but I shall not discuss the details inasmuch as Mr. Stead in his paper "The Outlook for Mosquito-Borne Disease Control in California" at the Association's last meeting discussed our original planning for the program and papers later in this meeting will completely cover this year's activities and our proposed program for the coming biennium developed in conference with our advisory committee.

"What have been the accomplishments of our program to date?" you might ask. Briefly we can list some of them:

1. Employment of more professionally trained and experienced men.
2. Development of sounder mosquito control programs based on entomological inspection work and use of intense larvicidal operations, including DDT larvicides and residual sprays to supplement permanent type control.
3. Development of district administration and encouragement of monthly superintendents' meetings held for the districts' mutual benefit.
4. New, light and relatively inexpensive mobile equipment to replace the slower and heavier power sprayers formerly used, besides acceptance of the airplane as a tool to solve many of California's problems.
5. Finally, a great expansion has occurred in the area included in mosquito abatement districts.

A glance at the statistics reveals that:

(a) The total area in mosquito abatement districts before 1945 was 4,645 square miles.
(b) Annexations and new districts since 1945 cover 6,353 square miles.
(c) Total area included in mosquito abatement districts to date is 10,998 square miles.
(d) The area in mosquito abatement districts with subvention contracts is 6,881 square miles
(e) Potential annexations and new districts to be organized in the near future will be 2,756 square miles.

For your general information I would like to add that the total budgets for the twenty-four mosquito abatement districts with whom we have subvention contracts amount to $1,037,887.00 with subventions.

Yes, this is big business and a big responsibility to you and to us. We must look to the future now and see that all of our responsibilities, needs and deficiencies are satisfied equitably. I cannot discuss them all but shall cover those which I believe are of major importance.

1. First, our subvention and Complementary State Program; it has been the recommendation of our advisory committee that:

   (a) Subvention monies are essential through at least the next biennium to promote and develop adequate mosquito control programs in endemic areas in the State and that we

ask the legislature to continue them in the present amounts on a yearly basis. Allocations to be on a revolving basis with aid to established districts reduced each year to allow for assistance to new districts and districts annexing new territory.

(b) Our medical, biological, ecological and control studies must be intensified to give us more definite clues to effectively combat virus encephalitis. We are equipped with the basic malariology necessary to control malaria.

2. The relationship of the Mosquito Abatement District to the local Health Department has in the past been a very loose arrangement perhaps through lack of interest or understanding. I believe that this is a very valuable relationship that should be strengthened in order that your public health value be fully developed. Whenever, a case of malaria occurs in your district your responsibility is to prevent secondary cases. Perhaps other vector borne diseases are causing an epidemic. Your worth to the community can be demonstrated ten-fold by stepping into the gap and providing the service to control that new vector. Your authority to render this service is provided for under the powers of the Mosquito Abatement District Board of Trustees as listed in the Health and Safety Code.

3. The relation of the Department of Public Health to the Mosquito Abatement Districts is a voluntary one. We are committed only to administration of Assembly Bill #28 and to the control of any outbreak of mosquito-borne disease. Our actions, while voluntary, are in our minds an expression of our desire to guide the establishment of permanent and strong mosquito abatement districts or other control agencies in all areas of the State of California where mosquito-borne diseases are endemic or potentially so. We have accepted the responsibility to provide professional consultation service as requested from any locality.

The demand for mosquito control in California as evidenced by the growth in mosquito abatement districts is our mutual challenge. Let us accept it without reservation for only through a professional and sound program can we succeed.

Mr. Robinson: Thank you, Dr. Halverson. The members of this conference can see that in the Director of Public Health we have a friend and a good counselor.

Justin M. Andrews, Deputy Officer in Charge of the Communicable Disease Center, U. S. Public Health Service, at

Atlanta, Georgia, was scheduled to present the next paper. However, we have received word that his plane is grounded at Los Angeles by a very dense fog, and probably will not be able to leave until this afternoon.

We will therefore pass on to the next paper scheduled, which is by Professor Herms.

Prof. Herms: I really did think a year ago when you presented me with a beautiful smoking set (I should have brought it down to show you and to use) that my time was over so far as my active connection with this group was concerned. So I was really surprised when Dick Peters showed me the program on which my name appeared and, worse yet, that I was scheduled at the Hotel Claremont tonight as master of cermonies for the occasion.

Some References to Recent Literature and Sundry Notes of Interest to our Members

by

William B. Herms, Professor of Parasitology, Emeritus
University of California, Berkeley

The task of abstracting in useful form for presentation in a reasonable time, even a small percentage of the recent literature in the field of medical entomology, proved to be impractical this year for various reasons. During the years 1945 and 1946 the volume of papers relating to insects as disease vectors increased markedly mainly because of contributions made by numerous entomologists, parasitologists, and other scientists who had been associated with the medical department of either the Army or Navy during World War II. The magnitude of our problem is indicated in the fact that H. H. Stage, now President of the American Mosquito Control Association lists 345 references to literature of specific interest to mosquito control workers in two issues (March and June 1946) of Mosquito News practically all published in 1945. In this connection it is interesting to note that 46 (13 plus %) of the 345 publications contained the letters DDT in the title and many others refer to DDT in the text of the article. Obviously few, or more probably none, of us would have time to review all of these widely scattered references in order to acquire a knowledge of DDT and its uses. It may be pointed out here that all workers concerned with the use of DDT should have for ready reference a copy of Miscellaneous Publications No. 606, United States Dept. of Agriculture, entitled "DDT and other Insecticides and Repellents". This 71 page publication was developed for the Armed Forces and is dated August 1946 hence because of the date is not listed among the references shown in Stage's lists mentioned above. An indication of the value of the publication is set forth in the following headings of sections in the text, viz.:- chemistry of DDT, its preparation in solutions, emulsions, suspensions, dusts, etc; benzene hexachloride (666); chemistry of repellents and miticides; DDT larvacides; DDT as a residual deposit for adult mosquito control; airplane application; DDT for control of flies, bedbugs, fleas, cockroaches, lice, mites;

insect repellents; toxicity of DDT.

No doubt many members of this groups subscribe to "Mosquito News", the official organ of the American Mosquito Control Association. It is a quarterly journal containing many articles as well as reviews and abstracts valuable to mosquito control operators. References and bibliographies are included in all issues. The value of this publication may be better set forth by reading the table of contents and a few excerpts from the June 1946 number viz.: "Six generations of Culex pipiens without a blood meal" by Wray; "Observations on the Habits of Anopheles freeborni in Northern Utah and Southern Idano" by Rees; "Mosquito Surveys and Inspections in the District of Columbia Area" by Good; "A List of Mosquitoes of Pennsylvania with Notes on their Distribution and Abundance" by Wilson et al.; "Effectiveness of Insect Wire Screening" by Bacon; "Breeding Habits of Anopheles farauti in New Guinea" by Hart; "Malaria Control in the Dominican Republic" by Caldwell; "Notes on Malaria Control in Managua, Nicaragua" by Sterling; News; Notes; Editorial; Reviews and Bibliographies.

While referring to the American Mosquito Control Association it will be of interest to all of you to know that this Association is setting up the machinery for the establishment of Research Fellowships. President Stage comments viz.:

"It is believed that this Association might provide exceptional facilities for testing the merits of, and working out the "bugs" from material and equipment designed for use in its various fields of activity and responsibility. With funds provided by a "donor" with a product or a problem requiring investigation, a specially qualified scientist would be employed to work full time on that problem. Then choosing the most appropriate areas available, rigorously controlled and checked experiments would be worked out in collaboration with Association member executives of the Mosquito Control Commissions. Thus, first hand, preintroduction and prepublication information about new products in their special field would become available to the collaborating Commission. Also mosquito control work as a whole would benefit through avoidance of sometimes costly mistakes through acceptance at face value the premature high pressure marketing of an insufficiently tested product. The manufacturer would profit from avoidance of the loss which results when an expensive selling "build-up" flops because an unimproved product turns out to be unsatisfactory; or when a potentially good product is given an almost hopelessly bad name because of some defect that could easily have been discovered and correlated."

The same organization is getting out a Who's Who in Mosquito Control on an international basis.

During World War II the initials MCWA (Malaria Control in War Areas) became very familiar to most of the members of this Association. The United States Public Health Service on July 1, 1946 officially inagurated the Communicable Disease Center (CDC) which replaces MCWA. The scope and

organization of the Communicable Disease Center will be described for us by the deputy officer in charge. We are most happy to have Dr. Justin M. Andrews in attendance and look forward with much interest to what he has to report.

Early in June of this year an important conference (Pacific Science Conference) was held in Washington, D.C. to form an effective organization of American scientists interested in the Pacific area. This conference consisted of a number of divisions, one of which, that of Public Health and Medicine, set up disease categories indicating a continued concern with arthropod (insect and archnid) borne diseases. Two categories are of interest to this group: (1) Diseases of major importance in the Pacific Area, - the dysenteries, malaria, hepatitis, the dengue complex, tropical dermatoses; (2) Diseases of lesser but peculiar importance, - scrub typhus, schistosomiasis, filariasis, Japanese "B" encephalitis. Another category called for a study of possible deleterious effects of the widespread use of DDT.

Having a bearing on the above disease categories are some statistical reports in Tropical Medicine News for June 1946, namely the following disease incidence of insect borne diseases in the U.S. Army during World War II (January 1942 - August 1945 inclusive) based on hospital admissions: malaria 440,789 cases, dengue 82,392 cases, sand fly fever 12,228 cases, scrub typhus 6803 (estimated), filariasis 2110 cases.

Much of the information gained during the course of World War II concerning insect borne diseases and of course other diseases as well reached us in confidential or restricted form. Since the close of the war many papers by former military personnel have appeared in various journals such as the American Journal of Tropical Medicine, Journal of Parasitology, and many others. Just a few of these references may be cited to illustrate. A great deal of research was done on trombiculid mites (chigger mites) particularily with reference to scrub or mite borne typhus (tsutsugamushi disease). One of the more recent publications by Philip and Woodward entitled "Tsutsugamushi Disease (scrub or mite borne typhus) in the Philippine Islands during American Reoccupation in 1944-45. II. Observations on Trombiculid Mites" in the Journal of Parasitology, Vol. 32, No. 5. pp. 502-513 (Oct. 1946). This publication gives a key to known or possible Philippine trombiculid mites numbering five species of which four are known to attack man and two of these Trombicula akamushi and Trombicula deliensis are demonstrated vectors of scrub typhus. A brief account is given of anti mite measures during certain military operations. These consisted of (1) mite reduction by manipulation of the environment of the vector, e.g.use of flame throwers, clearing etc., and (2) personal protection by use of dimethyl pthallate impregnated clothing. These several control measures were discussed earlier in a paper by Kohls, Armbrust, Irons, and Philip in the American Journal of Hygiene Vol. 41, No. 2., pp. 374-396; Studies on Tsutsugamushi diseases (scrub

typhus, mite-borne tyohus) in New Guinea and adjacent islands and further observations on epidemiology and etiology".

During the War our malaria control units had much to do with Anopheles punctulatus in New Guinea, the Solomons and elsewhere. Some of us were called upon to distinguish between this species and A. moluccensis; and then further difficulties arose when A. koliensis and A. farauti came into the picture. There was much confusion. This confusion has now been cleared up by Rozeboom and Knight in an article entitled "The punctulatus complex of Anophelines" in the Journal of Parasitology, Vol. 32, No. 2., pp. 95-123 (April 1946). The conclusion has been reached that A. farauti and A. koliensis are distinct species as well as A. punctulatus, but moluccensis becomes a synonym of farauti.

Some of our number have had to learn how to dissect mosquitoes in order to obtain an oocyst or sporozoite index in malaria survey work. For those who are beginners in this field the article by Hunter, Weller and Jahnes entitled "An Outline for Teaching Mosquito Stomach and Salivary Gland Dissection" in the American Journal of Tropical Medicine, (Vol. 26, No. 2, March 1946) is strongly recommended.

Important medican entomological investigations in the Pacific Area were conducted by U.S. Naval Medical Research Unit No. 2., of which several of our own students were members. Several papers have already been published dealing with these investigations, among them: "Mosquitoes of Okinawa and Islands in the Central Pacific" by Richard M Bohart and Robert L. Ingram. This publication is Navmed 1055 (110 pages with 20 full page drawings) by the Bureau of Medicine and Surgery, Navy Department, Washington, D.C. The authors state that only three species of mosquitoes are known to occur in the Hawaiian Islands, a fourth species Megarhinus inornatus having predaceous larvae and non-biting adults was introduced but apparently not established. The three known species are: Aedes albopictus and efficient vector of dengue fever; Aedes aegypti, also an efficient vector of dengue fever; and Culex quinquefasciatus an important vector of nocturnal filariasis elsewhere. Eight species occur in the Samoan group of islands. Aedes pseudoscutellaris is a strong vector of both nocturnal (periodic) and non-periodic filariasis. Of 6634 specimens 655 (9.9%) were found to be naturally infested with filariae in the field, and 80% of females became infective (14 days filarial survival) after feeding on a case with infective microfilariae.

For the Marshall Islands four species are reported, and for the Carolines nine endemic species reflecting the geographic isolation of these islands. For the Mariana Islands twelve species of mosquitoes are known.

Thirty-three species of mosquitoes are reported for Okinawa which is seriously afflicted with mosquito borne diseases, namely malaria, filariasis, dengue fever and Jap "B" encephalitis.

There are excellent identification keys for the identification of the various species (adult and larvae) arranged according to island groups. The descriptions are excellent and adequate data on biology are included. There are twenty pages of taxonomic illustrations. All in all this is a very useful publication.

Another valuable publication is "A Synopsis of the Philippine Mosquitoes" by Richard M. Bohart also a U.S. Naval Medical Research Unit No. 12 contribution (Navmed 580); Bohart gives keys to the identification of the 142 known species of Philippine mosquitoes. There are 18 species and 11 subspecies of Anopheles, four of which are said to be important vectors of malaria, only one A. minimus flavirostris being highly important. There is included a list of references and over 90 figures.

"The Mosquitoes of Japan and their Medical Importance" is the title of Navmed 1095 by Tsai-Yu Hsiao and Richard M. Bohart. These authors give keys to the 44 species and subspecies of mosquitoes of the main Japanese Islands and the Bouin group. Part III deals with bionomics distribution and relation to disease. Part IV gives a brief account of mosquito borne diseases in Japan, viz.: filariasis, Japanese "B" encephalitis, malaria and dengue. Three cases of yellow fever (not indigenous to Japan) are referred to as having occurred in two Prefectures. Fifty-nine references are listed.

Those of us interested in the wider field of medical entomology will want to consult the supplement to the American Journal of Tropical Medicine for September 1946 (Vol. 26, No. 5) which deals with "Human trypanosomiasis and tsetse-flies in Liberia". This is a contribution from the Department of Tropical Medicine Harvard University Medical School. Part I, by Veatch, deals with the disease; Part II (pp.57-94) by Bequaert is entitled "Tsetse-flies in Liberia: distribution and ecology; possibilities of control?" Part III concerns treatment.

Bequaert in Part II states that "in view of the difficulties of controlling Glossina palpalis in Liberia by directly attacking either the adult or the puparium, ecological methods are most likely to yield results commensurate with the effort. Such methods aim at modifying the environment so as to make it unsuitable to the insect.....Selective clearing is the most practical way of altering the environment so as to render it unfit to the adult and the puparium".

The regular issue of the American Journal of Tropical Medicine for September 1946 (Vol. 26, No. 5) contains an article of considerable interest to mosquito control agencies. This article is by Elmendorf, Marucci, Griffin, Meyer and Ryan, entitled "Longevity of killing effect of DDT for mosquitoes contacting screen wire painted with DDT solutions (see pp. 663-685). The solutions of DDT in solvents, acetone, kerosene,

Diesel oil #2 and others, were made so that a given amount of the solution would represent various concentrations of DDT per square foot when daubed on the wire with a cotton swab. The following comments are of interest to all of us who engage in experimental work. "It is unavoidable that some tests present descepancies, (1) when the measuring rod is a living entity and mortality constitutes the final measure of results; (2) when physical difficulties prevent the uniform application of the killing agent to all portions of the test surfaces; (3) when meteorological conditions differ on different test days and over different test periods; (4) when weathered surfaces, though receiving the same general natural exposure, may be affected by individual factors causing loss of potency, such as a gust of wind, or rain, or a blow by an object blown by a wind."

This paper contains numerous tables and graphs which must be carefully studied to get full benefit of the investigation, however, a few conclusions may indicate some of the results: (1) Two hundred milligrams of DDT per square foot in solution on screen wire proved to be more effective for kill on short contact than 100 or 50 milligrams per square foot; (2) DDT in solution proved more potent in its killing effect as measured by short contact periods, than DDT in dry crystalline form; (3) different solvents differed in their capacity to retain killing effect of DDT on short contact; (4) screen wire treated with DDT was revitalized by application of a solvent; (5) a percentage of mosquitoes (Aedes aegypti used in all tests) exposed to four contact exposures of DDT in certain solvents was capable of biting man for a certain time after exposure. Thirty minutes after such exposure, the percentage of mosquitoes unable to bite was large, reaching 61.1%. Accordingly, it is reasonable to assume that aerosol sprays, containing DDT alone, should not be relied upon to kill infected anophelines, if the building is to be enterest immediately after such spraying; (6) kerosene and also Diesel oil #2 would appear to be less effective as practical solvents of DDT under most field conditions, than the other solvents tested."

The second of a series of papers entitled "Studies on Important Malarias: 2. Ability of California anophelines to transmit malarias of foreign origin and other considerations" in Journal of the National Malaria Society (Vol. IV, No. 4, pp. 307-329, Dec. 1945) is of particular interest to this conference. The conclusion was reached that A. m. freeborni, A. punctipennis, A. m. occidentalis, A. pseudopunctipennis fanciscanus all apeared to have about the same susceptibility. All developed sporozoites. On the basis of the evidence presented, it appears justified to conclude that control measures are necessary for the foreign malarias brought to the American west coast by relapsing carriers.

Odam and Somerford in Science Vol. 104, No. 2708 (22 Nov. 1946) report their researches on the "Comparative toxicity of DDT and four analogues to Goldfish, Gambusia and

Culex larvae". The large-scale use of DDT in natural areas makes it necessary to study the effects it and related compounds have on all forms of life if control measures are to be developed. Of beneficial groups, fish have already been shown to be very vulnerable to DDT in the laboratory. Under natural conditions mortality of fish has been observed where large amounts or repeated doses of DDT were used in the control of mosquito larvae". The authors found that Gambusia are much less resistant than goldfish under the conditions tested. The minimum lethal dose for goldfish was approximately 0.1 ppm, for Gambusia it was 0.01 ppm and for Culex larvae 0.001 ppm. Therefore, the goldfish were 1/100 and the gambusia 1/10 as susceptible as the mosquito larvae. Mosquito pupae were much more resistant than both the larvae and Gambusia. The presence of aquatic plants in the bowls reduced toxicity considerably so far as the fish were concerned. The plants themselves were unaffected.

Many of our members are acquainted with the contributions of Don Rees of the University of Utah. The October 1946 (Vol. XXII, No. 4, pp. 143-156) issue of the Pan Pacific Entomologist contains an article by Harmston and Rees entitled "Mosquito record from Idaho". This article gives a rather accurate index of the mosquito fauna of Idaho. Thirty-two species are listed, three anophelines, A. freeborni, A. occidentalis, and A. punctipennis."

The latest issue of the Journal of the Malaria Institute of India (June 1946) came to hand early this month (December). This number like those preceding it contains a number of articles of considerable interest to most mosquito control agencies. Among these articles are the following: "A net for catching Gambusia fish from nurseries, tanks, and well" by the Regional Malariologist, S. G. Masillamani. A small town in Madras Province, India contained 1500 wells into which Gambusia were introduced requiring large numbers of fish. The catching net is essentially a mosquito netting bag suspended from a two foot diameter circular frame. To the narrow lower part of the bag is attached a 4" x 6" metal container. The net is hung over a pulley attached to one end of a six foot pole. A three inch block wood is so suspended above the net that it will float when the net is submerged. To the underside of the block is tied some minced meat or earth worms to which the carnivorous Gambusia are attracted. When sufficient fish are attracted to the bait the net is lifted. Thus as many as 200 to 300 fish can be caught at one time within a few minutes.

A second article by the same author describes "A Paris Green Distributor".

A paper by Wu et al is appropriately entitled "A preliminary report on some laboratory and field experiments to determine the relative effectiveness of pyrethrum, DDT, and gammexane D919 as insecticides and larvicides". Cockroaches, house-flies, mosquitoes, bedbugs, head lice, and

sandflies were used in these tests.

Many of our service personnel in training for malaria-mosquito control operations did their culicid "teething" on King, Bradley and McNeel's "The mosquitoes of the Southeastern States, U.S. Dept. of Agriculture Misc. Publ. No. 336. Under date of May 1946 a brand new publication of great value "The mosquitoes of the Southern United States east of Oklahoma and Texas" by Carpenter, Middlekauff, and Chamberlain has appeared. This is a 292 page monograph "The American Midland Naturalist Monograph No. 3" published by the University Press, Notre Dame, Ind.

Recently off the press (W. B. Saunders Co. Philadephia 1946) under the auspices of the National Research Council is Russell, West and Manwell's "Practical Malariology". This 684 page volume is dedicated to the personnel of the special field Malaria Control Organizations of the Armed Forces of the United States in World War II. The dedication continues to read viz.: "through whose self-sacrificing and intelligent efforts the military hazards of malaria so serious in 1942 and 1943, were subdued." As pertains to anopheline mosquitoes, you will not find a better consideration of control measures (pp. 417-577) such as larvicides, drainage and filling, naturalistic methods, control of adult mosquitoes, community control, control of man (man made malaria) and finally malaria control under military conditions.

In professional mosquito control operations one cannot avoid needing a good knowledge of other arthropods, such as flies, fleas, gnats, spiders and hosts of others. The people whom you serve are everlastingly asking - What is this? Is it dangerous? Does it carry disease? What can be done about it? Except for books dealing exclusively with the field of medical entomology, there is no more valuable book to be had than "A Manual of Tropical Medicine" by Mackie, Hunter, and Worth, also prepared under the auspices of the National Research Council and published by W. B. Saunders Co. 1945. This work consists of 727 pages, 284 illustrations, six in color. Section X - pages 504-650 (156 pages) is particularly appropriate.

Finally at least one other new book deserves mention here, namely, "Insect Microbiology" by Edward A. Steinhaus of the University of California. This work is published by the Comstock Publishing Co. Ithaca, New York, and consists of 763 plus X pages, 250 illustrations and a formidable list of references (88 pages, about 1700 references). This book will answer nearly all of your questions concerning the diseases and parasites that afflict insects.

Mr. Robinson: Thank you very much for that very instructive discussion on a very little bit of the literature that has come out. I'm sure you all see why it is quite impossible to allow Professor Herms to retire. We need him too much and we want him active among us.

We are going to change our program slightly and will now have a film on the identification of Anopheles mosquitoes. Dr. Usinger will show these pictures.

FILM STRIP

"ANOPHELES IDENTIFICATION"

Mr. Robinson: I am now going to ask Mr. Gray to moderate the program for the rest of the morning.

Mr. Gray: I had expected that as you are probably going to to hear enough of me this evening I might be allowed just to listen, but apparently they have consoired against me.

I first wish to present some distinguished guests we have with us. Dr. Hackett, will you please rise? Dr. L. W. Hackett is with the Rockefeller Foundation for Medical Research, at present being stationed at Buenos Aires. He is one of our great authorities on malaria, and is the author of the book "Malaria in Europe", which is fascinating reading. I consider it one of the classics in public health and medical literature.

Another traveller from afar is our old friend Harry H. Stage of the Bureau of Entomology and Plant Quarantine in Washington, D.C. He is also this year President of the American Mosquito Control Association.

Another is also an old friend from the same Bureau, Mr. C. M. Gjullin, now stationed at Corvallis, Oregon. Accompanying him is Mr. A. W. Lindquist and Mr. Andy Roth from Corvallis.

I now take pleasure in introducing Dr. William McDowell Hammon of the G. W. Hooper Foundation for Medical Research, who is retiring as Dean of the School of Public Health here at the University. He is also a member of the Commission on Virus and Rickettsial Diseases. Army Epidemiological Board. He will speak to us on encephalitis.

RECENT DEVELOPMENTS IN STUDIES OF THE ARTHROPOD BORNE VIRUS

ENCEPHALITIDES

by

The Neurotropic Virus Unit of the George Williams Hooper Foundation for Medical Research of the Univ. of California

Paper read by W. McD. Hammon M.D.

Members and professional associates are: W. McD. Hammon M.D., Dr. P. H., Director; W. C. Reeves, Ph. D., Field Director; Bernard Brookman S. A. San. (R)., U.S.P.H.S.; D. P. Furman, Assoc. Entomologist, U.S.P.H.S.; H. E. McClure, Assoc. Biologist, U.S.P.H.S.; C. M. Herman, Ph. D. (California Division of Fish & Game, Dept. Natural Resources)

The startling and apparently most important fundamental findings in the epidemiology of the arthropod-borne virus encephalitides are no longer achievements of the immediate past. It was sixteen years ago that the first of these viruses was isolated; thirteen years have passed since the first experimental mosquito transmission was made; thirteen years ago the virus was first isolated from man; it is eight years since the development of an encephalitis vaccine; and now, five years have elapsed since the first virus was isolated from a mosquito. A war - one such as this world had never previously experienced - has come and gone since these findings were made. Strange as it may seem, it appeared wise to some of our civil and military leaders to encourage the continuance of research on the encephalitides in the face of a nearly total war. I will not attempt to justify or to criticize their judgment, but will spend a few minutes reviewing what has evolved in relation to the offensive and defensive developments of the War.

Certain of the viruses of the encephalitides were recognized as serious epidemic potentialities in areas that had important climatic and topographical advantages for the training of troops in this country. The Canadian Air Force suffered rather unexpected casualties from the Western equine virus in 1941, and it was recognized that more serious outbreaks could occur. Experimental St. Louis mouse brain vaccine was developed,[1] tested on animals and men for safety[2] - with not too assuring results - but held in readiness for any emergency which might arise. Chick embryo Western equine vaccine was prepared, and also held against contingencies. It was not found necessary to use any of the vaccines, for probably most important of all, intensive mosquito control was established in and about cantonement areas. Malaria, and in some areas dengue also, were prevented. These are unsung victories over death and hysteria which were prevented.

Thoughts turned early to the Japanese B encephalitis of the Orient. Japanese submarines, planes and balloons were off our shores or over our heads from time to time. "B.W." was whispered as a possibility. Where two viruses thrived, possibly a third, and more dangerous one, from the standpoint of case fatality rates, might also be brought into play! Furthermore, we were expected to carry the offensive into areas where this disease was endemic and

epidemic. Mosquitoes of California were tested for their vector ability and seven out of ten tested were found capable of transmitting it[3]. What then were the potential vertebrate hosts that could serve as sources of mosquito infection? This problem had to be explored and such exploration was made in the laboratory. In the absence of a natural endemic field area for Japanese B virus, it was appropriate to study further in the field endemic viruses which we had about us, for knowledge of one could possibly be applied to the other.[4-6] In fact, further progress was made confirming the bird-mosquito-bird cycle for our domestic viruses,[7-8] but birds did not lend themselves equally well to Japanese B virus infection.[9,6]

Experiments with DDT in the control of Culex mosquitoes were indicated and carried out with results which disclosed the fact that its effectiveness was not as miraculous for Culex as it was for anopheline control.[6]

Mouse brain vaccine for the Japanese virus was prepared on an experimental scale,[1] and then, as troops neared Okinawa, Formosa and Japan, it was produced in hundreds of thousands of doses.. But we feared to use it because sensitization by repeated inoculations of nervous tissue produced severe, fatal encephalomyelitis in laboratory animals and similar results had occurred occasionally in man when rabies vaccine (also of nerve tissue) had been used. Strenuous efforts were made to produce chick embryo vaccines, and finally small lots of apparently satisfactory material were made available.[10]

Meanwhile, small civilian outbreaks of Western equine and St. Louis virus still occurred in this country, and isolations of virus from naturally infected mosquitoes reached approximately 150 in number.[6] The St. Louis virus, long suspected in California, was finally isolated, first from mosquitoes,[4] then from man.[11] Three isolations of a new virus were made from California mosquitoes and prolonged studies indicated that it infected man and many other mammals, both large and small.[6] It was probably, however, principally an infection of rabbits and squirrels, as the other two viruses were principally infections of birds. Outside of this state, chicken mites were found infected with the St. Louis virus,[12] then the Western equine virus[13] and congenital transmission of the former was demonstrated.[14] It was exciting to realize that if this mite should be able to transmit the virus by its bite, it would fit into the hypothetical description of the much sought after true reservoir. Thus far, however, this vector ability has not been demonstrated, and our enthusiasm must be held in check.

Then in the summer of 1945, encephalitis struck in Okinawa. Both natives and American troops were affected. The disease manifestations were horrifying. Mental and motor disturbances in those who did not die continued for weeks and many thought they would be permanent. Horrible

deaths occurred, and a small wave of hysteria ensued. Japanese B virus was isolated from a fatal case, and the diagnosis confirmed by serological tests.[15,16,6] The experimental mouse brain vaccine was ordered to be given to most of the local Army and some Navy personnel. Over 60,000 Americans were vaccinated. In the inevitable confusion, under field hospital and semicombat conditions and in the presence of malaria, encephalitis, poliomyelitis and dengue-like conditions, any illness occurring was likely to be called post-vaccinal encephalitis in a vaccinated individual, and Japanese B encephalitis in a non-vaccinated one. In one field hospital after another, I saw many of these, and the picture was most confusing. Finally, after many consultants had carefully analyzed the clinical data, it was decided that the vaccine was probably harmless. Unfortunately vaccine was used too late to demonstrate its effectiveness in the control of the epidemic. Extensive mosquito control by ground and by air was practiced where possible, and both anophelines and culicines were greatly decreased in numbers. What mosquitoes Dr. Reeves and I were able to find on Okinawa were usually only in native houses or in caves, and these were almost entirely Culex quinquefasciatus. On the basis of obvious epidemiological reasoning, we did not feel they were involved. Culex tritaeniorhynchus and Culex bitaeniorhynchus were suspected, but were very difficult to find during this waning phase of the epidemic. None of the groups who were studying the epidemic succeeded in finding infected mosquitoes. However, experience was gained in performing and interpreting in vitro serological techniques.

During the winter, Colonel C. F. Sams of the Public Health and Welfare Section of SCAP in Tokyo had the vision to anticipate the necessity of control measures in Japan for the coming summer season, and requested consultants from the Surgeon General's Office. Dr. John R. Paul and I went first for two months for a preliminary survey, and to set up a virus laboratory. Later, Mr. Harold F. Gray, Dr. Albert B. Sabin and Dr. R. Walter Schlesinger went out for the summer. Widespread mosquito control measures without trained-personnel or adequate equipment were out of the question, but local control was attempted in some areas. Greatest reliance was placed in pre-seasonal vaccination (now considered relatively safe) for troops, dependents and civilian governmental personnel, and over 200,000 persons were vaccinated - apparently without harm. Again, however, the effectiveness of the vaccine could not be determined because the Japanese and other non-vaccinated groups did not suffer from an epidemic. The only cases occurring in Americans were in Korea, and these constituted a very small outbreak. From our study of records of previous epidemics in Japan, it appeared obvious that after the recognition of an epidemic, vaccination would be of little avail. Since outbreaks are so explosive in character, vaccination to be effective must be done prior to the epidemic season.

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Meanwhile, in California, field studies in Kern County were continued with emphasis on the potentialities of wild birds as hosts. Because no satisfactory direct observation would reveal the feeding habits of Culex tarsalis on wild birds, and in the absence of satisfactory species specific precipitin sera, and avian malaria survey was made with the hope that it might shed light on the problem. It did, and most convincingly! No malaria was detected in domestic fowl but extreme infection rates prevailed in certain of the wild birds, and very high rates in Culex tarsalis and Culex stigmatosoma. No infected mosquitoes of any other genus were encountered. Occasionally Culex quinquefasciatus had oocysts, but no salivary gland infection could be found. Thus we had evidence indicating heavy and repeated feeding of Culex tarsalis on wild birds. In addition, five lots of mites, principally Liponyssus silviarum collected from the nests of wild birds were found to be infected with Western equine virus. These undoubtedly had acquired their infection from a wild bird and could be considered as hypothetical reservoirs and vectors. The proof of this, we hope, may be demonstrated eventually, for the chicken mite, as well as for these wild bird mites.

Thus we find ourselves at the end of the first post-war year, still making progress on the problem, more internationally-minded about it, but still without any practical, economical or effective means of control. We still place confidence - here in the United States - on mosquito control as far as the human disease is concerned, but we shudder at the tremendous cost when the problem is considered in the light of the extent of the areas involved. Certainly further research will eventually simplify the control. Whether this will be by showing us a weaker link than the mosquito on which to focus our attack, or by the development of an inexpensive and effective species control method, I will not hazard a guess. I continue to maintain, however, that in California as long as the disease continues to manifest its usual endemic and unpredictable epidemic pattern, that insofar as man is concerned, mass control by vaccine can seldom be effectively employed and will not be a popular or rational procedure.

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Mr. Gray: I would like to ask Dr. Hammon one question. Although all phases of the insect transmission of virus encephalitis are not completely proven as yet, and protection by vaccination appears to be at present impracticable, do you still consider mosquito control to be a valid program for the prevention of virus encephalitis?

Dr. Hammon: Yes, I certainly do consider it a valid program here in the United States at the present time. It is the only hope.

Mr. Gray: The next paper will be an important one on a new method of control of Aedes mosquitoes. It will be presented by Mr. Gjullin.

PRE-HATCHING LARVICIDES FOR THE CONTROL OF MOSQUITOES

C. M. Gjullin and W. W. Yates

U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine, Corvallis, Oregon

Paper read by C. M. Gjullin

Below the Bonneville Dam for a distance of about a hundred miles the Columbia River is bordered by extensive willow and cottonwood areas. These low areas are flooded by the annual rise of the river and produce large numbers of Aedes vexans and A. lateralis larvae. The amount of land covered and the time that the flood crest is reached varies from year to year. In some years the rise is gradual, and in others it is rapid, or there may be several rises and recessions before the flood crest is reached. The highest stage usually comes in May or June, but earlier rises will often cause large numbers of larvae to hatch before this time. These variations in the flood stage cannot be forecast with certainty, and an effective pre-hatching treatment must, therefore, be of such a nature that it can be applied several days or weeks before the land is flooded. It must withstand considerable rainfall and weathering and still be lethal to emerging larvae.

A few pre-hatching larvicide tests were made against Aedes vexans and A. lateralis in the Columbia River breeding areas in 1944 and 1945 with 5% DDT in diesel oil. In 1946 more extensive tests were made using both DDT oil solutions and Xylene emulsions. The emulsions were prepared

by diluting a stock emulsion containing 25% DDT, 68% xylene, and 7% Triton-X-100 (an aralkyl polyether alcohol) with 7 parts of water. The sprays were applied to the ground where the eggs were laid with either a hand-compressed air sprayer or a knapsack sprayer. Most of the areas treated were covered with low brush or grass, or dead vegetation, and in some places there was considerable ground litter of stumps, logs, and dead branches.

In tests made in 1944 diesel oil containing 5% DDT was applied at the rate of 0.1 to 0.2 pounds of DDT per acre. These test plots were flooded 18 days after the DDT was applied. There was no apparent mortality at 0.1 pound per acre. At 0.2 pounds per acre some of the larvae appeared to be affected, but there was very little mortality.

In 1945 tests were made with from 0.5 to 2 pounds per acre, but 6 days after the DDT was applied the areas were flooded very rapidly and both treated and untreated areas were covered before a check could be made on the effect of these applications.

In 1946 8 tests with oil solutions and 2 tests with xylene emulsions were made. The oil solutions were applied at the rate of from 1 to 3 pounds of DDT per acre. One test area where 2 pounds per acre was applied was not flooded until 54 days later. This treatment was 100% effective, and all the larvae were destroyed. In another test in which an area treated with 1 pound DDT per acre was flooded 51 days later 100% control was also obtained. The other applications made in this series of tests were flooded from 2 to 49 days after they were applied, and all were 100% effective.

One of the xylene emulsion applications, which was made at the rate of 3 pounds per acre, was flooded 40 days after it was applied and gave 100% control. The other xylene emulsion application was made at the rate of 2 pounds per acre. It was flooded 2 days after this application and was also completely effective.

Newly hatched larvae could be found in all of these treated areas from a few hours to 24 hours after they were flooded, but no live ones were found 48 and 72 hours after flooding.

Mr. Gray: Thank you very much, Mr. Gjullin.

I gather that approximately two pounds applied is really effective. Is that correct?

Mr. Gjullin: Yes. In one case we found one pound was very effective in oil solution. We had longer tests on oil than on xylene. The species, by the way, were Aedes vexans and Aedes lateralis.

Mr. Gray: Any questions? If this method is confirmed as to its effectiveness by the experience of others, it is going to be a very valuable procedure against both flood water and salt marsh Aedes species.

Mr. Robinson: Were any of the treated areas re-flooded?

Mr. Gjullin: None as yet.

Mr. Gray: That will be a very good test of the method, to re-flood several times. We all know that several floodings are necessary to hatch all viable eggs on a salt marsh. May we now hear from Dr. Metcalf from the Experiment Station at Riverside, who has a paper on airplane aerosols?

THE USE OF AIRPLANE DISTRIBUTED THERMAL AEROSOLS FOR THE CONTROL OF ANOPHELINE MOSQUITOES

(The data presented in this paper were obtained in experiments conducted while the author was a member of the staff of the Health and Safety Department, Tennessee Valley Authority.)

Robert L. Metcalf, University of California
Citrus Experiment Station, Riverside

INTRODUCTION

The airplane exhaust generator was developed as a result of a search for equipment for the distribution of DDT for mosquito control which would be simple, inexpensive, capable of covering large areas, and highly efficient without causing undue hazard to "wildlife." As perfected after several years experimentation, the equipment has proven exceptionally successful and has the following advantages: (a) it provides a relatively uniform coverage of insecticide over wide swath widths at exceedingly low rates of discharge, (b) the particle size of insecticide generated can be varied to meet field requirements, (c) by using finely divided aerosol particles, penetration of heavy vegetation can be secured where larger droplets are screened out, (d) the minimal dosages applied effectively control mosquitoes, but offer no appreciable hazard to "wildlife," (e) comparative cost records indicate that the expense of this operation is only one-third that of paris green dusting by airplane, and (f) the cost of equipping an aircraft for thermal aerosol production is much less than the cost of installation of dusting equipment.

Basic information on the design, performance, and use of this equipment has already appeared[1,2], and it is the purpose of this paper to summarize the present status of the method.

EQUIPMENT

The only departure of the exhaust generator from the basic principles of liquid atomization by gas streams is in the utilization of the hot exhaust gases of the aircraft engine (about 1000 degrees F.) for the energy source. This high temperature aids in the breakup of the liquid by decreasing the viscosity and surface tension and by greatly increasing the velocity at which the gases can be forced through an orifice.

When an oil solution is injected into the exhaust gas stream of an aircraft engine, the oil is largely atomized. The drop spectrum resulting is determined by the controllable factors of (1) volume and velocity of exhaust gases, and (2) the rate of liquid injection and the physical properties of the liquid used. It has been shown[2] that a linear relationship exists between these factors so that the conditions required to produce any desired mass median diameter of discharge can be calculated. In actual practice, the mass median diameter can be varied from 200 to 20 microns by varying the engine r.p.m., the rate of liquid injection or the cross sectional area of the exhaust stack at the point of liquid injection.

Exhaust generators have been successfully used on engines ranging from 60 to 2000 h.p. and capable of dispersing from 1 quart to 25 gallons of insecticide per minute. In simplest form the equipment consists of an elongated exhaust pipe ending in a venturi constriction into which the insecticide is fed by gravity feed plus venturi-vacuum. The venturi is the only critical portion of the equipment, and should be carefully designed to prevent undue backpressure on the engine[2].

In larger units, the use of a wind driven or electric pump to supply the liquid under constant pressure through simple nozzles in the venturi throat has proven highly desirable in order to prevent irregularities in treatment and to simplify calibration of discharge. Gas velocities ranging from 600 to 1400 feet per second in the venturi thoat will provide for optimum atomization while the rate of liquid feed is determined by the desired rate of insecticide application, cruising speed of the aircraft and the effective swath width obtained.

Among the various types of aircraft and engines which have been successfully operated with thermal generators for mosquito control are Piper Cub and Taylor Craft, 60 h.p.; Stearman PT-17, 220 h.p.; Stearman 4-DX, 450 h.p.; Vultee BT-13, 450 h.p.; Douglas C-47, 850 h.p.; Grumman TBM, 1750 h.p.; and Curtis SB2C, 2000 h.p.

INSECTICIDE FORMULATION

The use of the exhaust generator necessitated an insecticide formulation which would possess the following

features: (1) high concentration of active material to increase payload, (2) low volatility of solvent to prevent excessive evaporation in the hot exhaust gas stream, and to increase the safety factor, and (3) non-corrosive and non-poisonous chemical properties. The only commercial solvents appearing to meet all these considerations and which were readily available at low cost were the polymethylnaphthalenes. A fraction "Velsicol NR-70" was selected as being a highly standardized material which would maintain a stable solution of 30 to 35 percent DDT by weight and had a boiling point of 500 to 700 degrees F. and a flash point of 175 degrees F. A 20 percent solution by weight of DDT in this material was used as the standard insecticide.

In the operation of the generator, some screening smoke is formed by the evaporation of the solvent. This smoke which comprises about one-fourth of the solvent provides a very useful marker for the pilot. As a result of this evaporation, the aerosol droplets contain approximately 25 percent DDT as compared with the original 20 percent in the starting material.

BIOLOGICAL APPLICATIONS

Most of the discussion of the use of aircraft-dispersed, atomized liquids in the control of adult and larval mosquitoes has centered around the question of the optimum particle size of discharge. This question depends on a number of factors which will be discussed below. It should be emphasized that the data presented were obtained with reference to conditions on impounded waters and represents the most satisfactory solution to mosquito control problems in this type of breeding area.

Optimum sized particle to kill individual mosquitoes--The most satisfactory answer to this question can be obtained from a consideration of the lethal dose per insect. The best available data is summarized in the following table:

Toxicity of DDT to Individual Mosquitoes

	LD_{90} In mg./kg.	LD_{90} Per individual	LD_{90} As 20% DDT droplet
Aedes aegypti[3] adult	16 mg.	0.05 micro-grams	75 microns dia.
Anopheles quadri-maculatus[2] larva	10 mg.	0.025 micro-grams	60 microns dia.

David[4] suggests that the most efficient insecticidal particle size for flying insects is that in which every drop contains the minimum lethal dose. This is certainly true in the case of larvicidal applications where the settling out of the droplets is not a factor in removing the insecticide from the environment of the insect. In any event, this data would indicate that the upper limit of optimum droplet size is in the region of 75 microns diameter.

Settling rates of thermal aerosols--The settling rates of aerosol particles in still air is proportional to the square of the particle radius, according to Stokes' law which is applicable to spherical particles of less than 200 microns diameter. However, a pronounced downdraft exists in the wake of an aircraft which imparts settling velocities to aerosol particles, which are greatly in excess of the velocities indicated by Stokes' law. For example, a 50 micron droplet of 20 percent DDT solution will settle in still air at about 17 feet per minute, while in the wake of the Stearman 4-DX airplane is a downdraft of 600 feet per minute. This factor is of the greatest importance in the deposition of fine aerosol droplets.

Relationship of particle size to uniformity of treatment--In early experiments with aircraft sprays at low altitudes, it became apparent that coarse sprays were deposited in very narrow swaths directly under the aircraft. This resulted in gross overtreatment of the center of the swath, and in a very narrow effective swath width. Greater swath spread could be obtained by flying at altitudes of several hundred feet and utilizing wind drift, but this type of application is very wasteful of material, and is not suited to the treatment of sharply defined breeding areas. A plot of the behavior of various drop sizes in the swath cross section revealed the following information:

Relation of Droplet Size to Swath Width

Droplet Diameter	Percent recovery in center 20 ft. of swath	Total effective swath width
100-200 microns	95%	40 ft.
75-100 microns	60%	80 ft.
50-75 microns	40%	120 ft.
25-50 microns	30%	200ft.

Thus under these conditions the 25 to 50 micron droplet range provides the most uniform swath coverage without undue peaking and overtreatment in the center.

A detailed analysis of the swath characteristics of an aerosol with a mass median diameter of 35 microns, released at 0.1 pound of DDT per acre, has shown a total recovery of 9 percent of the discharge in a 200 foot swath. Approximately 0.01 pounds per acre of DDT was recovered in the central 20 feet of swath, and about 0.001 pounds per acre of DDT were recovered at points 100 feet on eith side of the flight line.

The utliization of smaller particles also favors uniformity of treatment because of the much larger number of particles which can be produced from a given weight of larvicide. At the minimum lethal dosage of 0.0001 pounds DDT per acre, the following numbers of droplets of 20 percent DDT solution are formed:

Droplet Diameter	No. of droplets per square foot at 0.0001 pounds DDT per acre
5	67,000
25	530
50	67
100	8

Aerosol penetration of plant cover--Repeated experiments involving the penetration of the aerosol through all types of plant cover from dense tropical jungle to rice fields, have shown that droplets over 50 microns in diameter penetrate very poorly through plant foliage. This is shown very graphically by the following data:

Penetration of Aerosols through Plant Cover

Rate of discharge 0.1 pounds DDT per acre

Cover	Recovery of aerosol in pounds per acre	Mass median diameter of recovery in microns
low	0.0057	60
medium	0.0014	40
high	0.0005	25

Experimental results under field conditions--The results secured in larvicidal tests of the application of thermal aerosols to a variety of anopheline breeding areas indicate that the distribution of 0.05 to 0.1 pounds of DDT per acre in this form has repeatedly given 98 to 100 percent larval control. Carefully conducted experiements have shown that the recovery of 0.0001 pounds of DDT per acre of water surface, as aerosol droplets, is adequate to give 90 percent or better anopheline larval control. The following table is offered as a practical guide to field treatment:

Width of 90% larval kill obtained at a treatment

Rate of 0.1 pounds of DDT per acre as a thermal aerosol

Swath treatment	Light cover	Medium cover	Heavy cover
single	200 ft.	120 ft.	60 ft.
200 ft. intervals	410 ft.	240 ft.	120 ft.
100 ft. intervals	300 ft.	225 ft.	160 ft.
50 ft. intervals	250 ft.	170 ft.	110 ft.

Aerosol treatments of large areas harboring adult anophelines have shown considerable promise in mosquito control operations. The distribution of 0.25 to 0.5 pounds of DDT thermal aerosol per acre has consistently resulted in 90 to 100 percent reduction in the adult mosquito population as determined by biting records and adult counts in diurnal shelters. It should be emphasized that satisfactory results with minimum dosages can be secured only under the proper meteorological conditions of still air existing at dawn and dusk, when breezes are at a minimum and "inversion" conditions exist. Under these conditions, aerosol droplets will remain visible in wooded areas for thirty to sixty minutes and adult mosquitoes are exposed to a maximum dosage of insecticide.

Results of extended field applications--As a result of the above studies of aerosols of varying particle size composition, it was concluded that a mass median diameter of 25 to 50 microns was most suitable for the control of Anopheles quadrimaculatus on impounded waters. Such an aerosol produced the most uniform coverage over a wide swath width, was most effective in penetrating vegetation, possessed maximum larvicidal and adulticidal effectiveness, and resulted in no harmful wildlife toxicity. Therefore, during the summer of 1945, extensive field tests were carried out on reservoirs of the Tennessee Valley Authority[5]. These tests indicated that the weekly treatment of 2,300 acres at 0.1 pounds per acre resulted in 90 percent or better larval

control as compared with 70 percent for comparable paris green treatments. Check records of adult catching stations indicated that the adult mosquito population was reduced about two-thirds over the comparable paris green treatment. In addition to the improved control obtained, records showed that the total cost of the DDT-aerosol treatment was only one-third that of the paris green dusting.

Comparative Cost of Paris Green Dusting and DDT-Aerosol Applied by Airplane[5]

	20% paris green dust	20% DDT solution
Application rate lbs. per acre	2 lbs. paris green	0.1 lbs. DDT
Acres covered by 1000 lb load	100	2000
Cost per acre:		
Materials	0.50	0.09
Plane service, flying time, loading, and inspections	0.29	0.17
Total cost per acre	$ 0.79	$ 0.26

Wildlife toxicity of aerosol application--Comprehensive studies have been made of the effects to "wildlife" of the standard 20 percent DDT-30 percent "Velsicol NR-70" aerosol applied at 0.1 lbs. DDT per acre by Hess at Wilson Dam, Alabama[5]. Sixteen weekly applications over the entire mosquito breeding season resulted in almost complete elimination of anopheline mosquitoes and surface Hemiptera, and a considerable reduction of culicine mosquitoes. There was no evidence of a reduction of other aquatic forms. A determination of the fish population after the above series of treatments indicated that no injurious effects had occurred.

SUMMARY

The engineering and biological factors involved in the development and use of airplane distributed DDT thermal aerosols for anopheline mosquito control have been briefly discussed. The results indicate that aerosols with mass median diameters ranging from 25 to 50 microns are best suited for the control of anopheline mosquitoes on impounded waters. The employment of such DDT aerosols in routine anopheline larvicidal operations has resulted in the reduction of larviciding costs to one-third those of comparable paris green dusting operations, and the degree of larval control has been greatly improved. No damage to "wildlife" has resulted from the DDT aerosoling operations.

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Mr. Gray: Are there any questions?

Mr. Dahl: Do heights make much difference in a flying program?

Dr. Metcalf: Of course you will get a wider spread if you fly higher. A good deal of our flying has been at about 20 feet. One flooded area of 2000 acres, with water under a heavy growth of trees, was flown at about 100 to 120 feet high.

Mr. Bohart: Did you conduct any experiments in relation to wind drift, or did you confine your operations to the early morning hours?

Dr. Metcalf: Usually we flew about eight o'clock in the morning. We flew on eighteen successive mornings. A few experiments were conducted with wing spraying equipment and we found this much better for high wind conditions. Our pilots became quite skillful in judging wind drift. Usually we were able to fly with and against the wind, rather than cross wind.

Dr. Usinger: I would like to ask how many fish were killed during your tests?

Dr. Metcalf: Our experiments were carried on for fifteen successive weeks. The area was carefully surveyed and stocked with fish to begin with. There were no injurious effects to the fish.

Mr. Gray: Why do you establish 90% kill as a basis instead of 100%?

Dr. Metcalf: We thought it more practical. We have never been able to attain 100% yet. It runs from about 60% to 90% though actually in most cases it was nearly 100%.

Mr. Gray: In this particular case you were dealing with Anopheles and with malaria. If you get 90% Anopheles kill you are going to control the malaria situation satisfactorily. A number of us are dealing with pest mosquitoes primarily and here it is the 10% we fail to get that causes the tax payer to howl. Did you make any comparative studies on the kill of culicine mosquitoes?

Dr. Metcalf: No, not in a very through way. There are not many pest mosquitoes where we were working.

A Guest: I am concerned with Lake County and would like to ask if this method is applicable to the gnat problem.

Dr. Usinger: You would have to spread it over the whole lake. If you could spread it long enough to get the gnats it would be fine but what about fish then?

Mr. Lindquist: In regard to this question, I believe no experimental work has been done on gnats but I had a chance in Florida to run a few larvicidal tests on species very closely related. We used one part DDT to 75 million parts of water and this was effective. One part DDT to 300 million parts of water gave 95% mortality. On Clear Lake gnat larvae I can only guess.

Mr. Gray: Have you tried it on any of the other groups of gnats?

Mr. Lindquist: I am not familiar with any particular work on them but I think there is something in the literature about blood worms.

Mr. Gray: Several years ago the Clear Lake people tried to get the federal government to do the job of eradicating the Clear Lake gnat for them, but after investigation it was decided that this was a local problem and it would have to be solved by the local people themselves.

We will now have a paper on DDT presented by Professor Douglas of the University, from the Davis campus.

DDT: Toxicity and Tolerances

by James R. Douglas

Assistant Professor of Parasitology

University of California, Davis

The history of the development of DDT may be compared with the swing of a pendulum. When the effectiveness of this insecticide first became known, largely as a result of its use by the armed forces, there appeared a plague of enthsiastic articles of a popular nature, which spread the belief that at last we had a panacea which will eliminate our insect problems. DDT was considered to be essentially non-toxic to mammals and safe to use under practically any circumstances. Following this period of popular acclaim a few reports appeared which suggested that DDT was not all it was thought to be; against some pests it was ineffective, and, what was worse, when it was fed to mammals it could be stored in the body and even transferred in the milk to suckling young. If the dose was large enough the animals developed uncontrolled tremors and died in a convulsive siezure. These reports when publicized, led to the belief that DDT was not safe for use except in certain cases. Now we are approaching a midway point where the problem can be viewed objectively and the role of DDT in our economy may be properly evaluated.

Almost from the beginning the toxicity of DDT to mammals has been quite intensively studied, however, much of the early work was concerned with determining the acute toxicity of this insecticide while the effect of subacute or chronic poisoning was largely neglected. Although there are rather wide individual variations is susceptibility within a given species, the median lethal dose (dose required to kill 50%) of DDT in vegetable oil for a number of animals is about as follows:

Mice, rats, cats and dogs = 150 - 300 mg/kg
Guinea pigs and rabbits = 300 - 500 mg/kg
Cows and horses = over 300 mg/kg
Sheep and goats = appx. 1000 mg/kg
Chickens = over 1300 mg/kg

From these figures we can see that approximately seven tenths of a gram of DDT would constitute the median lethal dose for dogs weighing ten pounds while the equivalent dose for hundred pound sheep would be about 45 grams (1.6 ounces) and for thousand pound cows or horses about 136 grams (4.8 ounces).

Like most other toxic compounds, the acute toxicity of DDT is markedly influenced by the route of absorption; acute manifestations will be produced by relatively smaller doses absorbed cutaneously than by the gastric route.

The rate of absorption by any route is, of course, largely dependant upon the form of the material; if the DDT is in the solid phase, cutaneous absorption is negligible. The absorption of solid DDT via the gasto-intestinal tract is rather capricious, depending to some extent upon the diet, whether it be high or low in lipoids which, as solvents, aid absorption. In general, a rather high proportion of the solid DDT ingested is passed unaltered out of the body in the feces. As one would expect, DDT is much more readily absorbed when it is in solution. Here too considerable variation is encountered depending upon the nature of the solvent. The inherent toxicity of the solvent is another factor which is often overlooked, not infrequently toxic effects have been ascribed to DDT preparations in which the solvent itself is known to have equal or even greater toxicity.

It appears then that DDT, when used as recommended, with reasonable care in handling, presents no serious hazard of acute intoxication. Unfortunately, the problem does not end with a dismissal of acute intoxications.

It has been known for some time that when DDT is absorbed by the body some of it is stored in the tissues and is not promptly and completely eliminated. Following the administration of subacute doses DDT may be detected in varying amounts in most of the tissues of the body, the amount in a given tissue being proportional to the size of the dose and the amount of lipoid material present. As would be expected, the highest concentration of DDT is reached in the body fat and in the milk fat of lactating animals, much lower concentrations are encountered in the muscle, liver, spleen, blood, etc. It appears that there is a definite relationship between the level of DDT ingested and the level of accumulation in the tissues. At a constant level of ingestion DDT apparently builds up to a maximum in the tissues and there-after a balance is maintained between the rate of ingestion and the rate at which the DDT in the tissues is metabolized and excreted. DDT then, is not a truly cumulative poison, its effect is not cumulative, an animal may store in its tissues a much greater amount than would normally constitute a toxic dose. When the ingestion of DDT ceases, if an adequate nutritional level is maintained, it is gradually metabolized and excreted over a period of several weeks. If large amounts of DDT have been accumulated in the tissues it is possible by placing the animal under starvation conditions to cause a rapid mobilization of the fat reserves and induce typical symptoms of DDT intoxication.

Since it appears that there is a rather definite relationship between the level of DDT ingestion and the level of accumulation in tissues, it follows that there will be a point in the lower range at which no accumulation will occur. Unfortunately there is very little experimental evidence on this phase of the problem. Dr. John H. Draize of the Food

and Drug Administration in an unpublished report has stated that in the rat the highest level at which no storage in fat occurred was 0.4 mg/kg/ day and was slightly higher for the dog and monkey.

For the purpose of this discussion, if we take 0.4 mg/kg/day as a maximum, a 1000 pound animal could ingest 180 mg DDT per day without significant accumulation in the fat. This means that with a total daily intake of thirty pounds of feed, the diet could contain about 13 ppm. Whether or not this would hold true for mammals other than the rat is impossible to predict on the basis of available information. However, it seems quite certain that for each domesticated animal a safe maximum level of DDT ingestion can be determined.

Now let us consider the problem of DDT "tolerances". Many people are apparently of the opinion that there is a general tolerance of DDT on food of 7 ppm. This is an erroneous and possibly dangerous conception. The facts are these: The Food and Drug Administration has established an informal tolerance of 7 ppm of DDT only on apples and pears because DDT is less toxic than the insecticides (lead arsenate and cryolite) commonly used on these crops. The Federal Food, Drug and Cosmetic Act holds that a food is adulterated if it contains any added poisonous or deleterious substance not required in the production of the food. As a reflection of the official attitude of the Food and Drug Administration on this problem, the following excerpt is quoted from a letter written by the Associate Commissioner of Food and Drugs, C. W. Crawford:

"Certainly we cannot say in advance, at this early stage of a difficult and many sided regulatory problem, what regulatory action the facts may justify or what quantities of this poison in milk, meat, eggs, etc. will be proceeded against. It is our purpose, however, to take prompt and vigorous action under any part of the Federal Food, Drug and Cosmetic Act which seems applicable whenever it is evident that there is any potential threat to human health from this quarter. We do not contemplate the issuance of any "tolerance", formal or informal, for DDT in such important foods for the young as milk, eggs, and meat.

It is perhaps relevant to point out that the Food, Drug and Cosmetic Act covers animal food as well as human food, and for both classes holds that any added poison whatever, which is not necessary or which can be avoided, renders such food adulterated under the Act."

In view of this attitude I think you will agree with me that, as public officials, you should employ or recommend DDT only where there is no possibility of appreciable contamination of food, either human or animal food. This should not be considered as a blanket condemnation of DDT in mosquito control operations. In the quantities ordinarily

employed in these operations there appears to be a very slight chance of serious contamination.

I think there is little doubt that official recommendations for the use of DDT on human and animal foods will be made in the future, but these must wait until we have more information. We are urgently in need of answers to these questions: 1) What is the maximum DDT intake for a particular animal at which no accumulation in the body will take place? 2) How rapidly is DDT eliminated from the body at various levels of accumulation? 3) What is the rate of weathering of DDT on various crops and under various conditions?

In the early phases of this problem we were handicapped by the lack of suitable analytical methods, particularly for the determination of DDT in animal tissues. At the present time progress is being slowed by a lack of adequate analytical facilities. The analysis of DDT requires a skilled and experienced chemist. There is no laboratory in California equipped or staffed to handle these routine analyses. However, I am confident these obstacles will be overcome and we will eventually find the answers to our questions.

Mr. Gray: Thank you very much. Are there any questions?

Mr. Stoltz: Is there any possibility of using less than ½% solution without damage to cattle or without a fall off in the milk production? This situation came up where I was this summer.

Dr. Douglas: I would say there is very little danger from DDT itself but there might be danger from the solvent.

Dr. Lee: We sprayed 5% on pasture land and the cows ate the grass. Is that dangerous to the cow or to those drinking the milk?

Dr. Douglas: It is not so much a question of danger as it is a matter of adulteration of food under federal regulations. If you spray a pasture with DDT and then put milk cows on it shortly thereafter, the butter fat will inevitably contain DDT. For example, if the whole milk contains only four parts per million of DDT, the butter fat will contain about 100 parts per million. While I see no reason to believe that this will harm any animal or person, it is still adulterated under the Food and Drug Act and liable to confiscation.

Dr. Lee: I do not know about that. But in Oregon we have quite a mosquito problem, and some of the dairymen have reported a severe drop in milk production, over 30% for example during periods when mosquitoes were numerous, and immediate relief following our use of DDT sprays.

Dr. Douglas: There is also the problem of pears and apples. It is not recommended that DDT be used on any edible portions of a crop for human or animal consumption.

A Guest: It works very well against alfalfa butterfly but the law won't let us use it.

Mr. Robinson: Have you done any work on the matter of the time which elapses for the sun to cause DDT to deteriorate?

Dr. Douglas: No, we haven't ourselves but there has been quite a bit of work on that.

Mr. Dahl: I think we should straighten out this matter of the percentages of DDT solutions used, in relation to possible toxic effects. The percentage of DDT in solution is not the important think. It is the actual amount of DDT applied per acre which counts, in terms of pounds of dry DDT applied. Keep that in mind. We have been using around 1/10 to 2/10 pounds of DDT per acre. That is the rate of application which counts, not a 5% or a 20% solution.

Mr. Thompson: You mentioned certain findings of DDT in tissues after slaughter. Were there any apparent pathological changes?

Dr. Douglas: Pathologically, no. Possibly the time period was too short and the DDT level too low to produce marked tissue changes. Even in cases of severe DDT poisoning there is little apparent change in nerve tissue.

Mr. Bendel: In spraying alfalfa, I had the men spray the water before the alfalfa grows. Would that be absorbed by the cattle later?

Dr. Douglas: No; it would be quite safe. There is no chance ofits doing any harm.

Mr. Bohart: What is the general reaction of the farmers and dairymen?

Mr. Gray: In general their reaction we find is an attitude of "Three cheers! Come again!" They are glad of the increase in milk and egg production. We have had no objections to residual spraying. We have not used DDT to any great extent as a larvicide. Where we do use it as a larvicide it is not in connection with crops for either animals or man. The only request we get is for more. There has been no back lash that I know of.

Mr. Bendel: Yes; the farmers and dairymen are much pleased. We sprayed some chicken houses very successfully. The owner went in with the hose. He didn't want to take the chickens out and we didn't want to take the responsibility of spraying with the chickens in the pens. He just went ahead and sprayed with the chickens there. The spray also went onto

the chickens' food and water. As it worked out, the chickens were better after the DDT was used.

Mr. Gray: They even directed a full stream on one chicken without any bad results.

Mr. Dennis: We found no objections to its use.

Mr. Emerick: We have sprayed DDT for gnats and flies as well as mosquitoes, with good results in Napa County. There have have been no mosquitoes found in places we have sprayed.

Mr. Robinson: We probably have used DDT as much as any district. We used a little over two thousand gallons of 25% concentrate and covered two hundred square miles. We have had probably one or two cases where a cow died and they tried to say it was because of the spray. However, we were able to prove we hadn't been there or were not responsible. We found the DDT very valuable.

Mr. Geib: We had one very peculiar experience with beef cattle. They lost weight just after the use of DDT, but when they were moved to a place we had not sprayed they gained in weight.

Dr. Douglas: One of the earliest signs of DDT intoxication is loss of appetite. You couldn't induce an animal to eat enough of the stuff to kill him. I put four groups of sheep on different levels of DDT, as high as 123 milligrams per day. This is roughly ten times greater than you would ordinarily encounter. At the end of 212 days on this diet, the group of sheep which had the most DDT weighed the most.

Mr. Gray: Reasonable care and ordinary common sense are required in the use of DDT sprays. Ordinarily, as used by the mosquito abatement districts there is no necessity to get the spray onto either human food or animal food, except to a limited extent on irrigated pastures. Usually on irrigated crops the mosquito breeding water is at the lower end of the field where excess water results in little crop growth.

Mr. Robinson: Most of our operations were done at the lower end of the fields where there is no feed for the cattle. Where water accumulates for not over four days there is no growth of feed.

Mr. Peters: I think it has not yet been made quite emphatic enough that there are thirty six districts in the state and a lot of them have used DDT widely. I have seen it used without any precautions. There is no positive proof of people or animals being affected by it. At our last meeting I attempted in behalf of some of the smaller districts to get a statement favoring its use, for the information of their trustees. It is a very effective improvement in control.

I think it has proved itself positively and I believe this Association should prepare a general endorsement of its use. I think that an Association of this kind speaking positively for it is more beneficial than the undercurrents of rumor and misinformation present in some areas. I urge that the positive side should be stressed in this matter.

Mr. Gray: Do you want a resolution drawn up? Is that what you are driving at?

Mr. Peters: Yes, I think that might well be done.

Dr. Usinger: I hate to prolong this meeting but I want to mention that in 1942 DDT had just arrived in this country and another larvicide was giving some promise. It turned out to be very toxic to mosquitoes and safe for people and animals. I refer to phenothiazine. It was tried out and it was found that its toxicity to larvae is comparable to that of DDT. However, DDT has received a lot of ballyhoo and publicity. Phenothiazine enjoyed no such publicity. If you are looking for a larvicide, how about phenothiazine?

Mr. Stage: I don't think I have had enough experience with it to say. We can count on the fingers of one hand the outstanding larvicides. DDT is one of the best things we can use. It is economical because it can be used as an adulticide as well as a larvicide. It is one of the finest improvements we have. But it must be placed in the hands of technical and responsible people and is not to be used by people who disregard wild life.

Mr. Gray: We used it on the Alvarado Gun Club. We sprayed this year with ½% in kerosene and the game keeper told us that prior to the spraying there were from three to five hundred sick ducks on the property but after they spraying there were practically none.

I will now turn the meeting back to President Robinson.

Mr. Robinson: I would like to introduce Dorothy McCullough Lee, Commissioner of Public Utilities for the City of Portland, Oregon.

Commissioner Lee: I want to remind you that you brought this on yourself. I protested. In the first place, with my limited information there isn't anything I can tell you. In the second place, if you get a woman talking it is difficult to stop her.

I have enjoyed tremendously the opportunity of attending other conferences you had as well as this one. I am not a stranger here. I am a graduate of the University of California. However, I am a graduate of Bolt Hall, getting my Juris Doctor degree in 1923. Little did I realize at the

time that I should take some interest in bugs. When I lacked a few science units I took zoology. It should have been entonology. I wish I had had a crystal ball and could have foreseen that.

Now I am Commissioner of Public Utilities. We have a number of miscellaneous bureaus in Portland that need a certain amount of overseeing. They are divided among the five commissioners. Two years ago I happened to draw "Insect Control". Being a lawyer, I found the utilities a "natural" but this matter of insects I did not. It has been a most interesting experience. Portland is located at the junction of the Willamette and Columbia Rivers. It is very natural we would have a large mosquito problem there, and particularly with flood water species. We have most unpredictable floods. Thousands of acres are flooded very rapidly. It means we have to have a great deal of equipment and highly trained people to be all over the place at once.

We have three principal species of mosquitoes: Aedes vexans, Culex pipiens and Anopheles pseudopunctipennis.

During the depression, when the WPA was going strong, they did a fine job for the community in brushing out the overflow areas. At that time I was busy in the State Legislature, and was only a little interested then in mosquito abatement; but I helped in passing the abatement law which was before the legislature. I have found out that in the early thirties WPA did a tremendous job in brushing. In those days, we had Mr. Stage in Portland representing the Division of Entomology and Plant Quarantine.

We are the recipients of our neighbors' mosquitoes. The northwest prevailing wind from the Columbia River brings about 70% of our mosquitoes, some of which are from our side of the river and some from the State of Washington on the north side of the river, especially from the region of Vancouver. We not only sin but are sinned against.

We started our program on two thousand dollars a year. There are at least seventy miles of river front on the Oregon side that flood, so this was something like throwing a snowball into that famous place that gets too hot. There didn't seem to be any local interest, and the city fathers looked upon mosquito abatement as unnecessary. They let the brush all grow back again and in a few years the flood area was back to its virgin state. We had some very earnest people going around with hand sprays but that was not enough. DDT was not available yet. Two years ago I proceeded to write letters to find out about mosquitoes and mosquito control. I was good at asking questions, being a lawyer. Twenty five thousand dollars a year is our budget today. From just having hand pumps, we now have three power pumps that do a very fine job. We also have two landing barges. A lot of our work is by water approach. We need a plane or two and I hope we can get some. Thanks to Dr.

Andrew's division, we have films -- a total of twenty between the two organizations in Washington and Georgia. We are going to have to do a great deal of educational work. We are having to educate people to the fact that mosquitoes do not breed in bushes and trees but in water. We are showing "It's Up to You" and "Winged Scourge". We must educate people regarding the use of rain barrels. We have done a lot of brushing. We have used DDT very extensively in all forms this year. We have used emulsion and the diesel oil misture. We found diesel oil the most effective.

This summer we had a very large flood, and our inspectors were finding as many as two hundred larvae per dip, on both sides of the river. I realized that in not more than ten days those Washingtonian mosquitoes would be all over Portland. Fortunately at the local Army Air Base we had a very enthusiastic Colonel, an overseas veteran, who didn't want mosquitoes at his base. He offered to fly a bomber himself if necessary. Knowing our two Senators, I was able to get permission to use a B-25 Billy Mitchell, the Army flying it and the City furnishing the material.

We used DDT in a heavier oil than Diesel, and sprayed over five thousand acres on each side of the river with excellent results.

So far as Oregon is concerned, they are starting from scratch. They have a tremendous problem in and around Portland. They have no malaria though there are a few returned veterans with malaria. Malaria has been present in southern Oregon. We do have Anopheles in Portland. It is most interesting to be able to meet with you people and I hope to come again.

Mr. Robinson: Thank you Commissioner Lee. We enjoy having you with us.

I will now remind you that our dinner meeting will be held at 7:30 p.m., in the Bamboo Room at the Claremont Hotel. We will adjourn until then.

ADJOURNMENT AT 5:15 P.M.

The dinner meeting was held with Professor W. B. Herms as Master of Ceremonies. Each person present was introduced. The first speaker of the evening was Dr. L. W. Hackett, Malariologist of the Rockefeller Foundation, who described conditions in Peru and outlined a mosquito and phlebotomus gnat eradication campaign which is projected in an isolated valley in Peru in 1947, for the control of malaria and orroyo fever.

The second speaker was Harold F. Gray, Engineer of the Alameda County Mosquito Abatement District, who spent three months in Japan during the summer of 1946, and who

spoke on mosquito control problems in Japan. A paper on this subject by Mr. Gray has been prepared for publication in "Mosquito News".

The Conference re-convened at 8:30 a.m., in Room 113 Agriculture Hall, Saturday, December 14, 1946.

Mr. Robinson: The first order of business will be the report of the Nominating Committee, Mr. Gray, Chairman.

Mr. Gray: The Nominating Committee recommends first that the Association establish an Executive Committee to control the policy of the Association. This Committee is to consist of the President, Vice-President and Secretary, and four other members, one to be the immediate past-president, one to be a district trustee, one a representative of the State Department of Public Health, and one a district superintendent. I move that such a Committee be authorized and established.

Mr. Raley: I second the motion.

Mr. Robinson: Those in favor say "Aye". Contrary "No". The motion is carried and it is so ordered.

Mr Gray: The Nominating Committee now makes the following nominations for officers of the California Mosquito Control Association for the year 1947.

President - Arthur F. Geib, Manager
Dr. Morris Mosquito Abatement District,
Bakersfield

Vice-President - Theodore Raley, Superintendent,
Sutter-Yuba Mosquito Abatement District,
Yuba City

Secretary - Richard F. Peters, Entomologist,
Mosquito Control Section,
Division of Environmental Sanitation,
State Department of Public Health
Berkeley

Members, Executive Committee
Past-President E. Chester Robinson, Supt.
East Side Mosquito Abatement District,
Modesto

Prof. W. B. Herms, Trustee,
Alameda County Mosquito Abatement District
Oakland

Arve H. Dahl, Chief,
Mosquito Control Section,
Bureau of Environmental Sanitation,
State Department of Public Health
Berkeley

Harold F. Gray, Engineer,
Alameda County Mosquito Abatement District
Oakland

Mr. Robinson: What is the pleasure of the members?

Mr. Washburn: I move that the nominations be closed, and that the persons nominated be declared elected to their respective offices.

Mr. Ewing: I second the motion.

The motion was then carried by unanimous vote.

Mr. Robinson: I now have the pleasure of turning the meeting over to your new President, Art Geib.

Mr. Geib: I thank you all sincerely for this honor, and I hope I can do nearly as good a job as Chet Robinson, who deserves a lot of credit for his fine leadership this year. With a full program time does not permit a speech of acceptance, so we will proceed with the first paper of the morning, to be presented by Dr. Breslow, on the epidemiology of encephalitis.

EPIDEMIOLOGIC ASPECTS OF ENCEPHALITIS IN CALIFORNIA, 1946

by Lester Breslow, M. D.

Before discussion of encephalitis in California during 1946, a brief account of the history of the disease may be of interest.

Human encephalitis appeared in California following World War I, as it did in many parts of the world, primarily as a winter disease in urban areas. A review of the seasonal prevalence of reported encephalitis in California even in 1920-1924, however, shows some summer peaks. Following this period, encephalitis declined reaching a low point in 1933. Thereafter, the reported incidence of human encephalitis began to rise again but the character of the disease was now quite different. Its symptoms and minimal after-effects as compared with the type occuring 20-25 years ago suggest that the two diseases are distinct. Also, in recent years human encephalitis has appeared largely during the summer months and in the same rural areas where equine encephalomyelitis is known.

The latter disease was first recognized in the Central Valley of California in 1930 where approximately 6,000 horses and mules were affected with a 50 percent mortality. The disease reappeared among horses in subsequent years, though with a lessened severity. Meyer, Haring and Howitt reported the isolation of the virus as the etiologic

agent which has become known as Western equine encephalomyelitis.

Later studies demonstrated that both the Western equine and St. Louis viruses caused human as well as horse disease and that mosquitoes are a vector. 1,383 human cases and 453 human deaths were reported during the 10-year period 1936-1945.

Certain features of the epidemiology of encephalitis have been well established, largely by workers in the Hooper Foundation for Medical Research. In spite of the strides made in the past decade, however, our knowledge of the epidemiology of encephalitis still has numerous gaps. A difficult problem for the physician, seeing a patient with encephalitis-like symptoms during the epidemic months, is to differentiate encephalitis from non-paralytic poliomyelitis. The two conditions have many symptoms and physical findings in common. Are there any reliable clinical differences between the two diseases upon which the physician may rely in diagnosing and reporting them? Two viruses, the so-called Western and St. Louis strains of encephalitis, have been identified as causing the disease in California. In recent years, for some unknown reason, comparatively few cases clinically appearing as encephalitis have been proved due to either of these known viruses. Is this a fault of our laboratory tests or are other causative agents involved? When the disease was first studied, it was considered possible that horses served as a reservoir of infection. Subsequent research showed, however, that the virus persists in the blood stream of the horse for only a day or so, thus making it unlikely that the animal could serve as a reservoir. More recently, chickens and other fowl have been incriminated, but even in chickens the virus does not persist in the blood stream for more than three or four days. The latest suggestion is that bird mites may play some role in the perpetuation of the disease. Actually, the reservoir of the virus is still not known. In particular, how does the virus persist through the winter, when the disease does not occur in man or horses? Many species of mosquitoes have been proved capable of transmitting the virus under laboratory conditions and several species have been found infected when caught wild in nature. Which of the mosquitoes already implicated is most important and are there others involved in the spread of the disease? Our knowledge of the ecology of even the known mosquito carriers is far from complete. What are the vulnerable spots in the life cycles of the vectors and what is the most economical way of disposing of them?

Thus several questions concerning the details of the epidemiology of encephalitis have remained unanswered.

Other papers presented at this convention describe the legislative aspects of the control of encephalitis

and other mosquito-borne diseases. It should be pointed out here, however, that the present legislative program provides funds not only for the control of known mosquito vectors but also for studies and demonstrations which may lead to the solution of the important problems mentioned above.

No final statements can be made concerning the 1946 encephalitis picture at this time, inasmuch as laboratory work and analysis of the data are still being conducted. However, certain remarks can be made. During June and early July, several cases of human encephalitis were reported from the San Joaquin Valley in which the clinical differentation from bulbar poliomyelitis (that is, poliomyelitis affecting the portion of the brain which adjoins the spinal cord) was especially difficult. Laboratory work up to the present time suggests that these cases, early in the season, were probably mostly poliomyelitis rather than encephalitis. However, these diagnoses have not yet been officially changed and, therefore, the number of reported cases to be mentioned still included them. Another factor, which should be mentioned as having probably influenced the reporting of cases, was the publicity concerning the encephalitis study program in general. When a wide campaign of this sort is carried on, it is to be expected that reporting of the disease by physicians and hospitals would be more complete than is usually the case.

With these two factors in mind, that is, the particular difficulty in differentiating poliomyelitis this year and the stimulation of reporting by the educational activities, it may be stated that from January 1, to December 7, 1946, 159 cases of human encephalitis were reported. This figure may be compared with 288 cases in 1945, which was the highest year on record. Of this year's cases which have been verified by laboratory tests, practically all occurred during the latter part of July, August and September. Thus, 1946 encephalitis occurred relatively late in the season. And the incidence was lower than in some previous years.

It has been noted that the occurrence of encephalomyelitis in horses usually precedes by about one month the appearance of cases in humans. The experience of 1946 tends to confirm this relationship. July and August were the months of heaviest incidence among horses as compared with August and September for humans--providing one accepts as human cases only those confirmed by laboratory tests. The incidence of reported encephalomyelitis among horses was also lower than in some previous years. In 1946 to date, 108 cases and 33 deaths among horses have been reported.

The Virus Laboratory of the State Department of Public Health has this year made certain improvements in the serologic test for encephalitis in horses and humans. These

improvements will result in the verification of a considerably higher proportion of cases, this year, than has been the case in previous years. This fact, coupled with the submission during 1946 of a greatly increased number of paired blood specimens which are necessary for the test, will give us a clearer picture of the disease throughout the State than we have previously had. Thus far, laboratory proved cases of human encephalitis in 1946 have occurred in Kern, Tulare, Kings, Fresno, Madera, Merced and Yolo Counties. Laboratory proved cases among horses have been found in Kings, Fresno, Merced and Sacramento Counties. Preliminary consideration, both of the clinical reports and the laboratory work now completed, indicate that during 1946 Kern and Fresno counties had the greatest number of cases of human encephalitis in California.

Besides the laboratory work on 336 specimens from human cases and 121 specimens from horse cases in the Virus Laboratory of the State Department of Public Health, detailed clinical and epidemiological histories were obtained during the season on over 95 percent of the reported human and horse cases. The information thus obtained will be correlated with the laboratory work as soon as the latter is completed.

The study program, as you know, was initiated only nine months ago. During this period, the staff had to be assembled and trained, problems outlined and field and laboratory work conducted. However, some progress can be mentioned.

The laboratory has found a means to increase the sensitivity of its test for the disease. This work has been facilitated by an increased number of properly spaced blood specimens submitted by practicing physicians and veterinarians.

Physicians and veterinarians have shown great interest in the diagnosis of the disease, both from a clinical and a laboratory standpoint. Field consultation by epidemiologists and a veterinarian on the staff of the State Department of Public Health has been well received. Practicing physicians and veterinarians have indicated their willingness to cooperate fully with health departments and with mosquito abatement districts in the study and the control of encephalitis.

One of the important features of this year's activity has been that a State-wide attack was launched. The fundamental studies of the Hooper Foundation were continued this year in Kern County and the findings of that group of workers are being reported elsewhere on your program. In several respects, the model for the State program had been established by the Hooper Foundation in previous years. The knowledge which has been gained in Kern

County and elsewhere justifies the wide scale attack which our state Legislature has seen fit to initiate. The application of all our available resources is necessary for the solution of the problems involved in the eradication of encephalitis and other mosquito-borne diseases. Inasmuch as 1946 was a relatively light year for both horse and human encephalitis, it provided an opportunity for us to try out our organization. The experience gained this year will be of great help in planning next year's activities. During the winter, a series of experiments is being conducted on the reations of horses to the encephalitis viruses. The studies should help in refining the laboratory tests and in interpreting their results. The importance of this work is obvious when one considers the difficulties in the clinical diagnosis of the disease.

Next year, it is hoped that quantitative data on the prevalence of various species of mosquitoes in different sections of the Central Valley will be obtained. This data should be correlated with the incidence of clinical and laboratory proved encephalitis. Carefully conducted counts of mosquitoes in certain areas according to a well-planned, routine procedure throughout the summer months would be a considerable contribution from the mosquito control workers to our knowledge of the epidemiology. During the past season, some attention was given to the inspection of premises where cases of the horse or human disease had been reported. However, the data accumulated by this year's field and laboratory work, when taken together with that of previous years, should enable us to select a number of areas where encephalitis recurs year after year. The establishment of stations for routine counting of mosquitoes during the entire season may help us to understand better the relationship between mosquitoes and the occurrence of the disease. The importance of such entomological observations to round out the clinical and laboratory picture cannot be overemphasized.

Mr. Geib: Thank you, Dr. Breslow. We will now have the paper deferred from yesterday by the fog in Los Angeles. Dr. Justin Andrews of the United States Public Health Service got in last night, in time for the banquet.

THE STRUCTURE AND SCOPE OF THE USPHS COMMUNICABLE DISEASE CENTER

by

Justin M. Andrews, Senior Scientist (R)

U. S. Public Health Service

The Communicable Disease Center was established July 1, 1946 at the direction of Surgeon General Thomas Parran of the United States Public Health Service, to continue certain of the activities of the Office of Malaria Control in

War Areas and to perform other specified functions. In order to understand the basic structure and scope of the peacetime Communicable Disease Center, it is necessary to review briefly the history of the parent agency developed to meet a wartime need.

The Office of Malaria Control in War Areas was instituted in Atlanta early in 1942 in response to a request made to the Federal Security Administrator by the Secretary of War. Its program, as developed by Dr. L. L. Williams, first Medical Officer in Charge, was one of direction and coordination of Federally implemented State health department activities aimed at the protection of military personnel against malaria in the United States, Puerto Rico and British Jamaica. Operational objectives involved major and minor drainage, filling, and antilarval efforts against vectorial anophelines around Army, Navy and war industrial areas where malaria might be transmitted (see Fig. 1). These totaled some 2200 or more when military training and production were at their height. These projects were known collectively as the War Area Program and, in addition to the environmental control activities, included: (1) wide scale application of epidemiologic, parasitologic, and entomologic procedures for the guidance and evaluation of control operations and (2) community educational projects designed to acquaint the populace with the basic facts concerning the nature, transmission and prevention of malaria. In certain areas, including the Territory of Hawaii, Aedes aegypti and dog-fly control were undertaken as a part of the War Area Program.

Reported malaria prevalence was at an all-time low when this program was started in 1942, as shown in Fig. 2, and, in spite of the introduction of large numbers of susceptibles into areas where malaria was or had been endemic, it continued to decline. By 1944 and 1945, large numbers of service casualties, prisoners of war and discharged veterans who had been exposed to malaria overseas were returned to the United States. Health authorities expressed grave fears that the introduction and dissemination throughout the country of so many actual or potential gametocyte carriers might serve to generate numerous and extensive epidemics of malaria. The significance of this possibility was admittedly indeterminate but in light of communicable disease experience following previous wars, it could not be ignored. Accordingly, the so-called Extended Malaria Control Program was developed by MCWA in 1945 to protect civilians against the threat of malaria from military personnel. Instead of being focalized around military establishments, this project was operated where conditions for the transmission of malaria, imported or otherwise, were known to exist, i.e., those counties in which malaria had been reported to be most highly endemic in recent years (see Fig. 3). Residual DDT was applied within domestic premises in these areas.

Veterans returning from overseas were carriers not only of malaria but of numerous other infections many of which were unknown or rare in certain parts of this country. While every reasonable effort is made by Medical Department personnel of the armed forces to detain such individuals until they are cured, it seemed probable that missed, relapsing or incompletely treated cases of malaria, filariasis, schistosomiasis, leishmaniasis, oriental hookworm disease, and possible other parasitoses might present themselves to practicioners in any State in the Union. To aid physicians and technicians in the diagnosis of tropical and parasitic diseases, special informational and training facilities were established in MCWA.

In the meantime, murine typhus fever appeared to be on the increase judged by morbidity reports (see Fig. 4), and was invading areas in which it had not been noted previously (see Fig. 5). The far-flung organization of MCWA with its multispecialist personnel, available equipment and other facilities offered a splendid opportunity for bolstering State resources in checking the advance of this steadily infiltrating disease. Thus, in 1945, the Typhus Control Program was added to the operational responsibilities of MCWA.

This outline of operational activities conveys only a superficial realization of the services necessary to support them. Personnel trained and experienced in insect and rodent control was needed for the successful conduct of this program but only a few such individuals were left in the country after military demands had been met. Therefore, it was necessary to train large numbers of inexperienced persons. To do this rapidly, audiovisual teaching techniques were used and, because suitable materials for this purpose did not exist, these had to be created. Field, laboratory and office facilities were established and staffed for mapping and surveying, for the collection, staining and examination of thousands of thick blood films; for the regular searching for and enumberation of larval and adult mosquitoes and other insects; and for the development of improved methods, equipment, and materials for the effective application of insecticides and rodenticides. Special investigations of operational significance were carried by MCWA alone or in cooperation with the National Institute of Health, the Health and Safety Division of the Tennessee Valley Authority, the Bureau of Entomology and Plant Quarantine of the U.S. Department of Agriculture, and various universities and State health departments. These researches have shown that foreign strains of malaria parasites, which might be introduced into this country by veterans or travellers, are transmitted as readily as native strains by Nearctic vectors. They have shed light on the frequent failure of DDT as a residual mosquito larvicide, on its general insecticidal efficiency against mosquitoes, house-flies and rat fleas, variations in durability and effectiveness as a residual mosquito imagocide, and on its effect upon certain aquatic

organisms other than insect larvae. These researches have extended knowledge concerning flight habits, range and sanitary threshold of Anopheles quadrimaculatus, on the significance of Anopheles crucians as a malaria vector, and on the measurement of fly densities and evaluation of fly control. Numberous new distribution records and taxonomic studies have been published concerning mosquitoes and new techniques have been devised for marking insects for flight range studies. A list of these and other research publication is appended.

V-J Day found MCWA with rapidly declining war-connected responsibilities. Troops were being demobilized; camps were being inactivated. But the basic U.S. Public Health Service organization of physicians, engineers and biologists which had become skilled and experienced in collaborative attack against insect and rodent-borne diseases remained. In the opinion of many health authorities it seemed desirable to continue MCWA as a peacetime agency, (1) as a safeguard against a recurrence of conditions prevailing in 1942 when this Nation could not find enough competent insect and rodent-control personnel to service the Army and Navy overseas and to protect the health of its civilians at home; (2) as a prevention against the establishment of exotic infections introduced into this country by returning veterans, occupational troops or as a result of global air traffic; and (3) to combat certain endemic infections, notably murine typhus, sylvatic plague, and insect-borne infections, which are progressively entranching themselves in new sections of the United States. It was for these and possibly other considerations that the Surgeon General of the U. S. Public Health Service ordered the conversion of MCWA to the Communicable Disease Center.

The purposes and functions of the daughter organization comprise certain inherited elements and several new ones. Collectively, they offer services to States which may be grouped as follows:

(1) Through State and Territorial Health Departments, field investigation and control of communicable diseases where Federal assistance is requested and existing provisions are not adequate.

(2) Field training in public health.

(3) Production of audio-visual and other aids for technical and professional training relative to communicable diseases and their control.

(4) Evaluation and consultation concerning techniques and practices in public health diagnostic laboratories.

To give administrative and technical direction to these objectives, the MCWA organization was revised and supplemented so that the pattern shown in the accompanying

charts finally evolved. Organically, the Communicable Disease Center is a Field Station of the States Relation Division in the Bureau of States Services of the U. S. Public Health Service. Fig. 6 shows the lines of authority of its administrative head, the Officer in Charge, and the inter-relationships of the headquarters and field organizations in the various States. These latter now number 15.[1]

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[1] Alabama, Arkansas, California, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia.

The headquarters of the Communicable Disease Center is located in Atlanta, Georgia, as are all the divisions except the Technical Development Division which is in Savannah, Georgia. The relationships and principle functions of these components are indicated in Fig. 7 and are discussed in more detail below.

The members of the Executive Office are concerned collectively with the formulation and transmission of over-all policy to divisions and the field organization and in the administrative direction of the Communicable Disease Center program.

The divisional functions are as follows:

1. Epidemiology

a) Maintains the statistics of reported morbidity and mortality concerning diseases of operational or investigational concern to the Communicable Disease Center and makes periodic analyses and interpretations of them for use in planning and evaluating programs.

b) Assists in field investigations by measuring effectiveness of control measures on human populations in terms of specific morbidity and mortality experience.

c) Assists States requesting Federal aid in analyzing and advising with regard to epidemic phenomena.

d) Supplies statistical planning and interpretive assistance to divisional and other programs.

2. Laboratory

It is not intended that laboratory activities of the Communicable Disease Center will duplicate unnecessarily those of the National Institute of Health, as the principal objective for the former will be to support field investigations and to provide services to State health

laboratories not now included in the NIH program

a) Provides diagnostic facilities - bacteriologic, serologic, parasitologic, virologic and rickettsial - necessary for the prosecution of epidemiologic field activities.

b) Maintains mobile laboratory units to assist epidemiologists in response to requests from States for epidemic aid.

c) Provides instructors and other teaching facilities for training courses of a laboratory nature.

d) Reviews and evaluates technical procedures in diagnostic laboratories.

e) Provides consultation for the correction of substandard techniques and for the improvement of administrative practices.

f) Develops standardized laboratory techniques to be used for survey purposes so that data collected at different times and places may have a greater degree of comparability than at present.

g) Provides State and local health laboratories with series of protozoologic, helminthic, bacteriologic, entomologic, and other specimens to assist in the training of technicians, as a reference museum and for circulation to local clinical laboratories.

3. Engineering

a) Provides facilities for meeting emergency measures necessary for the suppression of insect-borne diseases.

b) Assists Federal and State agencies in the control of certain endemic diseases transmitted by insects or rodents by providing demonstration programs or specialized professional or technical personnel to supervise such operations where justification for them is based on high disease rates and assurance of local participation in preventive programs.

c) Provides facilities for controlled large-scale field-testing of new or improved materials and equipment designed for communicable disease control.

d) Assists other Federal agencies and States in making surveys and recommendations regarding impoundment design, construction and maintenance for the purpose of minimizing malaria hazards.

4. Entomology

a) Identifies insects and other arthropods concerned in the transmission of communicable diseases.

b) Appraises the effectiveness of disease-control measures by determining changes in the densities of insect vector populations.

5. Technical Development

a) Develops and tests new methods of controlling diseases spread by insects and rodents.

b) Develops and tests new and improved equipment used in the control of communicable diseases.

c) Develops new and improved insecticides and rodenticides and determines the effectiveness and durability of new and existing compounds for the destruction of insects and rodents transmitting disease.

d) Devises new and improved methods of excluding rodents from structures occupied or used by humans.

e) Evaluates communicable disease control practices in terms of hazard to wild life or interference with agricultural activities.

6. Training

It is not intended for the training activities of CDC to infringe in any way upon the prerogatives or fields of endeavor of schools or teaching departments of public health, hygiene, preventive medicine, sanitary engineering or diagnostic laboratory technique.

a) Instructs employees entering the Center either as commissioned officers or civil servants concerning the history, interrelationships, and practices of the various units of the Communicable Disease Center, the U. S. Public Health Service and other public health organizations.

b) Provides training for the employees of State or local health departments or of other Federal agencies concerned with the prevention of disease in effective control practices for insect and rodent-borne diseases and in the laboratory diagnosis of communicable diseases.

c) Provides training facilities for the orientation and specialized training of sub-professional state and local public health workers not eligible to attend professional schools of public health.

d) Provides internship training in public

health for inexperienced graduates of schools and departments of hygiene and public health.

e) Maintains a library of motion pictures and film strips for the use of institutions, instructors and students in the field of communicable disease control.

7. Production

The production and distribution of audio-visual and other teaching aids will be restricted to the development of these materials for the assistance of professional and technical schools and individuals engaged in instruction and research concerning communicable disease. It is not planned to engage in lay health educational activities.

a) Develops and produces motion pictures, film strips and manuals illustrating, describing and documenting investigations and control procedures pertaining to communicable diseases. Series have been planned and are partially completed on the following subjects: malaria, typhus, tropical diseases and preventive medicine.

b) Analyzes and assists in the utilization of these and other teaching aids with the object of improving new training materials.

8. Library and Reports

a) Maintains a reading library for the use of investigators, instructors, and students of communicable disease research and control.

b) Prepares quarterly field bulletins, annual reports and a running history of the MCWA-CDC development and other program information materials.

c) Provides non-technical editorial assistance in the preparation of manuscripts to be submitted for publication.

9. Administrative

a) Establishes and administers personnel policies and procedures for both headquarters and field organizations.

b) Insures maintenance of Civil Service position standards.

c) Recruits personnel; advises on selection of candidates; determines qualifications.

d) Prepares consolidated budget; controls allotted funds; certifies and maintains accounting records

of expenditures; audits payrolls, miscellaneous vouchers and travel vouchers.

e) Purchases supplies, equipment and materials; maintains records of CDC property; provides warehousing and distribution facilities.

f) Repairs and maintains automotive and other equipment.

g) Prepares maps, charts and other drafted materials.

h) Reproduces mannual letters, field memoranda, etc., and distributes all such materials to the Headquarters and Field Organizations.

i) Prepares and processes machine records based on administrative, operational, investigational and vital statistics data.

Of the various field programs carried on by the Communicable Disease Center, those noted below have entomological interest. Complete details regarding the work cannot be given in all instances as certain of the investigational projects are incomplete and results of others are still to be published.

Malaria Control Programs. The next year will see the virtual liquidation of the War Area Malaria Control Program for the operation of which MCWA was activated. Comparable activities on a smaller scale will be continued in Puerto Rico and possibly a few continental locations at the request of War and Navy Departments. Mosquito control work is being done in the vicinity of Veterans Administration Hospitals, as this organization has no special provision for this type of service. Many of the patients brought together in these hospitals are suffering from malaria and other diseases acquired in the tropics making it imperative that complete mosquito control be effected in areas adjacent to these hospitals. This project is now known as the Military Areas Malaria Control Program. It consists almost entirely of larviciding which is being carried on currently in 27 different zones.

The Extended Program, DDT residual spraying in houses in malarious areas, will probably be maintained through 1948 to reduce the likelihood of liberating foreign strains of malaria from returning veterans, and should be continued longer as the most promising approach to the goal of malaria eradication in the United States. This work is being carried on in 265 counties in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee and Texas. From February 23 through October 31 of this year, 1,166,545 house sprayings

were completed.

Allocations of funds to States for malaria control are based on a formula in which a standard budgetary item for the support of the State CDC Activities headquarters organization is supplemented by amounts corresponding to each State's relative share of the reported malaria mortality experienced by the thirteen most malarious States during recent years. Federal dollar participation in this program is now roughly 75 to 80 percent of the total, but is diminishing each month. It is hoped that by the beginning of the next fiscal year, local sponsorship of costs will be increased to 50 percent or more, with Federal assistance restricted to supplying technical personnel, equipment and materials.

Impounded Water Studies. As a continuing element in the national malaria prevention program, areas in which water is to be impounded by the United States Engineer Department are studied by Communicable Disease Center engineers and entomologists, in association with State Health Department representatives, with the objects of determing (1) the extent of probable malaria hazard contingent upon uncontrolled impoundment, and (2) how this risk, if any, may be minimized by proper design, construction and maintenance of the impoundment basins. The Communicable Disease Center is reimbursed for these services by the United States Engineering Department. During the first quarter of this fiscal year, 26 of these projects were completed and final reports were submitted, field work was finished on nine more and requests were received for surveys of nine additional impoundments. Similar cooperative service is being rendered to other Federal agencies concerned in the impoundment of water in potentially malarious areas.

A notable contribution to the literature of sanitary science and practice is a compendious volume, now in press, entitled "Malaria Control on Impounded Water" which represents the joint effort of members of the Health and Safety Department, Tennessee Valley Authority, and the Communicable Disease Center of the U. S. Public Health Service.

Aedes aegypti Control Program. These mosquito control activities, a combination of DDT treatment and general sanitation, were originally undertaken at the request of the Navy and are being continued in 16 coastal areas of Alabama, Florida, South Carolina and Texas, as a protection against dengue fever and the potential threat of yellow fever. Local health departments furnished 57 percent of the costs during the first quarter of this fiscal year. All new projects are required to obtain at least 50 percent of their support from local sources.

Typhus Control Program. Grants-in-aid on a formula basis (standard budgetary item for the State CDC

Activities headquarter organization plus amounts corresponding to each State's relative share of the recent typhus morbidity reported in the nine States where the bulk of the Nation's typhus occurs) were made to Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas with special projects being supported in Arkansas and Virginia. Anti-typhus operations, including rat-proofing of buildings, rat poisoning, and the residual dusting of rat runs, burrows and harborages with 10 per cent DDT dust (see Fig. 8) were carried on in 130 counties of the 11 States.

This latter procedure effects an average decrease of tropical rat fleas, Xenopsylla cheopis, of nearly 90 percent per rat & might thus be expected to exert a reductive effect upon the incidence of murine typhus in man. The number of cases of typhus fever reported throughout the country dropped from a peak of 5,353 in 1944 to 5,180 in 1945. Current figures indicate that the decline will be even greater this year. A comparison of reported typhus prevalence in the 124 dusted counties and the 810 undusted counties of the same States indicated that the disease subsided more rapidly in the former during the first nine months of 1946 as the reduction in the dusted area was 37 percent and in the remaining counties 18 percent. Typhus control activities are supported locally to the extent of nearly 70 percent of their cost.

Muscogee County Insect Control Program. This project offered free DDT treatment to every one of the 23,959 dwellings or business establishments in Muscogee County, Georgia, and was accepted in over 95 percent of these units. Its purposes were: (1) to serve as an incentive to promote individual improvement of environmental sanitation of homes, yards and business places; (2) to benefit the communities by reducing the number of disease-bearing insects and insect pests; and (3) to determine how successfully DDT spraying and dusting operations on a county- and community-wide basis could suppress mosquitoes, flies, fleas, bed-bugs and cockroaches. Both hand labor and power methods were used to apply DDT in dwellings, privies, garages, barns, business houses, food establishments, dairies and to areas and surfaces where it might be effective against roaches. The different types of structures were treated variable numbers of times according to the results of inspection. The project was evaluated entomologically both by making regular insect surveys and density determinations in and around Columbus, the principle city of Muscogee County, and by making comparable observations in another city across the river in which no organized insect control program was carried out. Mosquito densities were sampled by means of light traps and by collections at diurnal resting places. Fly populations were estimated by using strips of adhesive fly paper exposed for 24 hours each week and by making enumerations with Scudder's fly-counting grill. Efforts were made to appraise changes in roach colonizations with traps but these were not

successful. No evidence other than the testimony of home occupants was obtained concerning variations in abundance of fleas and bedbugs. From all accounts, the project has been highly successful and a summary of results obtained will be published. About 40 percent of the cost is being borne by the Communicable Disease Center.

Malaria Field Studies. At Manning, South Carolina, near the Santee-Cooper impoundment, a Communicable Disease Center study is being carried on primarily to determine the effect on malaria prevalence of DDT residual spraying of houses and latrines as practiced by MCWA and CDC. During the last two years, the Santee-Cooper area has been the only one in the county with notable prevalence of malaria and even this has declined markedly. Clinical and parasitologic surveys for malaria are made in the area at frequent intervals and the densities of local anopheline populations are determined regularly. Thus, in addition to the fulfillment of its primary objective, this program provides valuable opportunity to maintain a watch on this most recent outpost of endemic malaria in the country with the view of obtaining early indications of potential upswing in malaria prevalence in time to prevent an epidemic spread of the disease.

At the Emory Field Station in Baker County, Georgia, another field study is under way, sponsored jointly by Emory University and the Communicable Disease Center. This area is topographically different from the Manning station, being representative of the limestone section in Southwest Georgia, notorious for its high malaria endemicity until recent years. Regular observations are being continued upon local malaria prevalence, adjacent anopheline densities and ecology and associated ground-water changes. The Communicable Disease Center is especially interested in the investigation of over-wintering habits of anophelines and in the malaria case-finding activities. This area also is considered to be a lookout station where painstaking surveillance may pay huge dividends in guarding against the return of malaria.

It is hoped to establish two more such combined observation posts and research projects in areas in other States which have been highly malarious in the past and which represent additional types of environment where premonitory indications of returning malaria might be reasonable expected.

Typhus Field Studies. This project is headquartered in Thomasville, Georgia, and is being carried on in four counties of South Georgia where murine typhus has been prevalent. Its primary mission is to determine the effect on the incidence of human typhus of dusting rat runs and harborages with DDT. Comparison of results obtained is being made with other typhus control methods. Field observations are being made on multi-purpose insecticides which have some

promise of reducing numbers of rat mites and lice as well as fleas.

Anopheline Host Preference Studies. The laboratory precedures concerned with these studies were commenced in 1944 at the Carter Memorial Labortory in Savannah, Georgia, but have since been transferred to the Virus Laboratory in Montgomery, Alabama. This is an extended investigation of the natural feeding habits of the more abundantly represented species of Anopheles. Recently engorged female anophelines are collected in many different States. Blood from their stomachs is collected on filter paper and is sent to the laboratory. By means of a precipitin technique, it is possible to determine whether or not the blood came from man, cow, horse, pig or chicken. The results of these tests are correlated with circumstances relating to the capture of the mosquito. They have already yielded information of importance in connection with the Extended Program of Malaria Control.

Dysentery Control Project. This is a cooperative undertaking with the National Institute of Health. Its headquarters are at Pharr, Texas. The primary objective is to determine whether or not the control of flies by insecticides will reduce significantly the prevalence of diarrheal disease. For this purpose, five small cities in Hidalgo County in the Rio Grande Valley are being intensively treated with DDT to Control flies while nothing of the sort is being done in four other nearby cities where original fly densities were comparable. Excellent but expensive fly control has been obtained by the methods used. If results indicate that flies are concerned in the transmission of infectious diarrheas, the next study will be to ascertain the possibility of developing economically feasible programs of fly control for the prevention of diarrhea.

Neurotropic Disease - Insect Control Project. The headquarters for this project are in Montgomery, Alabama, adjacent to the CDC Virus Laboratory. The object of this investigation is to determine whether or not the sudden and relatively complete reduction of insect populations of certain species is attended by measurable interference in the development of incipient epidemics of virus diseases. It is to be emphasized that this is not a state-aid operational project. Funds for this Project will be spent only where there appears to be reasonable hope of obtaining scientific information concerning the significance of insects in the transmission of virus diseases. The late summer and fall months of 1946 were spent in developing and improving rapid fly-control technique.

Encephalitis Studies. The Communicable Disease Center, in recognition of the threat of introduced and extended

encephalitic prevalence on the West Coast, is cooperating in a modest way with the Hooper Foundation on studies of possible insect vectors and avian reservoirs of this disease.

Other predominantly intramural activities of the Communicable Disease Center involve entomology to some extent. Thus a considerable portion of the in-service and special training programs is devoted to instruction in distinguishing basic types of insects or even in recognizing a limited number of species. Trainees are given reference collections of insects, including representative forms of importance in their special activities, to take back with them. The 6-weeks course given by the Parasitology Branch of the Laboratory Division to Federal, State and local health laboratory technicians includes brief orientation with respect to insects which may be sent to the laboratories from which the students come. This Branch of the Laboratory Division maintains a large reference museum of insects and, together with the Entomology Division, operates a central insect identification service for the field organization. Entomologic as well as other specimens are supplied to State health laboratories as a part of the Extension Service of the Laboratory Division. Many training films on entomologic subjects have been produced.

A major portion of the Technical Development Division is devoted to insecticide investigations. These include studies of various candidate chemicals possessing some activity as larvicides or imagocides against mosquitoes, house-flies and the ectoparasites of domestic rodents. Investigations are under way concerning the deteriorating influence of surface treatments and environmental changes on residual deposits, the effects of DDT larviciding on various wild life forms including other insects, fish, plankton, birds and mammals, and different methods of applying insecticides rapidly to large areas.

In summary, these are some of the functions and activities of the Communicable Disease Center - with special emphasis on those concerned with entomology. Collectively, they represent a purposeful effort on the part of the Federal government to transmute scientific facts about certain communicable diseases into field-tested control and prevention practices and by demonstration and training to familiarize the personnel of State and local health departments with easy, economical methods of applying them. In addition, the Communicable Disease Center assists, where directed, in the suppression of health hazards of interstate and extracontinental scope. In reaching these objectives, the Communicable Disease Center desires to cooperate to the fullest possible extent not only with other Federal agencies but with State and local health organizations, private physicians and laboratories, universities and scientific associations.

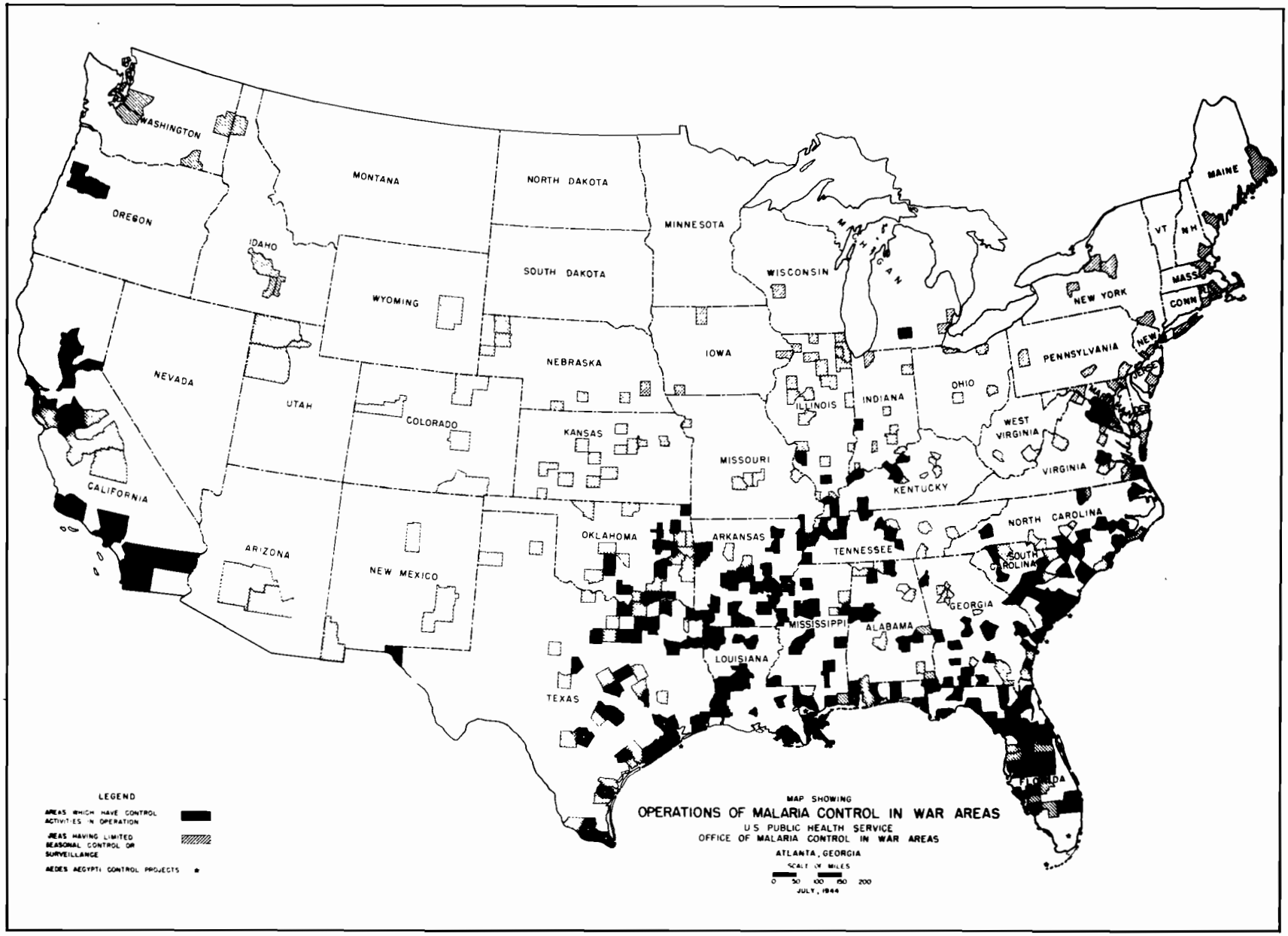

Fig. 1. Map of U. S. A., showing places in which War Area Malaria Control Program was operated in 1944.

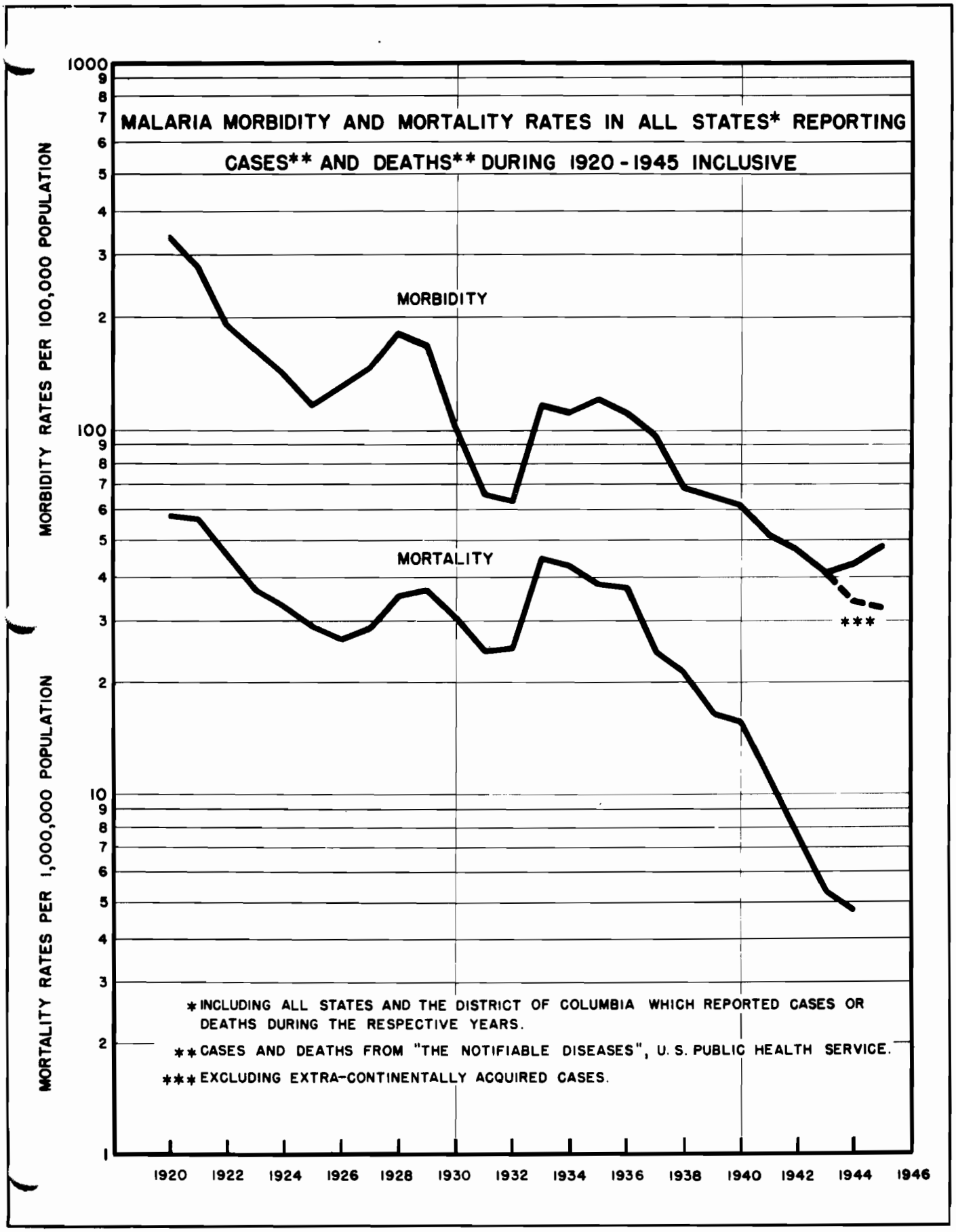

Fig. 2. Reported malaria morbidity and mortality rates in U. S. A., by years.

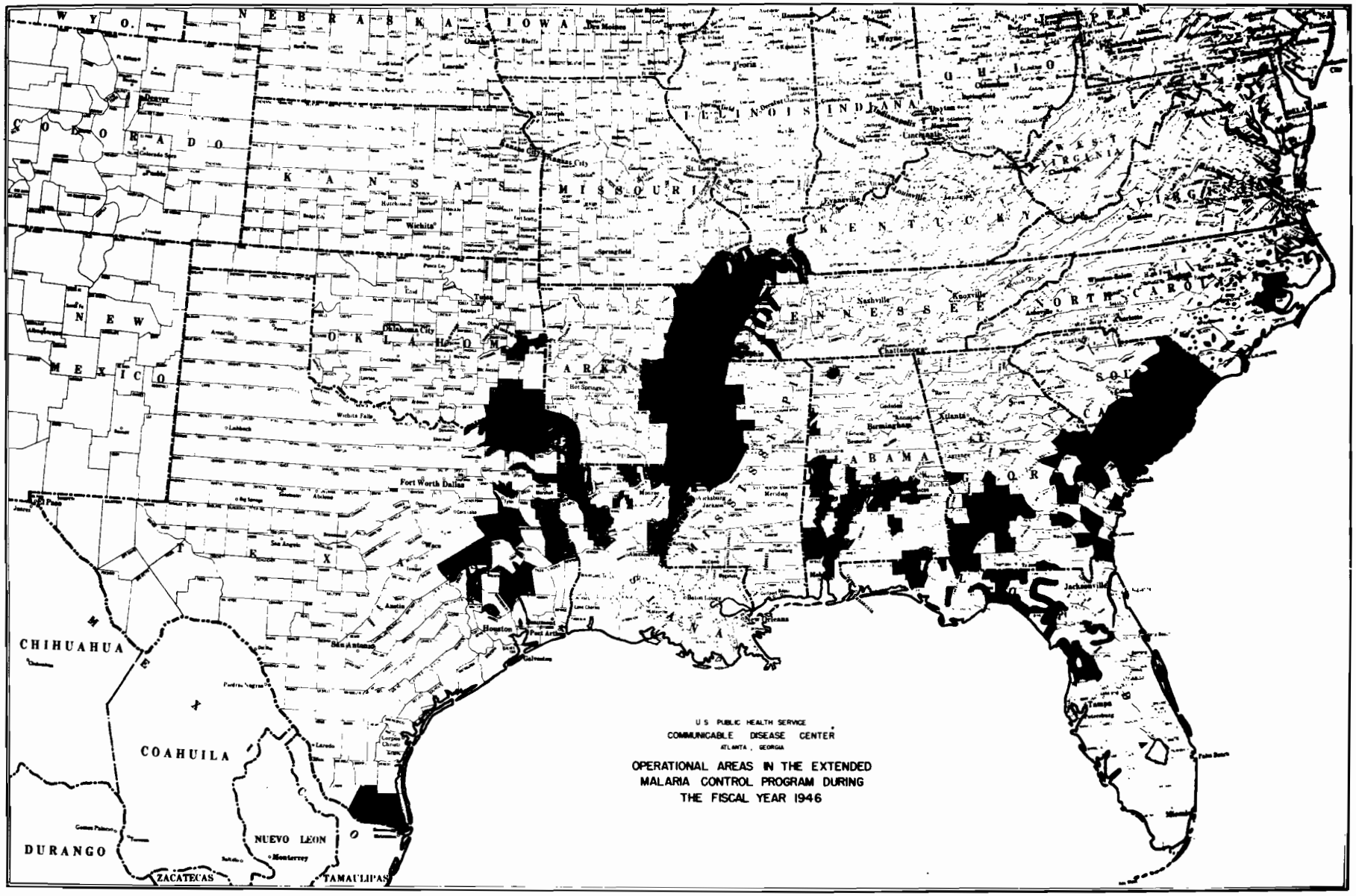

Fig. 3. Map of Southeastern U. S., showing areas in which Extended Malaria Control Program was operated in 1946.

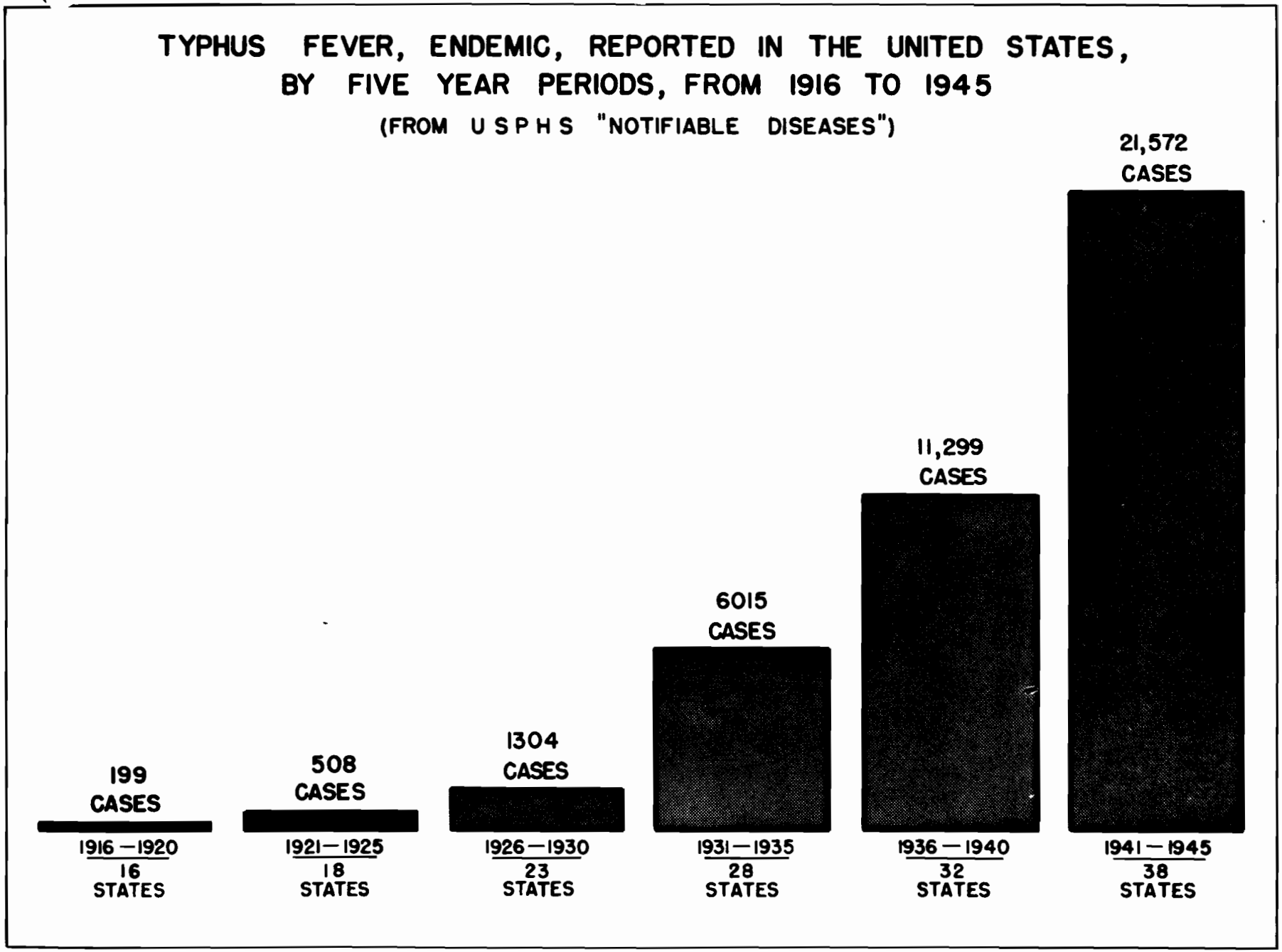

Fig. 4. Bar diagram showing increase in reported murine typhus fever morbidity in U. S. A., by 5-year periods from 1916 to 1945.

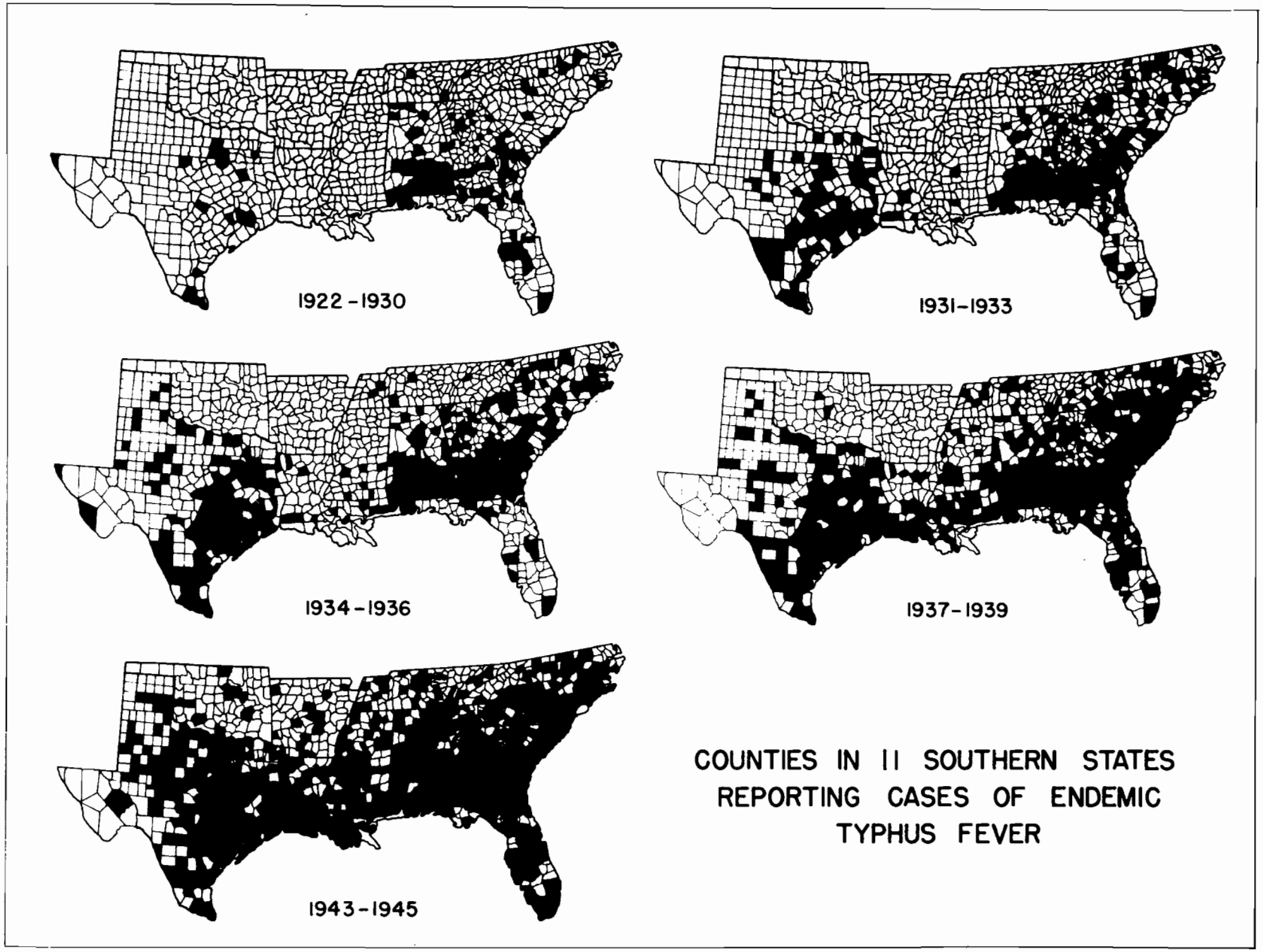

Fig. 5. Maps showing counties reporting murine typhus in 11 Southern States by periods from 1922 to 1945. First four maps from Melany, 1941; last map from Andrews and Link, 1947.

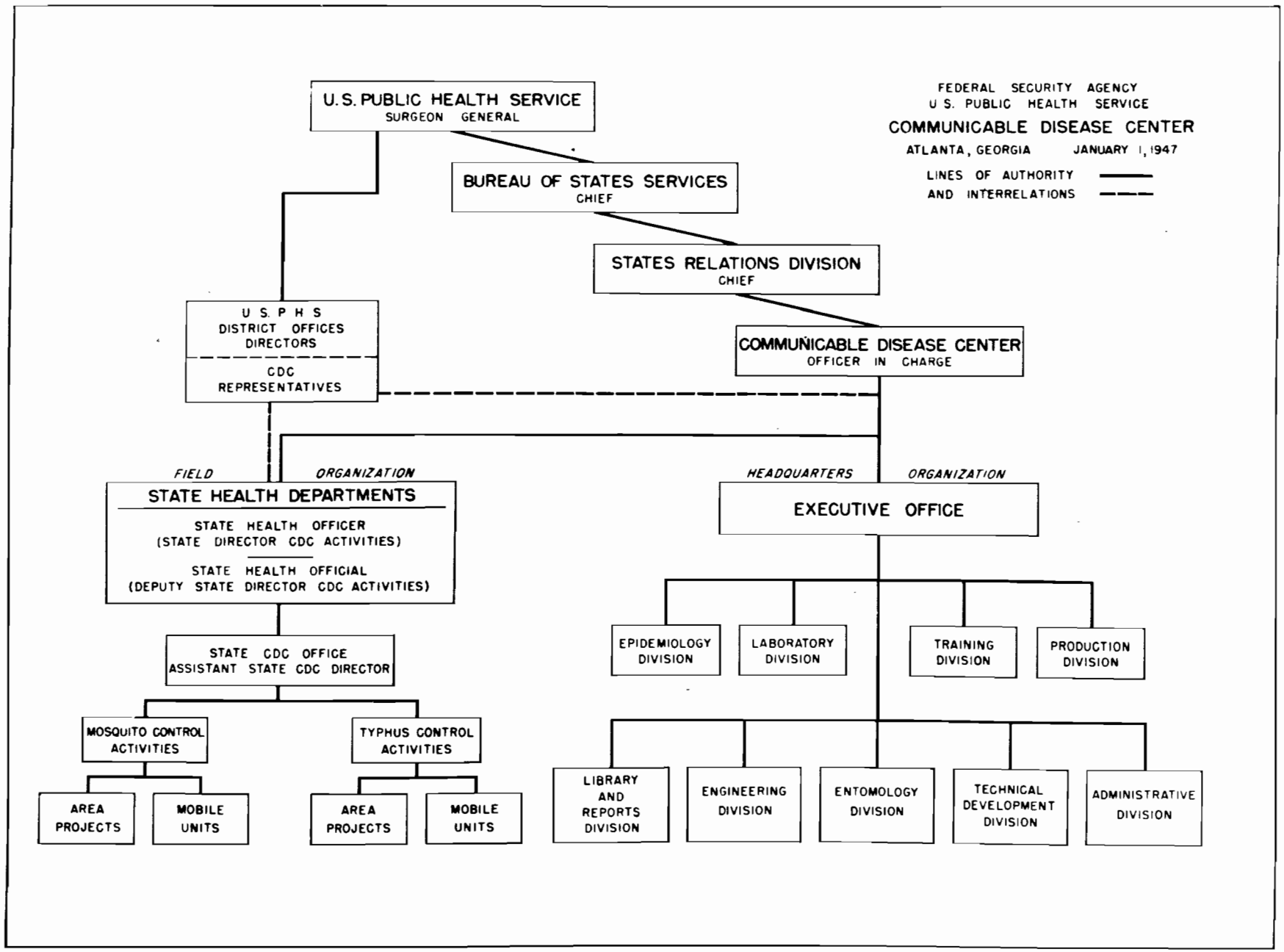

Fig. 6. Chart showing lines of authority and inter-relations of Field and Headquarters Organizations of the Communicable Disease Center, U. S. Public Health Service.

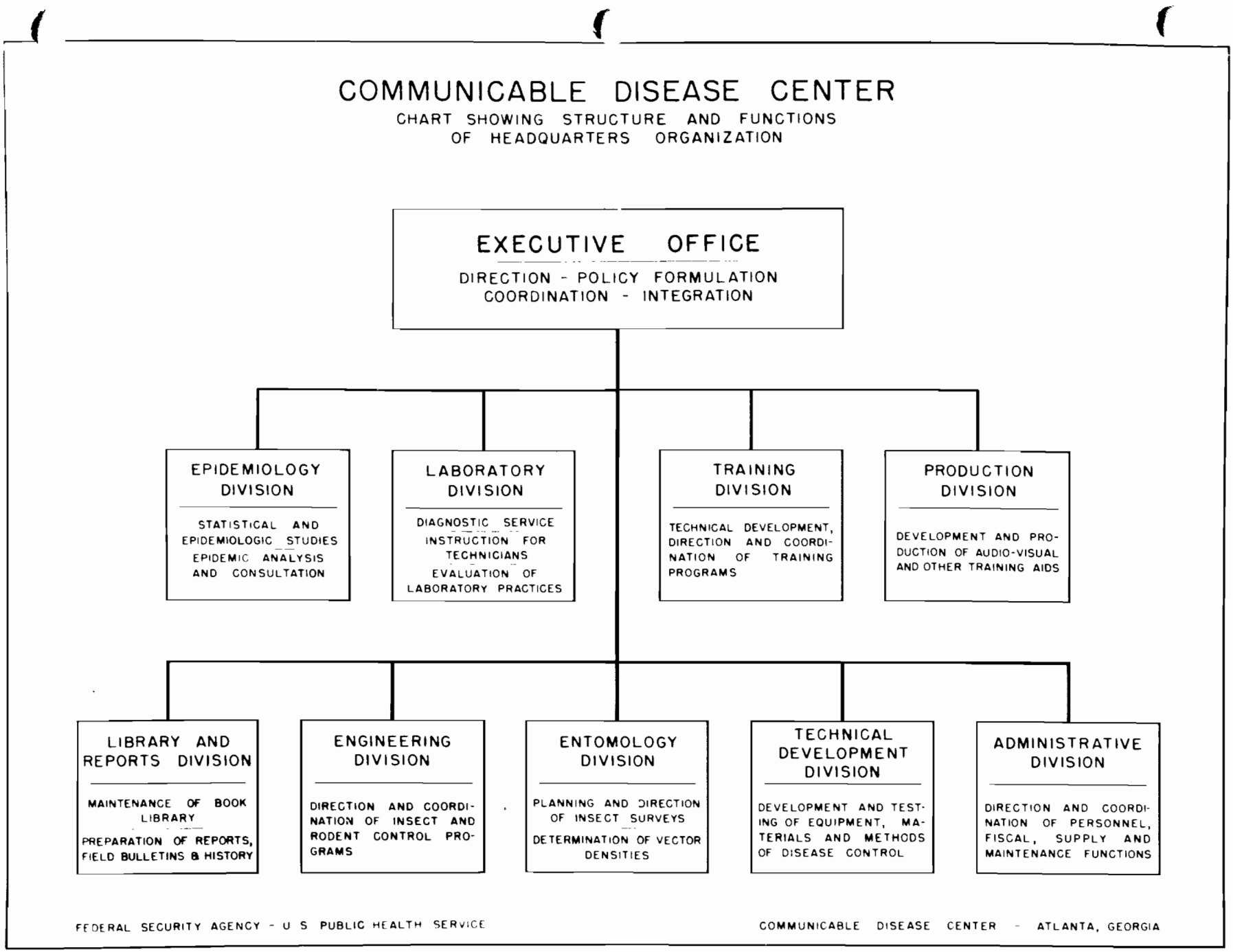

Fig. 7. Chart showing structure and functions of Headquarters Organization of the Communicable Disease Center, U. S. Public Health Service.

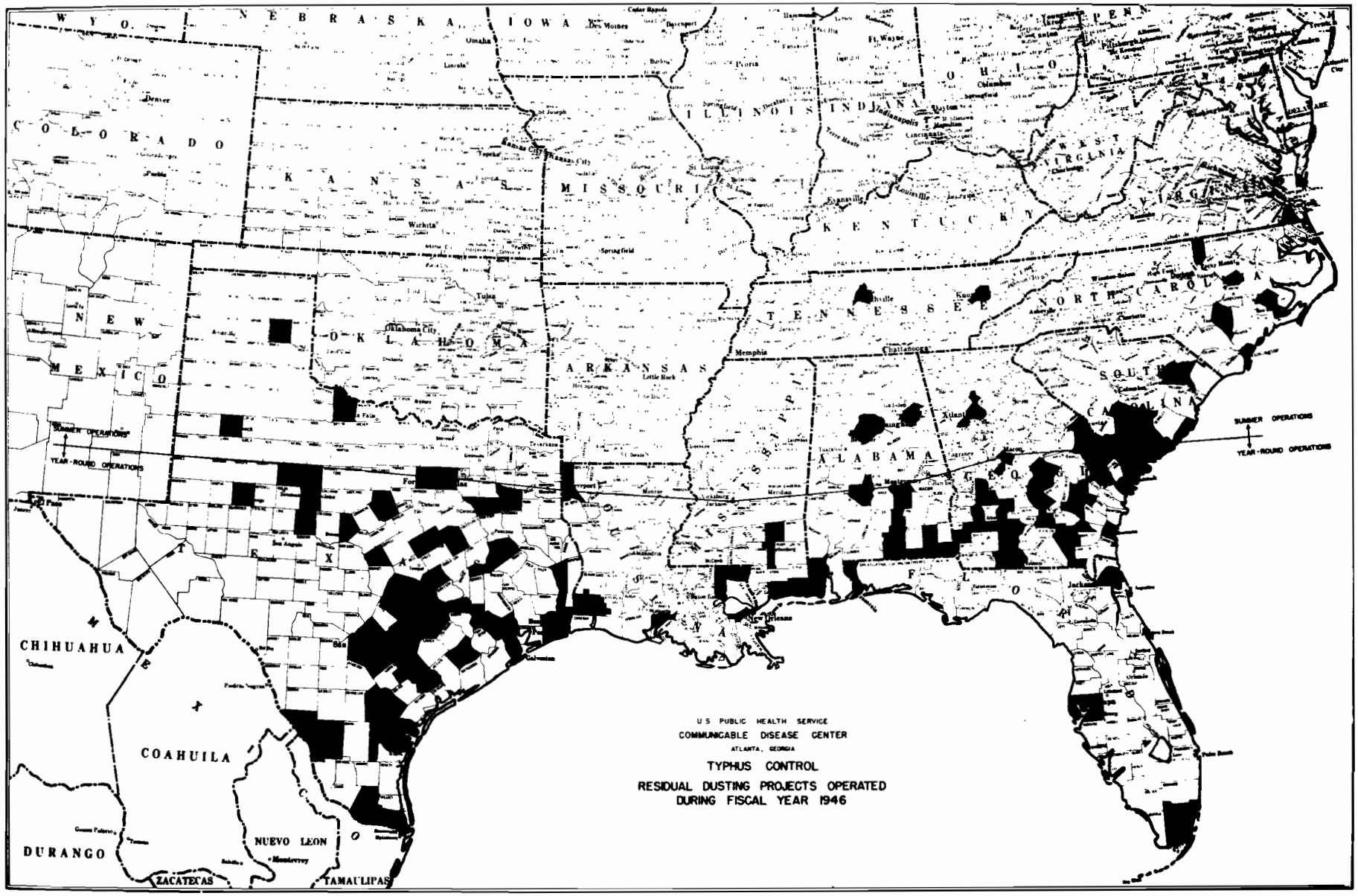

Fig. 8. Map of U. S. A., showing counties in which typhus control dusting projects were operated during 1946.

List of Scientific Publications Prepared by MOWA-CDC Personnel - 1942 - 1946

1943

Bradley, G. H. 1943. Density of Anopheles quadrimaculatus and the Prevalence of Malaria.
Proc. New Jersey Mosq. Ext. Assoc., 20-22

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J. Econ. Ent., 36(1):51-53

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J. Econ. Ent., 36(2):354

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Mr. Geib: Thank you, Dr. Andrews. I will now ask Mr. Ewing of the Merced District to preside for the remainder of the morning.

Mr. Ewing: Mr. Geib was running up and down the halls frantically looking for someone to take over and give him a chance to sit down for a while. He bumped into me and this is what happened.

Our next paper will be one in which we are all very much interested, as it concerns money. Mr. Dahl will tell us who gets what and how under the State subvention program

STATE SUBVENTION IN CALIFORNIA MOSQUITO CONTROL, 1946
ARVE H. DAHL, Chief, Mosquito Control Section
Division of Environmental Sanitation
State Dept. of Public Health

This paper will be a resume of all activities involving the allocation and supervision of subvention moneys made available by Assembly Bill No. 28 (1946 Special legislative session) through the current biennium by the Department of Public Health.

As provided by the section of Assembly Bill No. 28 dealing with subventions, "the State Board of Public Health was authorized to enter into cooperative agreements with any local district or other public agency engaged in the work of controlling mosquitoes in such areas and under such terms, conditions and specifications as the State Board of Public Health may prescribe. Such agreements may provide for financial assistance on behalf of the State and for the doing of all or any portion of the necessary work by either of the contracting parties, except that in no event shall the Department agree that the State's cooperation shall exceed 50% of the total cost of any acceptable plan."

Notices were sent to "All Local Health Officers and Mosquito Control Agencies" announcing the method to follow

in applying for subvention assistance as provided for in Assembly Bill No. 28. This method was developed prior to the organization of the Mosquito Control Section in a meeting of the Advisory Committee with the Division of Environmental Sanitation. It required that all applicants make a study of the history of malaria, encephalitis, and equine encephalomyelitis in their districts since 1940 and plot the occurrence of these cases on a map; make a map of the area they proposed to cover under the expanded program and prepare a budget for the expanded program estimating what percentage of each item was to be used on the vector control program.

The Mosquito Control Section was established as a unit within the Division of Environmental Sanitation on April 22, 1946. The principal functions of the unit being to direct for the Department of Public Health the provisions provided for in Assembly Bill No. 28 relating to mosquito control. For the purposes of administering this activity a professionally trained staff of mosquito control specialists was provided for.

The Mosquito Control Section represented the Department of Public Health in contacting the mosquito abatement districts to assist them in preparation of requests for subvention assistance. This involved visits to each mosquito abatement district to explain what was desired and give technical guidance in the preparation of budgets for expansion of programs in line with approved methods for controlling Anopheles freeborni and Culex tarsalis, the species known as the principal vectors of malaria and encephalitis, respectively.

Twenty-four mosquito abatement districts indicated their interest in obtaining subvention assistance. Official and preliminary estimates were received from twenty-one of the mosquito abatement districts for a meeting on April 24 between the Department of Public Health and its Advisory Committee on mosquito control. At this meeting the Advisory Committee recommended the amount of subvention money to be made available to each mosquito abatement district. They analyzed the requests from the mosquito abatement districts on the basis of the report accompanying the request for subvention, official reports of malaria, encephalitis and equine encephalomyelitis, general knowledge of the principal vectors of the disease, namely, Anopheles freeborni and Culex tarsalis and consideration of the entire State problem.

A list of all subvention contracts to date is given below. The total budget, amount of State subvention area, tax rate and the effective dates the cooperative program began in each district are shown:

1946-47
SUBVENTION CONTRACTS

MOSQUITO ABATEMENT DISTRICT	Area Sq. Miles	Budget 1946-1947	Tax Rate 1946 1947	State Sub-vention	Total Budget 1946-47	Date Contract Effective
						1946
Alameda	445	$85,460.	0.019	$ 8,790.	$94,250.	May 1
Delano	350	14,160.	0.14	10,000.	24,160.	June 1
Delta	227	17,525.	0.15	15,000.	32,525.	June 1
	(200 miles annexed October 1946-budget not included)					
Dr. Morris	770	99,197.	0.06	40,000.	139,917.	May 1
Eastside (Pest)	306	43,000.	0.10	30,000.	73,000.	May 1
	(108 miles annexed October 1946-budget not included)					
Durham	50	4,090.	0.15	3,900.	7,990.	July 1
Fresno	100	66,387.	0.06	20,000.	86,387.	June 1
Hanford	12	9,353.	0.15	7,000.	16,353.	June 1
Merced County	1995	97,500.	0.15	40,000.	137,500.	July 1
North San Joaquin	200	55,250.	0.10	13,750.	69,000.	May 1
Pine Grove	175	4,936.5	0.16	4,713.5	9,650.	June 1
Solano County	911	31,520.		9,000.	40,520.	July 1
Sutter-Yuba	400	43,670.	0.15	35,000.	78,670.	May 1
Tulare	160	20,262.	0.12	12,000.	32,262.	June 1
Turlock	275	34,735.	0.15	25,000.	59,735.	June 1
Consolidated	320	50,018.	0.15	30,000.	80,018.	Aug. 1
Shasta Basin (Redding) (Anderson) (Cottonwood) (Clear Creek)	100	21,400.	0.30	15,400.	36,400.	June 1
Los Molinos	200	6,000.		5,060.	11,060.	July 1
Monterey Co. Health Dept.	30	4,490.		4,000.	8,490.	June 1
Sacramento-Yolo	1997 (Budget not set)					
TOTALS	9023	$709,673.50		*$328,613.50	$1,037,887.00	

* 12 months contracts--additional $30,000.00 to be used to extend all contracts thru June 30, 1947.

The adoption of standard State financial procedures was required to handle the subvention contracts. Under this arrangement the mosquito abatement district is regarded as a contractor doing mosquito control work for the State of California. Our contract with the districts has usually been through the superintendents who have been designated by their Boards of Trustees to handle the contract for them. Final approval in all cases was contingent upon acceptance of the contracts by the districts, the State Department of Public Health, and by the State Department of Finance.

In keeping with the law, which provided that all activities were to be in accordance with standards set by the State Board of Public Health, Exhibit I containing all working conditions was made a part of each contract. This exhibit covering operational, entomological, and financial phases was as follows:

EAST SIDE MOSQUITO ABATEMENT DISTRICT

Exhibit 1

1. This contract is formulated and entered into pursuant to Chapter 72, Statutes of 1946 (First Extraordinary Session) of the State of California, and is a cooperative agreement between the Contractor and the State for the control of mosquitoes, and vector-borne diseases, including malaria, encephalitis, and equine encephalomyelitis.

2. The Contractor agrees to conduct a program of mosquito and vector control using the best known methods and procedures; the program, methods and procedures to be approved by the State.

3. The area to be included in the Contractor's activities is composed of the East Side Mosquito Abatement District in Stanislaus County, and in addition thereto a five mile zone extending on all sides of the District, excepting the territory south of the Tuolumne River now controlled by the Turlock Mosquito Abatement District.

4. The Contractor agrees that:

   (a) A system of entomological records will be established by the Contractor for recording densities of mosquito larvae and adults by species as collected at specific locations at regular intervals.

   (b) Contractor will maintain complete operational records and submit operational reports to the State at least every three months.

   (c) Contractor will allow the State at all reasonable times to check and investigate the species identifi-

cation and sample collecting methods being used, to make detailed investigations and evaluations of the control operations and to audit all financial records.

(d) Contractor agrees to submit certified financial expenditure reports to the State at intervals of three months during the life of the contract, such statements to show expenditures from each item of the budget.

5. The control program (see item 2 above) shall be based on and in accordance with a total budget in the amount of seventy-three thousand dollars ($73,000) a copy of the budget being attached and made a part hereof and marked "Exhibit 2".

6. The total financial assistance from the State shall not exceed thirty thousand dollars ($30,000). The "State's ratio of assistance" is the percentage which the maximum amount of State assistance ($30,000) bears to the total of the budget ($73,000) or 41.1 percent. Payments of the State assistance will be made as follows:

(a) Upon final approval of this contract, payment of not to exceed thirty-five percent (35%) of the maximum available assistance of the State to the project may be advanced to the Contractor.

(b) At the end of three months, upon the basis of a certified statement of the actual expenditures within the budget during the first three months, payment will be made to the Contractor of the "State's ratio of assistance" (41.1%) of the actual expenditures during the first three months, except that this payment when added to the initial advance shall not exceed sixty per cent (60%) of the State's total assistance.

(c) At the end of six months, upon the basis of a certified statement of the actual expenditures within the budget during the second three months payment will be made to the local district of the "State's ratio of assistance" (41%) of the actual expenditures during the second three months, except that this payment when added to all previous advances and payments shall not exceed eighty-five percent (85%) of the State's total assistance.

(d) Additional payment may be made at the end of third three months period upon the same basis, provided that this payment, when added to all previous advances and payments shall not exceed eighty-five percent (85%) of the State's total assistance.

(e) The final payment will be made only at the end of the term of the contract on the basis of a certified statement of actual expenditures, provided that the total advances and payments to the Contractor shall not be more than the lesser of the following two amounts:

(1) "State's ratio of assistance" which is 41.1 percent of the total actual expenditures of the program under the budget.

(2) Total financial assistance of the State ($30,000).

7. All payments shall be made on the basis of invoices submitted in triplicate by the Contractor.

8. This contract is for the period of twelve (12) months beginning May 1, 1946, and ending April 30, 1947.

Very few of the districts with whom subvention contracts were let had established programs which used operational daily reports that could be summarized to give a complete record of the activities in the district. Furthermore, none of the districts had incorporated complete entomological inspection activities into their control program. While species of mosquitoes were found and, occasionally, recorded as a matter of interest, the science of entomology as an aid to their control program was completely ignored. We found it necessary, in order to get operations under way, to prepare a daily report form and to supply them to the districts for the control crews which could be used to summarize their activities for the monthly operational report form. Submission of the Monthly Summary report was required as one of the working conditions of the contract agreement.

The Monthly Progress Report is designated to summarize all activities into units of material and man-hours required to cover areas or complete items of work. These figures can, of course, be converted to actual cost figures using current unit cost figures. These figures are also essential to the individual Boards of Trustees so that they may be completely informed on district operations. Let me mention the items included in this Progress Report:

(See copy of "Monthly Progress Report" included at the end of this paper.)

Entomological services in but a very few districts were very limited and, generally, not incorporated into the over-all control program. We encouraged the employment of entomological services in all districts. This service has yielded some results this year, but we cannot state that their true worth can be measured by activities this year. I

am sure that in the future their true worth will become apparent through financial savings to the districts and more efficient control. We requested this year only the establishment of adult collection stations, and that weekly collections be made in these stations. As a general guide we said that a minimum of five stations per district be established, or one station per fifty square miles for districts containing more than 250 square miles of area.

Financial reports, of course, have been submitted as required by the Department of Finance. I can assure you that this is one of the reports that has been completed satisfactorily. (Filthy lucre, the root of all evils is a true master.) In all cases we have expedited the handling of financial reports and invoices.

Considerable delay was experienced in receiving monthly summary reports from many of the districts. We found it necessary to assure ourselves of receiving the monthly operational reports by requiring that these reports be submitted before invoices covering reimbursement of work during the same period could be processed for payment.

We have asked for operational and entomological reports for several basic reasons. First, we have to be able to account to the Legislature and the State where the money has gone, and what we received in return for it. Adult collection stations are the surest way to make sure that no serious unknown trouble hits a district and are a year-round guide of the effectiveness of control work. In addition, they give a constant record of the presence of the mosquito vectors of disease we were and are primarily interested in. Secondly, our records and knowledge of the work being carried on throughout the State was extremely limited, as was the knowledge of the individual districts of the work they, themselves, were doing. It is impossible to evaluate and determine the cost of different methods of operation without complete summary reports on all activities. I have pointed out many times that now is the time to adopt sound programs and analyze all activities using basic and fundamental engineering and entomological principles which have been described in Herms and Gray's excellent treatise, "Mosquito Control." As we develop our programs, we must become more stringent on the quality of reports submitted to us.

The Mosquito Control Section established a district consultation service which brought to the districts a professional representative to inventory the activities being carried on and assist and advise the districts on their control problems. We have tried to have our representatives visit the districts at least every month and have encouraged their disseminating information on the good activities being carried out in all districts.

Our consultation service has also been extended throughout the State to any locality which does not have an organized mosquito control agency and requested assistance on their mosquito control problems. Our responsibility to be prepared for any emergency was accepted without reservation.

Standardized District Records:

After having completed six months' operation of many of the subvention contracts, we met recently with several district superintendents to reconsider the established reporting system, both entomological and operational, with the hope that we could standardize the records in all districts. Generally, we found that we were not able to discuss one set of forms, either operational daily report forms or entomological survey report forms, or incorporate entomological activities into district operations without considering all the forms that a district has to use. Basically, it was agreed that the fundamental need of each district was an adequate map locating their problems, and that the map should be developed on a section basis and contain property boundaries. Section maps should show sources of mosquitoes, including septic tanks, dairy drains, low spots in pastures, irrigation seepage, canals, etc. The second step in developing permanent records on a given plot of ground was stated to be operational records showing what was found breeding and what control was required on that plot of ground, whether it be an entire section or an individual mosquito breeding source. Finally, it was agreed that all districts who could adequately handle entomological survey work should develop a system of determining what species come from each parcel of land. This special phase will be a tremendous step towards completing the ecology of the mosquito species in that district. Only through such a procedure can species-sanitation be accurately carried out or attempted.

It was agreed that as a basic plan all districts should adopt good mapping procedure this year and a standard daily report form with those districts capable of doing so, to proceed with Step Two mentioned above. We have prepared new daily report forms in conference with a committee appointed from the district superintendents and have modified our monthly summary operational report forms to conform with the new daily report forms. These forms and the adult mosquito collection record forms will be a portion of this paper. The major corrections have been to delete figures on surveillance activities and adopt different units of measure for recording work accomplished.

Subventions Through June 30, 1946:

As I previously noted, the subvention contracts to date total $328,613.50 of the total intended allocation of $400,000. In order to extend the contracts through June 30, 1947, an additional $30,683. will be required. There is, therefore, some $40,000 still available to support the new

districts or old districts who annex more area before February 1, 1947. The following policies have been adopted regarding future subvention contracts and extensions to districts now receiving subvention that annex new areas before that date. Beyond February first no more allocations will be made; that as of that date all moneys not contracted for will be dispersed, as nearly as possible, to districts submitting requests for increases to their districts because of increased areas due to annexation.

Success of Subvention Program to Date:

I think it important to mention again the accomplishments of our program to date, which Doctor Halverson mentioned to you yesterday:

1. Employment of professionally trained experienced men.

2. Development of sounder mosquito control programs based on entomology, inspection work, and use of intense larvacidal operations, including DDT larvacides, and residual sprays to supplement permanent type control.

3. Development of district administration and encouragement of monthly superintendents' meetings held for the districts' mutual benefit.

4. New light and relatively inexpensive mobile equipment to replace the slower and heavier power sprayers formerly used, besides acceptance of the airplane as a tool to solve many of California's problems.

5. And, finally, a great expansion has occurred in the area included in mosquito abatement districts. This last mentioned success will be discussed in detail in developing the program for the coming biennium.

Winter Program (To cover period through February, 1947):

(a) The subvention contracts will require routine visits for the purpose of training the districts in administrative procedure, planning for next season's activities, and reviewing and analyzing their records of the past season's activities.

(b) A training program which will take our personnel to the mosquito abatement districts for the purpose of training their personnel in the techniques of mosquito control and basic field entomology during January and February. This program will involve entomological training (identification of mosquito species, inspection and

collection techniques) and instruction on control (use of residual sprays, effects of emulsifiers, use of DDT larvicides, area maps, etc.), and films and film strips on loan from the U. S. Public Health Service will be used on this program. In preparing our personnel for a more effective program, an in-service training program will be given them also.

This school is now ready to take to the mosquito abatement districts. Announcements were sent to all districts in the State early in December, and some of you may already have received it.

It is intended that this program will give to the individual field worker essential background to acquaint him with the reasons for his work in a thorough and efficient manner besides acquainting him with basic principles of good mosquito control. Training sessions will combine adjacent districts and last three days in each area. It is anticipated that the school can be presented to all districts north of the Tehachapi by the middle of February. Arrangements to present the school to areas in Southern California will be made at a later date.

(c) In the Yolo County Study area plans will be completed for next year's activities and studies on winter hibernation of mosquitoes will be continued.

Changes in our over-all program during the coming year will be covered in my latter paper entitled "Proposed State Budgetary Needs and Control Program for the Coming Biennium." This completes my summary of the subvention program in California for 1946.

California - U. S. Public Health Service, Communicable Disease Center Activities in California:

I will now take the opportunity to commend and review the activities of the U. S. Public Health Service, Communicable Disease Center, in California, throughout the war and now in assisting us in our new program. During the war the staff of this unit reached a total of thirty-five in August of 1942, with control and survey programs being carried on around thirty-seven Army, Naval, and Veterans' installations throughout California.

In early 1946 activities were reduced to a "Jap.-B" encephalitis protection program around the Army International Airports of entry - Hamilton, Fairfield, and Mather and a malaria control project around Castle Field in Merced.

It is now contemplated that in light of the present State-sponsored mosquito control program that their activities in the State of California will more profitably be utilized along lines of operational research, rather than along present actual control lines. Accordingly, the control encephalitis activities around the International Military Airport of entrance were terminated on October 31, 1946. Planes now enter the country at Fairfield-Suisun, which is within the Solano County Mosquito Abatement District, which is under subvention contract. The other project around Castle Field Army Air Base called for malaria control work throughout the fiscal year 1947. Inasmuch as subventions are given to the Merced County Mosquito Abatement District it was felt that necessary emergency control activities could be completed by the Mosquito Abatement District. Accordingly, this control project was terminated on November 15, 1946.

A new project proposal is planned for carrying on CDC activities in California to investigate special problems. In the meantime the following activities will be carried on by the California CDC program:

(a) At Merced two field entomological inspectors will continue regular inspections throughout the end of the calendar year.

(b) An Entomologist, will assist the Mosquito Control Section on a training program presented to personnel of mosquito abatement districts to take place in the several districts.

(c) The work of CDC in California to date will be reviewed and evaluated with the object of summarizing the results of the program, comoiling and editing such observations as deserve publication, and determining what lines of investigation will be most profitable for the present State program.

Essential assistance was also given in August of this year through the provision of entomological assistance in collecting, identifying, and shipping mosquitoes to the State Virus Laboratory for possible recovery of encephalitis virus.

Mr. Ewing: Thank you, Mr. Dahl. Next we will have a further paper on the State experimental program, presented by Dick Peters.

NAME ______________________ DAILY REPORT DATE ______________ DIVISION ______________ ZONE ______________

LARVICIDING or ADULTICIDING WORKSHEET

A or L	R or U	Indicate Service request with SR before Name	TYPE AREA or SOURCE NUMBER	L, P, or A	% & TYPE DDT	OIL	AMOUNT USED By Aerosol	By Power	By Hand	BLDGS., or DITCHES & CREEK Sq.Ft.Treat	FIELDS RIV.BOT. or PONDS Acres Treat	OTHER TREAT Specify	MAN HOURS
NO. SERVICE REQUESTS HANDLED ______			TOTALS —										

NO. INSPECTIONS ________

1st Column
A - adulticiding
L - larviciding

2nd Column
R - rural
U - urban

5th Column
L - larvae
P - pupae
A - adult

DATE _____

DRAINAGE CONSTRUCTION

TYPE	LOCATION	Lin. Ft.	Cu. Yds.	Sq. Ft.	Hours

MAINTENANCE

TYPE	LOCATION	Lin. Ft.	Sq. Ft.	Hours

WEED KILLER

TYPE	LOCATION	Gals.	Sq. Ft.	Power	Hand	Hours

REPAIR & MAINTENANCE EQUIP.

NAME & NO. OF EQUIP.	TYPE WORK	LOCATION	HOURS

GAMBUSIA DISTRIBUTION

Plants Rural	Plants Urban	Fish Ponds	Troughs	Tanks	Ditches	Ponds	Hours

TIME DISTRIBUTION

NAME	Total Hours	Larvi-ciding	Adulti-ciding	Serv. Requests	Insp.	Const.	Main.	Weed Killer	Repair Equip.	Fish

TRUCK NO. _____ SPEEDOMETER READING _____ MILEAGE _____

GAS _____ OIL _____ LUBRICATION _____

REMARKS:

(EVC FORM 2 -1/21/47)

From___ _____ to _____ 194__

MONTHLY PROGRESS REPORT
MOSQUITO CONTROL

T.A.D._____
Location_____
Superintendent_____

1. Larviciding, Rural

	Ditches & Creek Channels				Ponds, Irrigated & River Overflow Areas						
	% DDT	Gals. or Lbs.used	Sq. Ft. Treated	Man Hours	% DDT	No.Cess Pools	Gals. or Lbs.used	Acres Treated	Man Hours	"Plane" Hours	Total Man Hours
A. DDT-Oil by hand										XXXXXXXX	
B. DDT-Oil by power										XXXXXXXX	
C. DDT-Oil by plane											
D. DDT-Emul by hand										XXXXXXXX	
E. DDT-Emul by power										XXXXXXXX	
F. DDT-Emul by plane											
G. DDT-Oil-Aerosol, ground										XXXXXXXX	
H. DDT-Oil-Aerosol, plane											
I. Wet. DDT(spec. meth. appli.)											
J. Oil											
K. Other(spec. type & means of appli.)											

2. Larviciding, Urban

	% DDT	Gals. or Lbs. used	Sq. Ft. Standing H2O Treat.	No. Fish Ponds Treat.	No.Catch Basins Treat.	Sq.Ft.Irri. Ditch Treat.	No. Cess Pools Treat.	Other	Other	Total Man Hours
A. DDT-Oil by hand										
B. DDT-Oil by power										
C. DDT-Emul by hand										
D. DDT-Emul by power										
E. DDT-Oil-Aerosol, ground										
F. Wet. DDT(spec. meth. appli.)										
G. Oil										
H. Other (spec. type & means of appli.)										

3. Adulticiding, Rural

	Type & Strength	Gals. or Lbs.used	Buildings Sq.Ft.Treat.	Acres Treat.	Plane Hours	Total Man Hours
A. Residual Building Spraying				XXXXXXXX	XXXXXXXX	
B. Field Spraying			XXXXXXXX			
C. River Bottom Spraying			XXXXXXXX			
D. Public Gatherings (spec. type & means of appli,)						
E. Other (spec. type & means of appli.)						

4. Adulticiding, Urban

A. Residual Building Spraying						
B. Public Gatherings (spec. type & means of appli.)						
C. Other (spec. type & means of appli.)						

5. Drainage Construction

	Closed Drain		Fill		Ditches: Hand			Ditches: Machine			Ditches: Dynamite			Clearing & Grubbing	
	Lin.Ft.	Hours	Cu.Yds.	Hours	Lin.Ft.	Cu.Yds.	Hours	Lin.Ft.	Cu.Yds.	Hours	Lin.Ft.	Cu.Yds.	Hours	Sq.Ft.	Hours
A. Rural															
B. Urban															

6. Maintenance, Rural

	Sq. Ft.	Lin. Ft.	Total Man Hours
A. Removal of Aquatic & Semi-Aquatic Veg.		XXXXXXXXX	
B. Clearing Land Vegetation		XXXXXXXXX	
C. Ditch Cleaning (Including regrading)	XXXXXXX		
D. Cess Pool Repair & Replacement	XXXXXXX	XXXXXXXXX	
No. by owner_____ No. by Dist_____	XXXXXXX	XXXXXXXXX	

7. Maintenance, Urban

	Sq. Ft.	Lin. Ft.	Total Man Hours
A. Removal of Aquatic & Semi-Aquatic Veg.		XXXXXXXXX	
B. Clearing Land Vegetation		XXXXXXXXX	
C. Ditch Cleaning (Including regrading)	XXXXXXX		
D. Cess Pool Repair & Replacement	XXXXXXX	XXXXXXXX	
No. by owner_____ No. by Dist._____	XXXXXXX	XXXXXXXX	

8. Plant Removal with Weed Killer

	Type Used	Gals. used	Sq. Ft.	Plane Hours	Total Man Hrs.
A. Applied by hand				XXXXX	
B. Applied by power				XXXXX	
C. Applied by plane					

9. Overhead (Insp. & Gen. Sup.)

	Man Hours
A. Inspection, rural	
B. Inspection, urban	
C. Gen. Supervision, rural	
D. Gen. Supervision, urban	
E. Clerical	

10. Miscellaneous Work

	Man Hours
A. Engineering Surveys	
B. Entomological Surveys	
C. Repair & Maintenance of Equip.	
C. Gambusia Distribution, No. of places; rural	
urban	
E. Other (specify)	

11. Public Relations

	Man Hours
A. Addresses	
B. Radio talks	
C. Newspaper articles	
D. Meeting, etc.	
E. Other (specify)	

12. Man Hour Summarization

	Unclassified	Rural	Urban	Total
A. Larviciding				
B. Adulticiding				
C. Construction				
D. Maintenance				
E. Weed Killer				
F. Overhead				
G. Miscellaneous Works				
H. Public Relations				
Totals				
Sick Leave				
Annual Leave				
Grand Total				

13. General Information

A. Square Miles of Area: Under Surveillance_____
Under Control_____

B. No. Service Requests Handled: Rural_____
Urban_____

C. Total Vehicular Mileage_____

14. Brief Comments on Special Problems_____

(BVC ECR 3-1/9/47)

California State Department of Public Health
Division of Environmental Sanitation
Mosquito Control Section
RECORD OF ADULT MOSQUITO COLLECTIONS

Agency

Identified by

Stat No.

Light Trap No.

Location

	DATES COLLECTIONS MADE																								TOTALS	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Anopheles freeborni																										
Anopheles occidentalis																										
Anopheles punctipennis																										
Anopheles pseudopunctipennis																										
Culex pipiens																										
Culex quinquefasciatus																										
Culex stigmatosoma																										
Culex tarsalis																										
Aedes dorsalis																										
Aedes nigromaculis																										
Aedes vexans																										
Culiseta incidens																										

150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

ACTIVITIES IN THE STATE EXPERIMENTAL AREA

RICHARD F. PETERS
Mosquito Control Specialist
State Department of Public Health

When in the early Spring of 1946, Assembly Bill #28, which provided State assistance to local mosquito control agencies, was enacted as an urgency measure, only a fragmentary understanding had been arrived at in regard to the approach or approaches to experimental studies of mosquito-borne disease in California.

Of the $600,000.00 appropriated, an amount not to exceed $200,000.00 was allotted to the State Department of Public Health "for making the necessary studies and demonstrations and administering this act". Deducting approximately $50,000.00 estimated to be required for administering the subvention program and for consultation service to local mosquito control agencies, $150,000.00 remained to cover the demonstration studies over a period of about fifteen months remaining in the biennium. This amount was then further divided between the State Division of Laboratories (virus laboratory), the State Division of Preventive Medicine, Bureau of Acute Communicable Diseases, Section of Epidemiology, The State Division of Environmental Sanitation, Mosquito Control Section, and The G. W. Hooper Foundation.

Originally it was planned to study a heavily inhabited tract of land of approximately 500 square miles, seeking to become completely familiar with all contributing factors in the etiology of malaria and encephalitis. Because of the mode of transmission of malaria in California, being generally agreed upon and accepted, primary emphasis in studies was to be directed toward encephalitis, especially its recently proved vector, Culex tarsalis, its other possible vectors, its control possibilities undertaken through mosquito control and the significant relationships of intermediary animals. In this 500 mile area, effective "eradication" of Culex tarsalis was to be undertaken while studying its habits, life cycle, flight range etc. The incidence of encephalitis in man, birds, and mosquitoes was to be checked in this area and compared with other endemic encephalitic (control) areas, throughout the course of the study. An incidental objective was to gather valuable information concerning the control of pest mosquitoes as well, since their control was inevitable because of the wide range of choice of breeding place characteristic of Culex tarsalis.

Guidance in the experimental studies has come from the State Advisory Committee and it was this group that settled upon a portion of Yolo County as possessing the maximum of merit for accomplishing the program's objectives. Several areas of the state were subjected to careful consideration and the following points were used as a basis for selecting the study area:

1. History of mosquito-borne disease.

2. Presence of a wide variety of mosquito species.

3. Geographical considerations of location and natural boundaries.

4. Significant mosquito control problem.

5. Absence of previous organized mosquito control.

6. Presence of diversified agricultural practices.

7. Interest of local authorities, especially agricultural and health departments.

8. Proximity to institutions of higher learning and availibility of their facilities.

9. Location within a mosquito abatement district to allow for the powers of survey and control possessed by a district.

Since the funds available through provisions of this act were the basis for employing the staff required to conduct the experimental studies, the first essential upon establishing the Mosquito Control Section was to round out the personnel. At that time (April, May, June 1946) the professional candidates for such positions were (and still remain somewhat so) few and far between. Everyone eligible for G. I. post graduate training seemed to be "cashing in". By June a suitable administrator for the experimental area had been selected, but he remained with the study only until the middle of September, because of the housing shortages and the insecurity of a legislative session to the next, appropriation, for continuation of the study. He was unable to be replaced until November. The remainder of the staff we were fortunate in obtaining, since they included a graduate entomologist and five men trained in rodent survey who adapted readily to their new duties. A Sanitary Inspector and several laborers have been available off and on to supplement the staff.

The equipment shortage was the other chief factor limiting the extension of activities. Gradually, a bizzare lot of vehicles have been scraped together to afford mobility if little more.

Before long it was plainly apparent that the objectives of the experimental area had to be drastically revised. The personnel allowed could by no means survey an area of 500 square miles, let alone control it. Hence, the emphasis was altered for any, other than specific control demonstrations, to study of mosquito ecology by both breeding place and adult mosquito surveys and observations. The 500

square miles by force of human necessity slimmed itself to a total of 120 square miles. Revised planning in the area for the present and future calls for concentrating upon an area of approximately 16 square miles.

As has been mentioned, the approach in the studies had to be shifted from emphasis upon evaluation of the effects of control upon the encephalitis picture of the area to that of mosquito ecology with some specific control method evaluation.

Survey has been concerned with both larval and adult mosquito occurence, attempting to determine species peculiarities as to preference for, or choice of, breeding place, and resting place. In general studies have had to be confined to Anopheles freeborni, A. pseudopunctipennis, Culex tarsalis, and Culex stigmatosoma, since they have been the only species occuring in sufficient numbers. The absence of Aedes mosquitoes in the area has been most disappointing.

Efforts in determining the range of breeding place of the Yolo County mosquitoes have been based upon minute surveys and mapping of each section of the area under study. This section plan has since been accorded acceptance by a large number of mosquito abatement districts in California and will be used as a basis for gathering survey data to guide their control operations in the future. Breeding places for the purpose of this study have been lumped into four main categories and species preferences have been determined within each. They follow:

1. Water clear, unconfined, without presence of significant grass decomposition, with no or only slight foulness, with or without algae, usually slightly moving e.g., rice fields and stream margins.

    (a) Clearest, freshest water--A. freeborni

    (b) Slight stagnation--A. pseudopunctipennis

    (c) Some stagnation & decomposing grasses--C. tarsalis

2. Standing or very slowly moving water.

    (a) With marginal vegetation, containing some grass decomposition, some algae, and varying stagnation e.g., seepage, overflow ponds and drains

        (1) Clearest, slight stagnation--A. freeborni

        (2) Some stagnation--C. tarsalis, rarely C. pipiens

(3) Stagnant (foul)--C. stigmatosoma

(b) Without marginal vegetation e.g., hoof prints, shallow over flow ponds or seepage

(1) Clearest, no or slight stagnation--C. tarsalis, A. pseudopunctipennis

(2) Stagnant (foul)--C. stigmatosoma, A. dorsalis

3. Unconfined foul water

(a) Static, e.g., sewer drain, cesspool over flow, industrial wastes, sewage lagoons

(1) Clearest--C. tarsalis (rarely)

(2) More foul--Culiseta incidens, and C. stigmatosoma.

(b) Fluctuating level

(1) Recent--Aedes dorsalis

(2) Receding--C. stigmatosoma

4. Confined water, clean or foul, e.g., cesspools, catch basins, gutters, water troughs

(a) Clearest, with or without algae A. freeborni, C. tarsalis

(b) Slight stagnation, urban--C. tarsalis

(c) Slight stagnation, rural--Culiseta incidens

(d) Plant or animal foul--C. stigmatosoma

These categories by no means associate mosquito species with specific types of breeding places, but rather seek to generalize upon the combined factors which make for finding given species under given conditions. Plans have been formulated to make these categories interpretable in terms of measured pH, specific gravity, species of algae, species of plants, turbidity, etc.

The study area has thirty-two rural adult mosquito resting stations, and nine urban stations under observation. These include outbuildings, chicken houses, pigeon loft, bridges, and culverts. Adults have been collected from each station for ten minutes averaging twice a month, using a chloroform collecting tube. The collections extended over a period from June to November, inclusive. The same four species of mosquitoes were collected in significant numbers, which included: Culex tarsalis, Culex stigmatosoma, Anopheles freeborni,

and A. pseudopunctipennis franciscanus. There appeared to be no significant preference for one type of resting station as compared to another by any of the species observed.

Generally speaking, the number of adult mosquitoes collected corresponded to the rise and fall of the monthly mean temperatures with the striking exception of Anopheles freeborni in the month of October. The number of of this species collected rose sharply in August, then dropped considerably the following month. In October, it rose three times higher than the number collected in August. This suggests either or both a simultaneous mass emergence in the immediate vicinity or migration from outlying districts toward over-wintering shelters. Both the Culex tarsalis and A. pseudopunctipennis franciscianus adult collections consistently followed the temperature curve. As the temperature rose the number of adults of these species increased and as the temperature dropped, the numbers dropped.

In fact, the numbers of C. tarsalis dropped so low for the month of November when compared with A. freeborni as to suggest the following question: How does C. tarsalis over-winter in order to justify the observed early appearance of large numbers of this species in the spring? Perhaps they over-winter in the egg stage. At the end of another year's study we hope to be able to give an answer to this interesting hypothesis.

In comparing the ratio of males to females of A. freeborni it is noted that the females outnumbered the males on the average of about three to one during the summer months. During the month of October, the ratio is almost one to one; presumably the males have migrated into shelters from the breeding areas during the mating season. In November the male population is reduced considerably, to the ratio of twenty females for each male. Evidently the males die off after mating and the females then over-winter.

The C. tarsalis picture is somewhat different. Females also consistently outnumbered the males during the summer months. During August when the adults are most numerous the females outnumbered the males about twenty to one. Thereafter the total population dropped. By November the ratio was one to one, and the total population was very small as previously stated.

The absence of C. pipiens adults was very conspicious. Although there were a number of adult collection stations within the city limits of Woodland, relatively few were collected, despite the proportionately high larval observations in gutters and catch basins. This may have been due to a control program that was carried out in the city during the summer. Perhaps other types of collecting stations should have been used. More time will be spent this coming season observing the adult habits of this species.

Data concerning Culex stigmatosoma indicates the likely preference of this mosquito for natural resting places, as numbers collected in man made stations proved to be disproportionate to the amount of larvae observed. Gradually as summer waned larval occurence of this species in gutters and catch basins was succeeded by Culex pipiens.

Studies planned for 1947 in the experimental area will attempt to supply further information concerning the ecology of California mosquitoes. More specific and interputable data will be sought on the species available for study. It is hoped that some sort of "formulae" made up of the ecological characteristics of each species can be developed as a result of closely measured observations on each. Through such information, a better appreciation of the possibilities of species sanitation in control may be realized.

Mr. Ewing: We will now take a recess for ten minutes.

RECESS

Mr. Ewing: The next paper will be presented by Dr. Reeves on some phases of the Hooper Foundation work on encephalitis.

A PRELIMINARY REPORT OF THE RESULTS OF PLANNED COOPERATIVE FIELD STUDIES

by
the staffs of

The Neurotropic Vivus Unit of the George Williams Hooper Foundation and the Dr. Morris Mosquito Abatement District.

This investigation was carried out in collaboration with the Commission on Neurotropic Virus Diseases, Army Epidemiological Board, Office of the Surgeon General, U. S. Army; aided by a grant from the California State Department of Public Health, and assignment of personnel by the Communicable Disease Center, United States Public Health Service.

Paper read by W. C. Reeves, Ph. D.

The summer of 1946 marked a new point in cooperative endeavor between workers of the Dr. Morris Mosquito Abatement District and the Neurotropic Virus Research Unit of the George Williams Hooper Foundation. We believe that the results of this cooperative program and the benefits derived by each of these organizations are an example of the value of such projects. Much of the amassed data of this program is at present in the process of analysis, and unfortunately, it is not possible to present all of the findings at this time. However, it is possible to outline the manner in which this

joint program was set up, and to discuss certain general ecological observations on the flight range of Culex mosquitoes, findings on the biology of larval Culex and the application of such data to practical problems of a mosquito abatement district.

In April of 1946, those persons responsible for the direction of the Dr. Morris District, and those in charge of the field program of the Hooper Foundation Research Unit discussed the ways and means by which each organization could benefit from the activities of the other. They considered the pitfalls which too frequently lead to misunderstandings between one organization concerned with as complete a control program as possible, and another organization interested in the success of such a program, but still more concerned with the accumulation of scientific data on the biology and disease vector importance of mosquitoes. A complete understanding of the aims of the two programs, and a logical approach by which these aims might be achieved, was soon reached. With the two organizations in full accord, and sympathetic with each others needs, cooperative projects were developed which did not seriously interfere with normal operations of either group.

A major problem for most mosquito abatement districts has long been the need for additional training of their inspectors in entomological methods of inspection for adult mosquitoes in daytime resting places, collection of mosquito specimens for identification, and particularly for instruction of newly employed personnel on the basic ecology of adult mosquitoes together with the application of the benefits and uses from such training and the consequent accumulated data. This type of training can best be obtained by actual demonstration and participation in such activities under field conditions. The Hooper Foundation staff agreed to assist in this training program, as with the additional personnel it afforded, extension of its own program on the flight range and larval biology of Culex mosquitoes was made possible. Obviously the data accumulated from such studies would be of considerable value to both organizations.

Flight Range Studies:

Very little is known concerning the flight range of Culex mosquitoes, and certainly this is the first reported study on the flight range of California Culex actually based on the release of marked specimens and their subsequent recapture at varying distances from the release point. We are not going to go into all the details of the methods employed in this study, as you are undoubtedly more interested in the results obtained, and their application to your control activities.

The adult mosquitoes to be used in this study were reared in the Foundation laboratory from field collected larvae. These adults were dusted with a non-toxic fluorescent material, Rhodamin B and any specimens so marked were easily recognizable at a later date since under ultraviolet rays they

appeared to be covered with small pin point red spots. Marked specimens were released in the middle of our study area, and on the following days collections of wild adults were made at varying distances from the release point in an attempt to recover the marked specimens.

The mosquito species included in these experiments were Culex tarsalis, Culex stigmatosoma and Culex quinquefasciatus. These species were studied because of their importance as disease vectors and pests.

A total of 12,500 marked Culex tarsalis was released, and 14,873 specimens of wild mosquitoes were collected in an attempt to recover marked specimens. Only 5 marked Culex tarsalis were recaptured. Two of these were taken at a distance of one half mile, and three at one fifth of a mile from the release point.

There were 4,500 marked Culex stigmatosoma released, and 3,048 specimens were collected in attempted recoveries. Ten recaptures were made; 9 at one fifth of a mile, and 1 at a mile distance from the release point.

26,900 marked Culex quinquefasciatus were released, and 18,244 mosquitoes were collected in attempted recoveries. The 47 recaptures were as follows:

29 at one fifth of a mile
8 at one fourth of a mile
2 at one half mile
2 at three quarters of a mile
5 at one mile
1 at two and one half miles

The difficulties encountered in such studies are, we believe, obvious. Of 45,000 specimens marked and released, only 62 were recovered or less than 2/1000. While there are many possible explanations for this low rate of recoveries, one of the most important factors is that we only collected and examined 36,165 mosquitoes in our attempts to recover those 45,000 specimens which we had released. Since approximately 51 square miles were covered in these collections, and 36,000 mosquitoes is a very small sample from the total mosquito population of that area, the chances of making recoveries were somewhat low. In other words, the number of mosquitoes marked and released was extremely small in proportion to the total mosquito population of the 15 square mile area. To obtain more complete data, it would have been necessary either to release much greater numbers of specimens, or to make many more extensive collections. This was impossible with the limited personnel available, and even these figures would have been impossible to obtain without the assistance of the personnel of the Dr. Morris District. The members of the District who participated received extensive and valuable training in the methods of collection and detecting adult

mosquitoes.

Now let us consider the application of the findings of this study, as they apply to the control program of a mosquito abatement district. You are concerned with how extensive an area within your district will be invaded by an untreated or undiscovered breeding source of Culex. You are concerned also with the distance outside of your district in which control activities must be carried on to afford protection of those persons living in your district. It is obvious from even these limited studies that an extensive breeding ground of Culex quinquefasciatus (such as a sewer farm or dairy drain) even when located more than a mile outside of your district can serve as an important source of trouble within your district. The numbers of mosquitoes released in these studies are not even a small part of the "drop in the bucket" which even a limited breeding grounds can produce. Admittedly with the data at hand we do not think of Culex as having the flight ranges credited to Aedes, but we can no longer think of Culex solely as a back yard problem, and as being a nuisance only to those persons living in the immediate vicinity of the breeding grounds. We know now that Culex quinquefasciatus frequently may travel a mile, and is even able to go two and a half miles. Culex tarsalis may travel at least a half mile, and Culex stigmatosoma have been recovered up to one mile from their release point.

Larval Biology of Culex

The Hooper Foundation staff had developed as a part of its program an investigation of the biology of the aquatic stages of Culex tarsalis. It was felt that in order to further facilitate the control of this important disease vector, more extensive knowledge was essential. The Dr. Morris Mosquito Abatement District was intensely interested in similar data on all species of mosquitoes in that area. Such information would aid in evaluation of their control program, and undoubtedly lead to indications of which types of water were the most frequent sources of the worst pest and disease bearing Culex. With a more detailed knowledge of the preferred breeding places of the various species as a guide, inspectors could concentrate their efforts to produce the maximum benefit. With an increase in the uses of adult collecting stations as indicators to evaluate the control program, it was essential to know in detail the types of water from which the various species were most likely to come. With this mutual problem in mind, the two organizations once again pooled their resources and personnel to materially increase the data which should be collected, as well as to standardize the method of handling, recording and analyzing such data so that a basis necessary to the results of the work of both groups might be established. Personnel of both organizations made extensive larval collections throughout the six summer months; basic data were recorded on a standardized form, and all identifications were made by

trained entomologists.

A total of 936 collections have been analyzed. Of these, 315 collections (33.7%) contained C. tarsalis; 613 collections (65.5%) contained C. quinquefasciatus; 66 (7.1%) C. stigmatosoma; 56 (6.0%) A. pseudopunctipennis and and 18 (1.8%) A. freeborni.

C. tarsalis has been found in Kern County associated either with one or several of the following species of mosquitoes: C. quinquefasciatus; C. stigmatosoma; C. thriambus; C. erythrothorax; C. inornata; C. incidens; A. pseudopunctipennis; A. freeborni and A. dorsalis; and A. nigromaculis.

One river side pool yielded C. tarsalis with C. stigmatosoma, C. quinquefasciatus, C. thriambus and A. freeborni.

In Kern County 93 per cent of C. tarsalis collections and 99 per cent of C. quinquefasciatus collections were from man-made sources. About one half of the tarsalis and one fifth of the quinquefasciatus collected were from irrigation water. In both cases the most important sources from irrigation were waste and tail water, irrigation sumps and canal and ditch margins - thus bearing out the importance of improved irrigation practice as a mosquito abatement measure.

Twenty per cent of tarsalis collections and 63 per cent of quinquefasciatus collections were made in domestic and farmyard situations. Sources for C. tarsalis around the house and in the farmyard, in order of their importance, were found to be ground pools due to leaky faucets and the like, drinking troughs for domestic animals, drainage and cesspool overflow. For C. quinquefasciatus these sources were found to be drinking troughs, leaky faucets, dairy drains, cesspools and their overflow. These conditions further indicate the need for detailed inspection of premises by the Abatement District, and education of the public in the means of making correction of such sources.

In the past, a number of the district superintendents have questioned the value of detailed entomological data obtained by collection and identification of larval and and adult mosquitoes in relation to their districts. While most districts have been established for the abatement of pest mosquitoes, it is a foregone conclusion that should an extensive outbreak of a mosquito borne disease occur within the boundaries of a district, the mosquito abatement district itself is invariably held responsible by the local taxpayers for allowing such a situation to develop. In the event of such a situation, it is essential that the district be able to present a clear and concise picture of the prevalence of the responsible species, and what operations of the district have been aimed at its control. When a Board of Trustees or

a Committee of local taxpayers begins to ask questions, the value of the abailability of well founded and recorded data from which a concise report may be orepared at once, instead of vague remarks concerning personal impressions, cannot be over estimated. Such reliable data may mean the difference between responsible personnel looking for a new job and keeping the ones they have.

If reliable data is continuously collected, a district can more intelligently direct the emphasis of its program and keep its finger on any species changes. Such changes often prove of major importance to the district's control program, in that they call for a shift in the type of control operation in many instances.

The following is an illustration of the application of what is currently known as "entomological" data, to a very practical problem by the Dr. Morris Abatement District:

In July of this year a physician in Bakersfield began reporting cases of malaria to the Kern County Health Department. This was not a simple matter of one or two cases, for within the following four months he had reported over 20 cases. The question of whether Anopheles mosquitoes were so prevalent in and around Bakerfield that an epidemic of malaria could occur, arose immediately. It was the responsiblity of the Dr. Morris District to answer this very pertinent question, and if it were found that such a situation existed, immediately institute measures to control the outbreak. Within several days following the report of this situation to the district, a detailed report on the current Anopheline picture in the vicinity was prepared, using their adult and larval collection records as source material. Briefly, this report included the following data:

> Potential Anopheles breeding waters in this area are limited for the most part to canals, ditches, the Kern River and seepage from any of these sources. Water of this type in this area is quite limited and seasonal. There are seven main canals that flow through the district with all but three of these usually drying up by July or August of eaoh year. These canals are stocked with Gambusia affinis (mosquito fish) in great numbers and favorable A. freeborni breeding locations are limited to a few weed-grown spots along their margins.

In June and July larval collecting stations were established along these canals and in the most favorable breeding locations. A total of 140 collections have been made at these stations and in nearly all instances collections contained an average of less than one larva per dip.

A total of 839 larval collections have been made in the District and the species in these collections have been identified Anopheles freeborni was present in only 17 out of the 839 collections and Anopheles pseudopunctipennis in 45.

During the present season 9 to 54 adult collection stations have been maintained in the District. These were visited weekly and the mosquitoes present counted and if possible 25 collected and identified. In addition miscellaneous collections of adult mosquitoes have been made at random throughout the District. A total of 643 adult collections have been made including 13,010 identified specimens. Of these specimens only 26 were A. freeborni and 42 A. pseudopunctipennis.

These data collected throughout the District along with the finding of no Anopheles in premise inspections at the homes of the first reported cases of malaria, indicate anophilism is at a very low level within our District.

This report when submitted to the State and County Health Departments and the Board of Trustees of the Dr. Morris District, supplied sufficient authenticated information to assure these bodies that the situation was under observation, and well in hand. What appeared to be an epidemic of new malaria cases was, at worst, largely a series of patients relapsing from infections suffered in preceding years. The problem resolved itself into one for medical treatment, rather than one of more extensive and more complete mosquito control. With the low density of Anopheles known, the danger of the spread of malarial infection was shown to be at a minimum.

Mr. Ewing: Mitchell Mondala of the Washington State Department of Public Health is unable to be present. Dick Peters has a telegram from him. We will therefore pass on, and ask H. H. Stage to speak on the American Mosquito Control Association, of which he is President.

Mr. Stage: It is always a pleasure to be able to attend your annual meetings. It so happens that this year I am attending in a dual capacity, one as President of the American Mosquito Control Association. I hope this honor will be passed on to one of your members within the next few years.

I would like to discuss with you the aims and objectives of the American Mosquito Control Association. Many of your members are also members of the American Association, and I hope many more will join us. I cannot do better than read some of our objectives from the back of our membership blank.

(READS)

As regards our publication, "Mosquito News", I cannot say anything more generous than what Professor Herms said yesterday afternoon.

Our organization has grown steadily and I believe it will continue to grow numerically and in value .

The Association has two or three projects that I consider important to members. We are interested in developing a list of people engaged in mosquito control and related subjects. This list is to appear in Who's Who in Mosquito Control. I have asked Professor Herms to serve as Chairman. He has five or six helpers. In a year or two it is hoped we will have such a volume compiled. Another publication is an index to the literature. That will be a tremendous task and will again require a couple of years. It will serve a very useful purpose when finished. Another thing is the Membership Campaign. Harold Gray is Chairman of the Membership Committee. I would like to ask you who already belong to the Association to raise your hands. Probably half belong. The rest should make excellent prospects, Harold.

Mr. Gray: We have here application blanks for membership and I will hand you a blank and take your check from you for four dollars.

(Application blanks were distributed and a number of new members signed up.)

Mr. Ewing: Thank you very much, Mr. Stage. I will now turn the meeting back to President Geib.

Mr. Geib: We will now adjourn for lunch and reconvene at one o'clock.

RECESS

The meeting reconvened at 1:15 p.m., President Geib presiding.

Mr. Geib: For the afternoon session I will ask Ted Raley, Superintendent of the Sutter-Yuba District to preside.

Mr. Raley: The first discussion on this afternoon's program will be a presentation of kodachrome slides, with descriptive comment, by H. H. Stage, concerning a malaria control project in Dutch Guiana.

Mr. Stage: About a year ago representatives of the Aluminum Company of America came to the Bureau of Entomology and Plant Quarantine for advice on the control of malaria on a bauxite mine in Surinam in South America. On account of fire hazard and also possible toxic effect on animals it did not appear advisable to use the ordinary xylene emulsion of DDT. Under the conditions it appeared probable that a 50% DDT wettable

powder would be the best answer, and I was selected to go this bauxite mine and supervise its use, which I did under leave of absence from the Bureau. I took with me 1½ tons of the DDT material.

I shall present a series of color photos taken on this trip, with a running commentary on them.

(Mr. Stage then presented a series of slides showing the country, the people, and the mosquito and insect control measures taken by the company under his advice.)

Mr. Raley: Thank you, Mr. Stage, for this most interesting and informative discussion. It is an honor to have you with us. I well remember the pictures you showed us at our last conference, on your tests of repellents near the Arctic Circle. I am sure that many of us would like to join you on these expeditions.

Our next paper will be by Mr. Jones of the State Department of Public Health on engineering principles in mosquito control.

THE APPLICATION OF ENGINEERING PRINCIPLES TO MOSQUITO CONTROL IN CALIFORNIA

by

Robert W. Jones, III
Mosquito Control Specialist

Engineering principles have been applied to mosquito control work for many years. Even as long ago as 1717, the Italians were aware of the good effect of drainage to such an extent that this principle was accepted as dogmatic in the medical schools of that day, according to Sir Ronald Ross. But the most notable example of mosquito control projects dependent in the main on permanent corrective measures has been the work done by Gorgas, LePrince and Crenstein in controlling the vectors of malaria and yellow fever in the Panama Canal Zone.

Engineering principles have a universal application to mosquito control work, but some of the techniques are more applicable to one specific area than to another. For example, in the southeastern states, the chief problem is the drainage of swamp areas that give rise to the vector of malaria, Anopheles quadrimaculatus; in New Guinea, which is known for its extensive swamp areas, it was found that the chief problem was the control of man-made mosquito sources, so that drainage of the swamps was not necessary; on Luzon in the Philippines, the chief problem was the elimination of sources of the malaria vector, Anopheles minimus flavirostris,

by the installation of syphon dams on hill-side streams; in New Jersey, the problem is the control of salt-marsh species of mosquitoes by drainage and flushing; and in California, the problem is not only the control of the malaria vector, Anopheles maculipennis freeborni, and the vectors of encephalitis, but also general pest abatement.

The application of engineering principles to mosquito control does not resolve itself merely to drainage and filling operations in the field. An engineer deals primarily with weights and measures, cost analyses, labor production, and surveys; the word itself is derived from the Latin ingenium, which means "natural capacity or ingenuity". The application of engineering principles is, therefore, a broad subject covering many phases of mosquito control work, but the following items, some of which are basic to any mosquito abatement program, are the ones to which we must pay the closest heed:

(a) mapping program
(b) reporting system
(c) record system
(d) permanent control measures; e.g., drainage and filling
(e) control incidental to larviciding activities; e.g., brushing, etc.
(f) larvicidal measures
(g) adulticidal measures
(h) balanced program; i.e., larvicidal, adulticidal permanent
(i) balanced personnel; i.e., engineer, entomologist

Let us analyze these items: It is of primary importance that an adequate mapping program for any control area under consideration be instituted at the outset. No district can hope to know and understand the varied problems facing it in terms of mosquito sources until, and unless, it has a complete and thorough map of the area. The map should be of sufficient scale to show all possible mosquito sources; a minimum scale of one inch to 2,000 feet should be used. All water surface, running or stagnant, temporary or permanent, must be shown, as well as other pertinent data such as roads. bridges, general topography and population distribution. Such a mapping program should, therefore, be the first step in any abatement procedure.

However, it must, of necessity, be a changing record, since most of the mosquito sources in this state are dependent on irrigation practices. One should be able through the use of zone, township, and section designation, or through such other system as might be devised, to locate each mosquito source definitely by code designation. Such a system has the obvious advantage of permitting the replacement of personnel or the training of new personnel to maintain continuous operations with a minimum of effort on the part of the superinten-

dent; as well as allowing an efficient and rapid cross-check system on the work of the men in the field to be instituted. The latter factor is an extremely important one if the superintendent of a large district expects to be able to know at all times of the progress and status of the job he is attempting to do.

It will, of course, be necessary to maintain certain records to be in conjunction with the map of the area. A report of each inspection and treatment of a mosquito source must be kept as a running record so that comprehensive records of the changing ecological picture and the costs of the various phases of the work may be prepared and analyzed. This entails the use of a daily report form by the men in the field which will show what the ecological picture at a given mosquito source is, where the source is located, what treatment has been instituted, how much larvicide has been used, and the time required for the job. The source location as shown on the daily report is an important itme for several reasons, chief among these being the facility allowed in cross-checking on the efficiency of the field crews. Added to this are the marked advantages of being able to defend a district against charges of lack of work and against unfounded claims for damages due to the unexplained death of cattle or failure of crops.

A permanent record system giving the pertinent information of ecology and treatment of a section or of individual sources should be established, with basic information gained from the daily reports. This will enable an overall picture of the situation in a district to be built up over a period of years. From these permanent records, analyses of the work may be made. The analysis of costs may well in the next few years be of paramount importance if general economies in the State and local governments are instituted. In such an event it would prove necessary, in order to continue on a curtailed budget, to plan and to concentrate the work done on those areas in a district where species of mosquitoes that are either disease vectors or serious pests were found to be more numerous. In areas where species of mosquitoes that are not disease vectors and seldom bite man were prevalent, little work would be necessary. As you can see, it would not be enough in such an event, i.e., a budgetary reduction, to merely go out and kill mosquito larvae wherever they were found. A scientific approach to the problem would, at such a period, be as mandatory as it is now desirable. Unless a program toward this end has been in operation for several years and the past records are available for study and analysis, a district would have a difficult time. One that was only interested in eliminating mosquitoes without plan would be in for a period of serious discomfort, if not total failure and dissolution.

The next majo phase of a mosquito abatement program which I wish to discuss is permanent control work;

the elimination of mosquito sources as opposed to their continuous and transitory treatment. Of course, the use of DDT has made our temporary treatments much less transitory than during that previous period when we were using only Diesel oil. However, our major cost in the operation of a mosquito abatement program is in labor, and any routine, temporary treatment which can be eliminated places us that much in the black on our ledgers.

Many of us may feel that since the major problem of mosquito breeding here in California is dependent upon irrigation water, little can be done in the way of permanent control work. However, much of the breeding that takes place occurs in irrigation water that would not be present if proper tail-end drainage were supplied. Such drainage should, of course, be the responsibility of the drainage district and any major work along this line would have to be undertaken by this district. But there is much that the individuals of a mosquito abatement district can do to encourage a drainage district in such work and there is also much that can be done directly by the abatement district during the winter months in elimination of mosquito sources by drainage and by filling. Here again an over-all map of the area comes into play, for any drainage work done must tie up with the existing system so as not to cause another problem in another place.

Educational work has been done by some districts toward the elimination of problems through the individual property owner. Here in California it is not sufficient merely to secure the co-operation of individuals in closing cess-pools, burying or puncturing cans, and the like. An intensive educational program must be undertaken to show the individual that proper irrigation practices will not only lessen mosquito densities but will also benefit him agriculturally.

Of course, there remain problems which cannot be handled in any other way than by temporary and continuous larvicidal measures. One of the prime examples of these is the retention of water for long periods in orchards in order to size the fruit. It is apparent that in such cases permanent measures cannot be utilized. However, permanent control measures are applicable to many of the existing problems. Drainage and filling have been recognized for years as a means toward the control of mosquitoes and the reduction in cost of control work. Much of the work done by well-known figures in the mosquito abatement field has been solely dependent on such permanent corrective measures. Each mosquito source thus eliminated places a district that much nearer its goal of mosquito control.

In addition, in order to properly and efficiently carry out a larvicidal program on those sources which can not be permanently eliminated, such work as clearing and brushing, regrading of channels, removal of emergent vegetation and floatage from ponds and sluggish water courses, must be done. Most of these phases of the work can also best be

carried out during the winter months. Here, too, we find the necessity for the over-all planning of a program in order to effectively reach our goal. Piece-meal work toward this end would prove decidedly ineffectual, since one would have no idea of where to begin his work in order to minimize the time needed for larvicidal operations.

This brings us to a consideration of larvicidal measures, which may seem far removed to some of you from the subject of this paper. However, engineering principles need also to be applied to this phase of abatement work. Larvicidal operations, particularly since the advent of DDT, have become very technical in nature. Properly designed spray equipment has become necessary so that the correct dosages of the larvicides may be applied. Time-cost studies must be made here in order to reduce the cost of the program as much as possible. Solvents and emulsifiers must be chosen with care in order to do the necessary job efficiently. Light, mobile equipment has replaced the heavy, slower equipment formerly used with Diesel oil. This change has been made possible through the considerable reduction in bulk of the larvicide through the use of DDT. Comparative cost analyses need to be made in order to determine the economy and feasibility of continuing larvicidal control or eliminating such control through permanent corrective measures.

Larvicidal operations will also entail the use of spray rigs mounted on planes. The rigs may be either of the conventional liquid spray type or may be of the aerosol type. In either case, the determining factor in a decision to use planes in larvicidal activities will be dependent on the relative costs involved. In addition, all this equipment is under study and subject to design changes in order to increase the efficiency and decrease the costs of such operations.

Adulticidal measures in a control program call for the same cost studies and equipment design studies as do the larvicidal measures. The chief part of this phase of an abatement program is residual spraying. It is extremely important here that the operations in the field receive the proper study and consideration. It has been generally accepted that the optimum residue of DDT on a sprayed surface in residual work is between 150 and 200 milligrams per square foot. In order to be sure that this optimum is reached, it is necessary to study and know the spray equipment, nozzles, % DDT and solvent used, as well as to carry out time-motion studies on the men doing the work.

In any abatement procedure it is necessary to plan and carry out a balanced program. Each one of the phases covered, i.e., larvicidal, adulticidal, and permanent, has its place in the program. Its proper weight can only be determined by the application of engineering principles. A balanced program will require a like balance in the personnel involved, i.e., the engineer and the entomologist. The entomologist is needed to determine species, densities, sources, and to check

control results. The engineer is needed to analyze these data and then apply the mechanics of sound engineering principles in order to obtain efficient and economical control. Unless such a balanced program with balanced personnel is developed and maintained, efficiency and economy are generally lost.

Mr. Raley: Thank you, Mr. Jones. Since our time is very limited, it will be necessary to dispense with discussion and proceed with the papers. The next is by a man who has been most helpful to the mosquito control movement in California, Mr. Frank Stead.

Mr. Stead: It is possible that the title of the paper I am going to present may not have been readily understood, so I wish to clarify it by a few preliminary remarks. You must remember that water is the greatest of all problems in California. It is true that almost enough water falls in California to match the needs of the state, but it is very poorly distributed as to both regional and seasonal needs. The bulk of our rainfall occurs in the winter, but the bulk of the need is in the summer. Regionally, the northern part of the state, say north of Sacramento, has a surplus of rainfall above its regional need, and the remainder of the state has deficient water supplies.

It is therefore necessary in California to plan carefully for the development and use of the available water supplies, and conferences to develop such over-all planning have been held, and general plans for water usage developed. In this planning the mosquito control people have not been represented, but the water planning agencies need to hear your side of the problem, as there needs to be wise planning to minimize unreasonable use of water. While it is important to irrigate in California, there should be no waste of water, for reasons that are obvious to you but which are not obvious to many users of water. Cooperation among all those who have interest in the water problems of the state is necessary and advantageous to these various interests, and my paper is intended to clarify the problem in relation to your interests and the welfare of the state.

RELATION OF MOSQUITO BREEDING TO USES OF WATER

by
FRANK M. STEAD, Chief
Division of Environmental Sanitation
State Department of Public Health

Occasionally it is a good idea for those charged with the responsibility of controlling mosquito breeding to raise their eyes from the immediate demands of the local problem and consider those broader aspects of activities which are in the last analysis responsible for the mosquito breeding problem itself. Since mosquito breeding, of necessity, results from and is confined to areas of surface water it is pertinent

to consider those activities and interest which govern the uses of water and its distribution on the surface of the ground.

The Central Valley of California is endowed with tremendous water resources but their distribution, both with respect to place and time, is such that under unregulated conditions undisturbed by the activities of man a relatively small portion of the total area in the Central Valley would be watered during the mosquito breeding season. Under natural conditions most of the runoff in the Central Valley occurs during winter months and the greatest portion of the runoff is confined to the northern portion. There are at least six important uses or benefits which require regulation of water and it is the purpose of this discussion to consider them from the standpoint of the effects which each has on the problem of mosquito breeding.

Flood Control

The first interest to be served by regulation of water is flood control. The Central Valley project now under construction by the U. S. Bureau of Reclamation at an ultimate cost of approximately a quarter of a billion dollars is justified principally on this consideration. The regulation of water to accomplish flood control tends toward the maintenance of uniform flows in rivers, canals and water courses. By the elimination of periods of overflow flood control measures tend to reduce mosquito breeding areas during the early part of the mosquito breeding season, but by the making available of sizable stream flows throughout the year flood control measures serve those subsequent uses of water which result in the spreading of water on the surface of the ground throughout the summer months so that the end result of flood control measures is undoubtedly an increase in mosquito breeding.

Power Development

The requirements of power development, which is frequently accomplished at the point of release of water from flood control reservoirs, is a factor tending further toward a uniform release of water throughout the spring, summer and fall and consequently tends toward an increase in subsequent uses of water which affect mosquito breeding.

Irrigation

Probably the most important beneficial use of water in the Central Valley is its use for irrigation. This use of water spectacularly results in the bringing of water to otherwise dry areas, and the spreading of it over large areas on the surface of the ground. When large quantities of irrigation water at low cost are available there is a tendency to wasteful practices which result in the actual flooding of areas of wasteland in the vicinity of irrigated fields. A less obvious but equally important effect of irrigation is

that the continued application of water to a new area results over a period of time in a gradual rising of water tables so that areas of land at a low elevation which would otherwise be dry become flooded. This increase in flooded or marshy areas which are sometimes considerably remote from the areas of irrigation themselves multiply the cost of mosquito control measures many times.

Industrial Use

The volume requirements for water used by industry are huge. Many industries use more than a million gallons of water a day. The demands may be year round, as in paper mills, or seasonal as in canneries. In the latter case the season of heavy demand coincides with the mosquito breeding season. The principal effect of industrial use of water on mosquito breeding, however, lies not in the quantity of stream flow necessary to supply the industries, but rather in the disposal of industrial wastes. The activities of state regulatory agencies in the prevention of pollution of streams result in the large scale disposal of liquid industrial wastes on land. Since these industrial wastes contain suspended and colloidal material, they tend to clog the pores of the soil on which they are spread. Consequently, large areas of land are flooded with shallow ponds and many square miles of new mosquito breeding areas are thus created every year.

Domestic Use

The quantity requirement for domestic use of water from the streams in the Central Valley are in total relatively small compared to industrial and irrigation demands. Quality requirements, however, are extremely high and require the maintenance of large volumes of stream flow. In some areas, such as those served by the Contra Costa canal, the increased flow from Shasta dam has resulted in the elimination of brackish water and there is now taking place in the unlined waterways a process of leaching out of the salt from the soil of the streambed and banks. Since this leaching process imparts salinity to the fresh water in these waterways it is necessary to maintain large volumes of flow for purposes of dilution. Another factor in the water quality where domestic use is concerned is that of temperature, and again in the case of the Contra Costa canal large volumes of flow need to be maintained for the maintenance of satisfactorily low temperatures for domestic use.

Salinity in Flow

Entirely aside from the factor of leaching of salt from the soil in unlined stream channels is the problem of maintenance of fresh water conditions at the mouths of the San Joaquin and Sacramento rivers. In order to prevent the upstream travel of salt water during periods of high tide, it is necessary to maintain large volumes of fresh water flow

at all times. This requirement is existent the year round. The benefits of salinity control are numerous, one of the principal benefits being the availability of large volumes of fresh water for industrial purposes at the industrial sites near the mouths of the rivers in question.

It is apparent from the factors discussed that the problem of control of mosquito breeding is not a fixed or static one but instead may be affected by many factors of water use over which mosquito control agencies have no control. Almost without exception the increased regulation and use of water in the Central Valley will tend toward an increase in the problem of mosquito breeding, both from the standpoint of increased area and an increase in the number of months per year during which surface waters will occur. The cost of mosquito control in the Central Valley is already a tremendous one with the area now under control. If as a result of the factors of increased water use and a rising standard of comfort on the part of the people, it becomes necessary to provide complete mosquito control for the entire Central Valley, these costs may well become prohibitive. It appears, therefore, that far-seeing planning on the part of those agencies whose responsibility it is to regulate water uses must be done in order that the situation not develop where in our enthusiasm for one type of benefit we create insuperable problems on the part of those agencies engaged in mosquito control and the protection of public health.

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Mr. Raley: Thank you, Mr. Stead. We all appreciate your efforts to clarify this matter for us. It is one of the most important and valuable presentations which we have had at our meetings.

The next paper will be by Chester Robinson on proposed legislation.

Mr. Robinson: In view of Mr. Stead's paper it appears that I should re-write portions of this paper.

PROPOSED LEGISLATION

by

E. Chester Robinson

Members of the California Mosquito Control Association:

In this report to you on the proposed legislation relating to mosquito abatement districts to come before the State of California legislature meeting in January 1947, I have not put in the exact wording of these bills. The reason for this is that wording of the bills have not been approved by the legislative council. Therefore, we will consider only what the bills are to accomplish and the reason for their presentation.

First and foremost, to most of us, is the request to the legislature for the continuance of the state subvention fund. The amount we will ask for will be $1,200,000.00 for the biannum for the fiscal years 1947-1948. This is equivalent to the $600,000.00 granted for the fiscal year 1946-1947. The advisory committee to the State Department of Public Health believe that to stop the state assistance at this time would leave incomplete the research and demonstrations now in progress. They further believe that because of the high labor, equipment, and material costs, that new districts, those now being formed and the enlargement of existing districts will require financial assistance. It is therefore recommended by this committee that a program of reducing the percentage of the state participation in district's finances be instigated. In other words, it is anticipated that after a few years of assistance to get the districts well established that they should then be self-supporting. The state finance committee will be presented with this request for the subvention fund and if the request is granted it will not be necessary to present a bill to the legislature.

1. An amendment to section 4004.5 of the penal code to add mosquito abatement districts to the other districts mentioned in this section. The reason for this bill is that some District Attorneys have ruled that it is illegal for the Board of Supervisors to advance money to mosquito abatement districts in anticipation of tax revenue.

2. Add to Section 2300 the following sentence: "The amount of money necessary for the District's purposes may include a cash basis fund and an emergency fund."

These changes in the mosquito abatement act are necessary to make it legal for a mosquito abatement district to create a reserve fund to operate between the end of the fiscal year and the time tax revenue is available.

3. "2314. The district board may establish and maintain an emergency fund, for the purpose of defraying unusual and unanticipated expenses incurred during epidemics or threatened epidemics of insect borne diseases. Expenditures from such emergency fund may be made only upon a four-fifths affirmative vote of the district board. Such emergency fund is not to exceed 25% of the estimated expenditures for a fiscal year."

In view of the fact that so many districts are now being formed on a county-wide basis, and in some cases several counties, it is thought advisable that an emergency fund be established in order that these districts might immediately start operations to control an epidemic of mosquito borne diseases.

4. Add a section to the Mosquito Abatement Act, authorizing the Board of Trustees of a district to change the name of a mosquito abatement district.

5. Add a section to the Mosquito Abatement Act, allowing consolidation of mosquito abatement districts upon a three-quarters vote of the Board of Trustees of the district wishing to consolidate. This resolution of intention should then be approved by the Board of Supervisors of the county or counties in which the districts are located.

6. Add a section to the Pest Abatement Act on consolidation. This is necessary because under the present law there is no provision for consolidation.

7. Add a section to the Pest Abatement Act specifically authorizing the Board of Trustees to sell real property. This is necessary because the present law intimates the right to sell, but does not specifically state it.

8. Add a section to the Pest Abatement Act allowing the Board of Trustees $5.00 per meeting in lieu of expenses. This section is added in order that the Pest Abatement law will conform with the Mosquito Abatement Act.

9. Add a section to the Pest Abatement Act. "2313. The district board may establish and maintain a cash basis fund for the purpose of drfraying district expenses between the beginning of a fiscal year and the time of distribution of tax receipts in a fiscal year. Such cash basis

fund shall not exceed 60% of the estimated expenditures for a fiscal year."

The reason for this act is so that the Pest Abatement Act will conform with the Mosquito Abatement Act.

When these bills have been given a number, the superintendents and their Boards of Trustees will be given this information and it is suggested that they immediately contact their State Senators and Assemblymen and request their cooperation in the passage of these bills.

Mr. Raley: Thank you, Mr. Robinson. I assume that copies of the proposed bills will be mimeographed and sent to all the district superintendents in advance, so that they can be presented to their Boards of Trustees and later urged upon our Assemblymen and Senators.

Mr. Robinson: We hope to have most of them in shape to deliver to Secretary Peters next week.

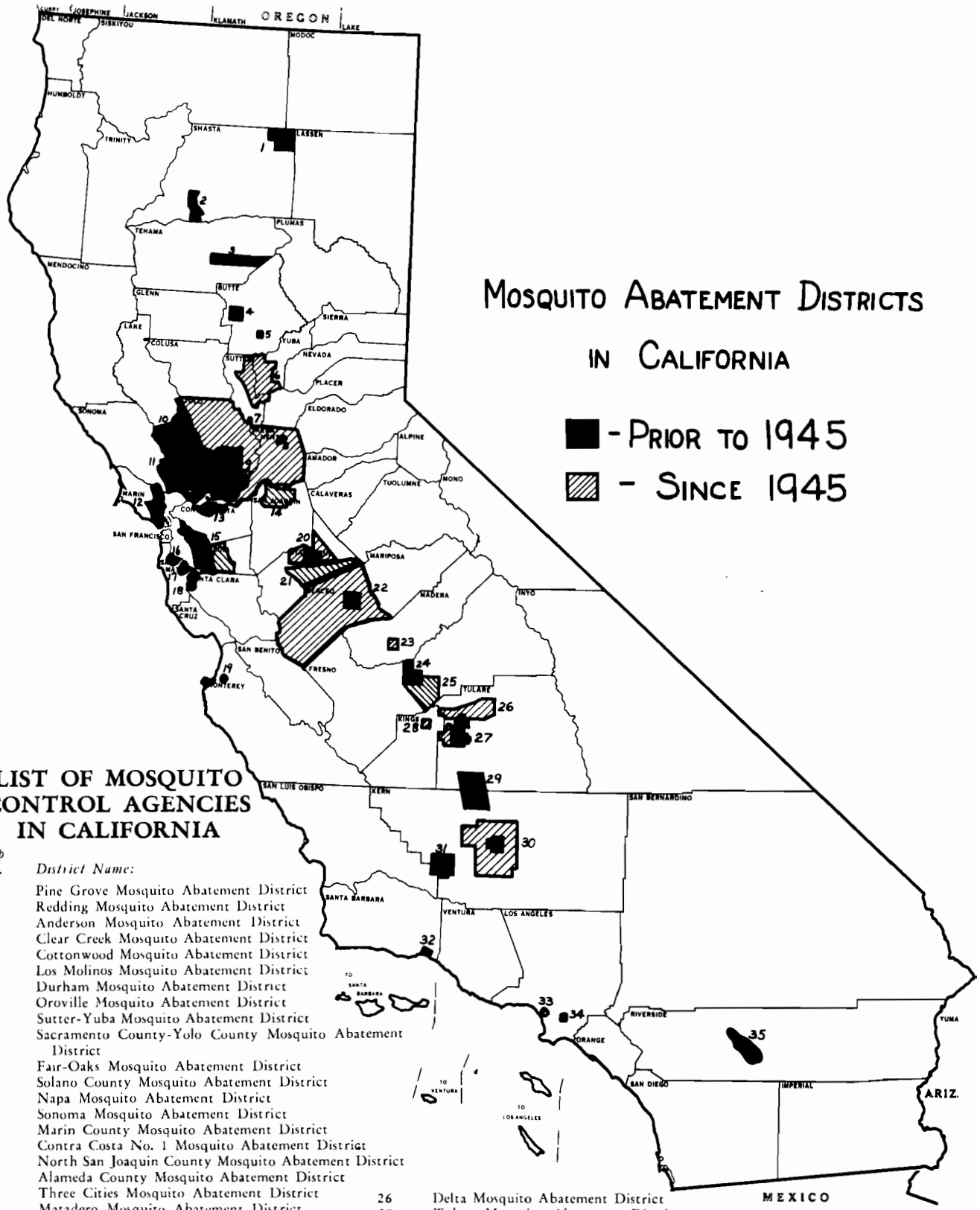
Mr. Peters: I have a letter from Edwin T. Jacobsen, Secretary of the Board of Trustees of the Delano Mosquito Abatement District, protesting against any proposal to eliminate payment of compensation to Secretaries of Boards of Trustees. As there is no proposal for such legislation, the letter will be filed if there is no objection.

Mr. Gray: In event of certain proposals to increase the contributions from the Districts for the support of our Association, it is suggested that we get a promot opinion from the Attorney-General on the legality of these contributions. We have been paying them on the theory that they are authorized by paragraphs "c" and "j" of Section 2270 of the Health and Safety Code. At present we are awaiting an opinion from our District Attorney on the matter. If we are eventually to contribute large sums for the support of increased activities of the Association on a long time basis it is necessary to be absolutely sure legally.

Mr. Raley: We are also trying to get an opinion from the District Attorney of Sutter County.

Mr. Robinson: I have asked our District Attorney about it and he does not think there is anything to worry about, especially if it is based on a contract for certain services rendered by the Association to the districts. However, it will be wise to have an opinion from the Attorney-General before going ahead.

Mr. Raley: We will now have a paper by Mr. Dahl on the state control program for next year. The paper will be illustrated with slides.



MOSQUITO ABATEMENT DISTRICTS IN CALIFORNIA

■ - PRIOR TO 1945

▨ - SINCE 1945

LIST OF MOSQUITO CONTROL AGENCIES IN CALIFORNIA

Map No.	*District Name:*
1	Pine Grove Mosquito Abatement District
2	Redding Mosquito Abatement District
2	Anderson Mosquito Abatement District
2	Clear Creek Mosquito Abatement District
2	Cottonwood Mosquito Abatement District
3	Los Molinos Mosquito Abatement District
4	Durham Mosquito Abatement District
5	Oroville Mosquito Abatement District
6	Sutter-Yuba Mosquito Abatement District
7	Sacramento County-Yolo County Mosquito Abatement District
8	Fair-Oaks Mosquito Abatement District
9	Solano County Mosquito Abatement District
10	Napa Mosquito Abatement District
11	Sonoma Mosquito Abatement District
12	Marin County Mosquito Abatement District
13	Contra Costa No. 1 Mosquito Abatement District
14	North San Joaquin County Mosquito Abatement District
15	Alameda County Mosquito Abatement District
16	Three Cities Mosquito Abatement District
17	Matadero Mosquito Abatement District
18	Pulgas Mosquito Abatement District
19	Monterey County Health Department
20	East Side Pest Abatement District
21	Turlock Mosquito Abatement District
22	Merced County Mosquito Abatement District
23	Madera County Mosquito Abatement District
24	Fresno Mosquito Abatement District
25	Consolidated Mosquito Abatement District
26	Delta Mosquito Abatement District
27	Tulare Mosquito Abatement District
28	Hanford Mosquito Abatement District
29	Delano Mosquito Abatement District
30	Dr. Morris Mosquito Abatement District
31	West Side Mosquito Abatement District
32	Carpinteria Mosquito Abatement District
33	Balona Creek Mosquito Abatement District
34	Compton Creek Mosquito Abatement District
35	Coachella Valley Pest Abatement District

PROPOSED STATE BUDGETARY NEEDS AND CONTROL FOR THE COMING BIENNIUM

by

ARVE H. DAHL, Chief, Mosquito Control Section

Sometimes I feel it is unfortunate that the business of our meetings can't be a little more entertaining. If any general expression of pleasure were to be shown by hand-clapping during one of my papers I'd think of Ed Wynn's first professional appearance in a gas-lit outdoor amusement park. The applause, he says, wasn't terrific, but it was steady; in fact he began to hear scattered hand-claps as soon as he began to act. After his fifth interrupting bow, the stage manager hauled him off by the scruff of the neck. "They're not applauding you, you fool," he grumbled, "they're slapping mosquitoes, get on with the show." I shall pay attention to that last phrase and get immediately into the last scheduled formal paper scheduled for our meeting - "The Proposed State Budgetary Needs and Control Program for the Coming Biennium."

First, let us look at the map of the State and see where the expansion in mosquito control has occurred. (Attached map-showing districts organized before and since 1945).

As noted by Doctor Halverson and Mr. Robinson, our Association President, the growth of area contained in mosquito abatement districts during the past year has been phenomenal. The total area included in formal mosquito control districts before 1945, was 4646 square miles. Since 1945, new districts and annexations to old districts have totaled 6353 square miles, giving a total area now included in mosquito abatement districts of 10,998 square miles. In addition, actual anticipated or possibly indicated future annexations and new districts can be listed as follows: The East Side Pest Abatement District annexed 106 square miles on October 28 of this year; and Delta 200 square miles in October, the Madera County Mosquito Abatement District organized this year contains about 140 square miles. However, it is anticipated that the Madera County Mosquito Abatement District will annex at least an additional 200 square miles and probably all the area in the county west of the Santa Fe tracks. In Fresno County, indications are that annexations will occur in the Reedley and Clovis areas to the Consolidated Mosquito Abatement District. Further indications have been that the people in the vicinity of Biola, Kerman, and San Joaquin desire a district of some 400 square miles separated from the other two districts now in that county. The Sutter-Yuba Mosquito Abatement District has indicated that they would annex additional area as soon as operations are begun by the new Sacramento County-Yolo County Mosquito Abatement District. The Doctor Morris Mosquito Abatement District has indicated

that an area will be annexed in the vicinity of Shafter and Wasco. Indications of interest in new districts have been presented to us from Riverside and San Bernardino, Ventura, and San Jose. The total potential new area amounts to 2756 square miles. As you will note by observing the map, the greatest amount of this area lies in the great central valley. This area also is generally confined to the irrigated areas of the State. As irrigation increases, so may we anticipate the demand for mosquito control to increase.

The general conclusions for our future program reached in a meeting with the State Department of Public Health Advisory Committee on mosquito control, following discussion of the encephalitis studies and subvention program as it had been carried out to date, were:

1. That it was still their decision that if anything definite is to be resolved from the program that it would have to be carried on at least during the coming biennium;

2. That a minimum of money was being expended on research and basic medical study of encephalitis;

   (a) Of current subvention monies the committed allocation to the Sacramento County-Yolo County Mosquito Abatement District of $35,000 be reduced to $20,000 inasmuch as half of 1946 had gone by without operations; a further cut being recommended if operations were not underway by February 1st;

   (b) That the balance of subvention moneys be expended; first to new districts, and, secondly to districts with whom we have subvention contracts that annex new territory during the present fiscal year; new contracts to be completed by February 1st;

3. That with the occurrence of encephalitis outside of the Central Valley we cannot justifiably restrict our activities to that area alone;

4. Subvention moneys are essential through at least the next biennium to promote and develop adequate mosquito control programs in endemic areas in the State. Subvention allocation in the future must be on a revolving basis, with aid to established districts reduced each year to allow for assistance to new districts and districts annexing new territory.

5. It was the conclusion of the Advisory Committee that inasmuch as the present allocation of $600,000. covered the work of really one year, that the request to the Legislature should be for a double

amount, or $1,200,000 for the 47-49 biennium.

This completes the plan for continuing the subvention program during the coming biennium. The entire program in regard to district and state activities for the coming biennium can be divided into two sections: (1) Activities of the districts themselves, assisted by the State, and (2) the study and operational research program contemplated by the Mosquito Control Section. First, in regard to the control programs of the districts; after a year's operation we will have defined our objectives to the full understanding of all districts in the matter of adopting professional and accepted techniques of mosquito control. All districts will have acceptable operational daily reports and will be obtaining basic information from their monthly operational reports which will be of value to them in analyzing their work and planning their future activities. Entomological work will be incorporated on an increasing scale insofar as is possible in connection with subvention contracts. Our consultation service to districts and in localities in the State desiring assistance on their mosquito control problems will be greatly improved through the present year's activities. Certain programs will be encouraged and a system of disseminating useful control information to all districts will be encouraged and adopted if no other arrangement can be made for this service.

In regard to the complimentary investigational program to be carried on through the State Department of Public Health, Mosquito Control Section, our philosophy has been changed from that in force during the current year. In addition to our Yolo County experimental area, we shall promote several projects which are to be worked in conjunction with established mosquito abatement districts. In considering the proposed projects, the State Department of Public Health's Advisory Committee on mosquito control concurred that more valuable practical information could be obtained, and that greater assistance could be extended to the districts at the same time by their establishment than by concentrating all efforts in a single formal area of our own. It was concluded that the following projects should be undertaken within the limits of the personnel of the Mosquito Control Section, assisted by the U. S. Public Health Service, Communicable Disease Center unit, assigned to the California Department of Public Health, addition to the Yolo County demonstration area:

1. Thermal Ground Aerosol: Sutter-Yuba Mosquito Abatement District:

   In view of the great amount of ground thermal aerosol work done by the Sutter-Yuba Mosquito Abatement District, it was deemed advisable to study the problem in this area. It is anticipated that two field inspectors will be in on the project, and that general supervision of the work can be extended by Magy and Fowler, who will be

stationed in the Yolo County demonstration area. This project will be designed to evaluate the use of thermal ground aerosols for larval as well as adult mosquito control.

2. Sewer Farms - Winery Wastes:

Practically every district, and nearly every town, has a sewage disposal problem which at present is creating a mosquito nuisance. In addition, according to work done by the Hooper Foundation, possible vectors of encephalitis are found in these sources. It is conceded that ideal disposal methods will largely eliminate mosquito breeding. What is needed is definite knowledge on the best emergency treatment, as well as continuous larvicidal treatment, for sewage farms and winery wastes. It is proposed that this work be done in Fresno County, with one man assigned to this project, control work to be accomplished by one of the mosquito abatement districts.

3. Canals - Ladino Clover Fields; East Side Pest Abatement District:

The control of mosquito breeding along canals and dead ends, borrow pits and ladino clover fields is important. Certain techniques developed by the East Side Pest Abatement District need thorough checking. It is proposed that one man be assigned in this area to work on this problem.

4. Sloughs, Pastures, Weed-killer; Tulare, Hanford, and Delta Mosquito Abatement Districts:

Special work needs to be done on evaluating control of mosquito breeding in sloughs and orchards. The use of weed-killer in sloughs and in inaccessible areas need investigation. One man, if available, will be assigned to this project.

5. Evaluation Studies on the Use of Airplane Thermal-Generators and Sprays; Doctor Morris Mosquito Abatement District:

There is a definite need to evaluate effectiveness and costs of the use of airplanes on general control activities in California. Inasmuch as the Doctor Morris Mosquito Abatement District has purchased three planes this year, it is proposed that workers be assigned to that district for the entire season to evaluate airplane work. In view of the magnitude of the evaluation study, it is proposed that an engineer supervise the program, to be assisted

by three inspectors.

6. Drainage Techniques; Redding Mosquito Abatement District:

As a part of the general supervision of the districts in the north, it is proposed that Mr. Snyder be stationed in Redding again next year. One of the major problems in that area is drainage maintenance. It was proposed that complete details on this work be recorded during the season.

7. Rice Fields, U. S. Public Health Service, Merced County Mosquito Abatement District:

This project was considered one that could be made a portion of the work of the Public Health Service in California. The Advisory Committee indicated that our thoughts, which called for setting up a single investigation in the Merced area near the Communicable Disease Center Malaria Control Project at Castle Field, would be very worthwhile. It was felt, however, that comparable work should be carried on in another area in the Sacramento Valley, where the real rice bowl of the State exists. Discussions included use of inspection techniques, discussion of the literature on the subject, and details of organization for the project. (A secondary advantage to doing this work at Merced is the feasibility of continuing studies on the residual effect of DDT in the area immediately surrounding Castle Field. The buildings and artificial resting places sprayed in the fall of 1945 did not show a marked increase in the number of adults this fall when other resting places contained hundreds of Anopheles freeborni. It is proposed that these studies be continued along with the ricefield investigations.)

8. Collection of Mosquitoes for Examination in the Virus Laboratory:

It is considered important that the studies on the distribution of encephalitis be continued. It is proposed that this activity also be carried on by the U. S. Public Health Service, CDC unit. It was thought that workers in the several areas could assist in the collection of live mosquitoes for a unit that would identify and freeze mosquitoes for shipment to the Virus Laboratory during the coming season. At least two entomologists will be required on this detail.

9. Species Distribution:

This information will largely have to be collected from records obtained in completing the other special projects and from the several mosquito abatement districts. However, it was the feeling of the Advisory Committee that special emphasis should be placed on this item. Accordingly, some definite plan will have to be made for extending the collection activities, particularly on Culex tarsalis, whereby the length of season, density, and other data can be collected over a large area.

10. Local Entomological Services:

It was proposed as a secondary benefit from the establishment of special projects throughtout the Sacramento and San Joaquin Valleys that special consultation service could be extended to the mosquito abatement districts during the season. These benefits would include identification of mosquitoes, assist in making adult collections, instructions of new personnel, and similar services.

11. Yolo County Demonstration Area:

The Advisory Committee stressed that if the information we had to know could not be obtained in Yolo County, then that area should be abandoned, and the information should be sought in other areas. It was concluded and agreed that general activities should largely be concerned with ecology studies and a certain amount of experimental work, such as improvement of standards of larval and adult collecting methods, investigation of new insecticides and solvents; tests on nozzles, various types of equipment not tested in districts, and, possibly, flight range studies. Other suggested topics were comparison of DDT deposits from different solvents and DDT residues on agricultural products.

With five men tentatively allocated to the Yolo County Demonstration area, care must be exercised in order that studies undertaken can be completed. General comments by the Committee were as follows:

(a) That the ecology studies involving the setting up of sixteen sections in which routine inspections twice a month, or oftener, will be carried out, plus a study of selected habitats, such as sewer farms, ricefields, orchards, canals, etc., were worthwhile and

should by all means be carried out.

(b) The adult collection records inaugurated last June should be continued.

(c) That before any experimental work in connection with DDT deposits, new insecticides, etc., is done, a very thorough search of all literature on the specific problems should be made, and only those items appearing to be promising should be investigated.

(d) The study of DDT residues on agricultural products will have to be done through some outside agency. Perhaps collection of samples can be done by mosquito control organizations, but, if possible, the entire problem should be wished off on some other organization.

This completes my paper on the "Proposed State Budgetary Needs and Control for the Coming Biennium". The continued healthy and progressive attitude of all mosquito abatement districts and cooperation on our mutual problems by all vested parties is necessary if we are to achieve the goals we have set before us.

Mr. Raley: Thank you, Mr. Dahl. We will now have recess for ten minutes.

RECESS

Mr. Geib: For the remainder of the papers I will ask Ed Washburn of the Turlock District to preside.

Mr. Washburn: We will now have a series of reports on district activities this year. The first paper will be given by Ted Raley of the Sutter-Yuba District.

A REPORT ON DISTRICT ACTIVITIES

T. G. Raley, Superintendent

SUTTER-YUBA MOSQUITO ABATEMENT DISTRICT

Three things combined to make the program of the Sutter-Yuba Mosquito Abatement District a successful one in its first year of operation. The Board of Trustees instructed the Superintendent to do all things necessary to rid the district of mosquitoes, the personnel were willing to work night and day to accomplish this objective and then there was DDT. This same pleasant condition still prevails and will go a long way toward making future operations successful.

Operations started in March and as men were hired they were put into the field to survey the mosquito problem. As no mobile equipment was owned by the district at this time each employee used his own vehicle on a rental basis. Until spray units were delivered in late March very little actual control work was attempted. In these early weeks an effort was made to impress the property owners with the need of cooperation. With the aid of dry weather and the normal seasonal decline of Anopheles freeborni the district was off to a good start. This dry warm weather kicked back however when irrigation started. Everyone irrigated at the same time and Aedes larvae started appearing by the millions. If we hadn't had DDT for both larviciding and adulticiding, mosquito control would have had a black eye.

DDT was our salvation. Used as a larvicide we were able to treat many situations that we couldn't have treated with oil. Mixed with water it made a much clearner material to work with and the men and equipment were not covered with a thick coating of dirt and oil. The cost per gallon of mixed larvicide was less than oil and transportation problems were reduced. A few gallons of DDT concentrate plus water that was always readily available meant lighter, more mobile equipment. Used as an adulticide DDT offered new methods of mosquito control never before dreamed of. Better public relations were achieved from our adulticiding program than from all other activities combined. It was direct, it was apparent and it gave immediate relief from mosquitoes and other pests as well. People saw the control crews working in their own and their neighbor's yard and felt that their tax money was being well spent. As the exhaust aerosol was developed, large-area adult control was possible. Ranchers with large labor crews working in the fields and orchards were very pleased with results of our fogging.

DDT was used in all operations with confidence and we found that it was justified. Some flowers were destroyed, probably by the solvents rather than by DDT, and a few fish were killed. These few minor accidents have been educational. People were so pleased with the relief from mosquitoes no one seriously complained. Everyone who reported trouble seemed more interested in helping perfect methods rather than in complaining. From the limited experience gained in one season the future of DDT in the Sutter-Yuba area looks bright.

As mosquito breeding declined in the fall, an extensive, district wide, adulticiding program was carried on against the over-wintering adult. The exhaust aerosol proved to be a very worth while addition to our equipment. For culverts, underneath houses, large buildings filled with boxes and other equipment, where it was nearly impossible to treat by spraying, the fog did a good job. The aerosol helped to speed up this program as well. This program plus area fogging in February and March will help to reduce the over-wintering adult and should help reduce the larvae population in the early spring.

Plans to make a systematic survey and record of existing sources of mosquitoes have been set aside temporarily in favor of ditching and clearing. This survey will be combined with the larviciding and inspection work in the spring. All winter activities are being directed toward reducing breeding areas and the existing adult population.

Mr. Washburn: The next report is by myself on the operations of the Turlock District.

SUMMARY OF THE TURLOCK MOSQUITO ABATEMENT DISTRICT OPERATIONS

by

G. Edwin Washburn, Superintendent

The Turlock Mosquito Abatement District was organized under the Mosquito Abatement Act of the State of California on February 28, 1946. This district comprises approximately 350 square miles of the southern portion of Stanislaus County. It all lies within the Turlock Irrigation District, hence the ranches are under irrigation from this source. The problems arising in mosquito control here stem largely from excess or waste irrigation water. The large acreage of Ladino clover pasture lands make an ideal habitat for the breeding of certain vicious biting field mosquitoes namely: Aedes. With each successive irrigation (about each 10 days) there arises a fresh "crop" of mosquitoes in the waters of these fields. Considerable emphasis has been placed on the control of the disease bearing mosquitoes found in this area. The malaria mosquito (Anopheles freeborni) is found here in large numbers breeding in fresh water. Of recent importance has been the control of the principal vector of equine encephalomyelitis (sleeping sickness) known as Culex tarsalis. This species is cosmopolitan and is therefore a difficult mosquito to control. In all, about 20 species of mosquitoes have been found in the Turlock Mosquito Abatement District.

Control measures were instituted as rapidly as suitable equipment could be obtained and personnel adequately trained. The Jeep was chosen as an ideal mobile piece of equipment. An Essick Air Power sprayer was mounted on the Jeep. This makes a spray rig which is adaptable to many uses; i.e., larviciding, or residual spraying, is extremely mobile, economical to operate and requires but two men to use effectively. The cost of such a piece of equipment varies with local conditions but should be in the neighborhood of $1,800.00. The TMAD has 4 such units with additional units planned for the future with expansion of the District. These sprayers operate at 80 lbs. psi thus delivering per nozzle about 1 gallon of liquid insecticide per minute. An average two man crew can adequately cover from 50 to 100 acres of mosquito breeding area per day. Hand sprayers of the 3 gallon cylindri-

cal type are used to augment the power sprayers for there are many situations where it is not feasible nor economical to use power equipment. At the height of the season (June, July, August) 18 men comprised the personnel of the TMAD.

The use of aircraft in mosquito control was used to advantage in river bottom areas inaccessible to the Jeeps. This has proven to be not only a means of gaining adequate mosquito control but also an economical means.

Insecticides used in the control measures of the TMAD have been Diesel Oil and DDT. The oil has been used alone or in combination with DDT in varying strengths. By far the most economical material used has been a DDT-xylene-water emulsion. All field operations against mosquito larvae have been strikingly effective using this material at a ½% DDT strength. Residual spraying operations about buildings against adult mosquitoes has given excellent results using a 2½% DDT emulsion. The greater portion of the supplies and materials purchased and used by the TMAD have been war surplus materials. This has resulted in a great saving to the District and has given us a source of excellent materials.

The winter program of activities has been planned along two lines; one residual DDT spraying about farm steads and the other drainage operations including clearing and brushing. Several areas of considerable extent will be drained thus affording permanent control of these places. The residual program is being extended to those sections of the district where larviciding operations were at a minimum last summer. This will be extended if time permits.

Mr. Washburn: The next paper will be by Ed Davis of the Consolidated District in Fresno County.

Mr. Davis: I did not prepare a paper. We are a young district -- we officially started operations on August 16th of this year. The equipment situation was and is still bad. We have been able to purchase some jeeps and a few power spray rigs. I thought I had a small district at first, but after driving around it for a while it looks very large -- on one trip I almost expected to run into the Nevada state line. However, we are having a meeting Monday night with the idea of annexing the Reedley area, which will add another 140 square miles and include everything down to the Tulare County line, where we will abut onto the Delta and Tulare districts.

The bulk of our county is orchard grape and farm land, and the soil is generally sandy. Our most difficult problems will be in the western portion of the District. Our Board of Trustees takes great interest in our work, and our President, Mr. Adolph Pruess, is attending this conference. I maintain he is one of the best presidents a Board or a District could have.

Mr. Washburn: Thank you, Mr. Davis. A good many districts have enlarged their boundaries, but the biggest now is the Merced district, of which Wes Ewing is Manager.

Mr. Ewing: The original Merced District was quite small, but in 1945 it was enlarged by annexation to include the entire county, a total of 1995 square miles. However, as we are collecting taxes for the enlarged district it has been necessary for us to get out and do something fast, lest our people think nothing is being done. We succeeded in getting a very little equipment, but the labor situation in the spring was bad. Now there are a good many men looking for our type of work and we will be able to expand our program.

Our winter program will be surveying and maintenance of drainage. We have much to learn about our district, and intend to study our problems carefully. We have established a training school for our men, and take them to our Los Banos laboratory for a four hour session each week. This work is in charge of our entomologist, Mr. Smith, and our men appreciate the training and are interested.

There is a great deal of opposition to our operating out of a central depot, owing to the sensitiveness of the various localities in our county, and the area is too large anyway to be worked from one main depot. We expect to divide the District up into eight divisions of about 250 square miles each, with a crew and one or two pieces of equipment in each.

We have done a little experimental work with airplanes, and expect to use them extensively for some of our work. We now have an arrangement where the operator will take his plane free of charge to the place where we are working.

Mr. Washburn: Thank you, Mr. Ewing. We will next hear from Mr. Gordon F. Smith, the entomologist of the Dr. Morris District, on their operations.

ENCEPHALITIS VECTOR CONTROL PROGRAM of the DR. MORRIS MOSQUITO ABATEMENT DISTRICT

Presented by

GORDON F. SMITH, Entomologist

Problem:

The Dr. Morris Mosquito Abatement District encompasses 764 square miles in the south eastern part of the Central Valley with Bakersfield at the approximate center. This area contains all types of land from undeveloped semi-arid areas to highly developed irrigated farming districts

and a great deal of unincorporated urban and suburban residential territory. These unincorporated areas are for the most part unsewered and with the usual problems of this type of area. This area has for the past few years been recognized as one of the primary encephalitis areas of California.

At the time of inception of the Encephalitis control program here last May little information was available concerning the breeding habits of Culex tarsalis the principal vector of this disease. Dr. William Reeves of the Hooper Foundation for Medical Research who has been studying the disease in this area for some time, agreed on the necessity of obtaining more information on the biology of the mosquito concerned and offered the cooperation of his staff in determining larval material and making analyses of biological surveys.

Method of Approach:

The normal operations of this district in the past have been primarily against pest mosquitoes with emphasis on Aedes breeding in large irrigated and flooded areas. During the heavy breeding season a small crew was also employed in house to house inspection in the heavily populated areas. For the most part the equipment in use consisted of power equipment suitable for the control of large breeding areas.

In the light of information at hand it was felt that Culex tarsalis breeding would be found primarily in small breeding spots calling for close inspection and the use of light hand equipment for control. Although there was, at the time, a group of men doing house to house inspection their work was restricted to residential areas and coverage, though rapid enough to keep the adult mosquito population below pest level, was not sufficient for disease control. With the necessity in mind for supplementing the work of this crew and the need for more specific information concerning the breeding habits of Culex tarsalis in order to develope more efficient vector control methods it was decided to set up a special section for encephalitis control.

For this purpose that portion of the district which was most populated and which was expected to cover the greatest part of the encephalitis problem was divided into five encephalitis control areas (Map). In setting up these areas an effort was made to make them as nearly equal as possible in the amount of work necessary.

A special group of men was hired to serve as inspectors in these areas. An effort being made to hire men who were receptive, mentally alert and capable of learning rapidly. These men were given a period of indoctrination, going out with experienced crews to learn the essentials of mosquito survey and control. They were also given background information on what was known of encephalitis and on entomological survey and control procedures as they related to the

control of insect borne diseases. As equipment became available and the men were considered sufficiently trained to begin their primary function they were assigned an encephalitis control area.

Since the function of these inspectors was close inspection for control of small sources principally of Culex mosquitoes, the major piece of equipment necessary was a vehicle. They were furnished with hand spray equipment for control purposes and instructed to report any large breeding places to the operators of power units working in the area.

Control Evaluation:

As an index to adult population and to check on the efficiency of these operations a system of adult collecting stations was set up immediately upon beginning operations in each of the five areas. An attempt was made to put from 10 to 12 stations in each area. The stations to be scattered through the area as evenly as possible and at least a mile from each other. In selecting the stations an effort was made to get well protected and shaded places although in some cases it was necessary to take what could be found. The large proportion of the stations were established in chicken houses since the mosquitoes involved have been shown by Dr. Reeves to prefer bird hosts.

In operation these stations are visited once weekly, on the same day each week and as near the same hour as possible. Since the counting and collecting of all the mosquitoes in a station would be too time consuming, the men were instructed to count all the mosquitoes present, if possible, but to count for no longer than 10 minutes. After recording the count they took a sample of the mosquitoes present of 25 or more specimens if possible which were brought in to the office. These samples were determined as to species and sex and recorded on the appropriate section of the field collection report form. For the purposes of gross statistics the species were grouped on summary sheets under White Legged Culex, (Encephalitis carriers), Dark Legged Culex, Aedes, Anopheles and other Genera. This material was then entered on graphs, one being kept for each collecting station, one for each area and one for the district. These graphs studied for periodicity, affect of temperature and relative humidity etc. (Graphs)

As you see these I have here are only for Culex mosquitoes. Other genera were not prevalent in the stations and for the purposes of this talk were not included. These stations are maintained year around and the graphs are brought up to date each week.

Reporting Methods:

For the purpose of obtaining field reports with the all desired information a form was drawn up and printed in

manifold books, the inspector keeping the carbon copy and the original being turned in with the sample. The form is being revised at present to conform to a punch card code set up by Dr. Reeves and Mr. Brookman of the Hooper Foundation unit. It was made as simple as possible in order to reduce confusion and increase accuracy in its use by the field men. Essentially it is a check off form as to larval habitat conditions with a space for description of adult collecting stations and a remarks section.

We wish here to express our appreciation for their help and cooperation in this work to Dr. Reeves of the Hooper Foundation, Mr. Brookman of the U. S. Public Health Service and the other members of the Hooper Foundation Field Research Unit.

Mr. Washburn: Thank you, Mr. Smith. The final paper in this group will be presented by Ted Aarons on the Delta District work.

DELTA MOSQUITO ABATEMENT DISTRICT

by

THEODORE AARONS, Entomologist
Delta and Tulare Mosquito Abatement Districts

The Delta Mosquito Abatement District, with headquarters in Visalia, was formed twenty-four years ago; its main function being to wage an anti-anopheline campaign and thereby reduce the malaria rate which was high in the country.

Unfortunately, records are not available concerning these early activities. It is the opinion of many of the older residents that the efforts of the district were of value in the reduction of malaria. The economic development of this section of the San Joaquin has been rapid--a factor of importance in mosquito abatement.

My duties as entomologist for the Delta and Tulare Districts commenced June of this year, at which time, upon the discretion of the trustees, the Delta District was completely re-established.

DDT was introduced into control operations, new equipment was procured, personnel trained, and a mosquito abatement plant established for the first time in the history of the district.

A preliminary mosquito survey revealed that three of the five known vectors of the virus encephalitides were to be found in Tulare county. However, the most conspicuous mosquito in terms of biting habit and population density during the second half of the year was Aedes nigromaculis,

a species which was reported in California for the first time January, 1939.

The Delta Mosquito Abatement District before 1946 covered twenty-seven square miles, with Visalia as its center. Upon receiving its requested subvention fund from the State for assistance in mosquito control, the district expanded to include forty square miles.

It was apparent that it would be difficult to achieve efficient mosquito control with continued operation of a small district; consequently, it was proposed that at an appropriate time, the Tulare Mosquito Abatement District and the Delta Mosquito Abatement District would seek consolidation. It was agreed by Mr. Rolland Henderson, Superintendent of the Tulare Mosquito Abatement District, as well as numerous county residences and myself that more rapid mosquito control could be realized if a district were organized on a county-wide plan.

Towns and farming areas south of Tulare expressed an interest in annexing to the Tulare Mosquito Abatement District, as did individuals in the area north of Visalia to the Delta Mosquito Abatement District.

The territory north and adjacent to the Delta district (Woodlake, Ivanhoe, Goshen) has just been annexed. The Dinuba region representatives are also interested in being included in the district. With the continuation of mosquito abatement interest, it will not be long before the entire valley section of the county will be a part of the control program.

The Delta district now includes approximately 285 square miles. With the expected addition of the Dinuba region, the district will contain approximately 500 square miles, which would make our border in the north contiguous with the Consolidated district of Southern Fresno County.

The Tulare and Delta Districts have worked in close cooperation this past season. Mr. Henderson has been interested in trying new control methods. Frequently, throughout the summer, specialized apparatus was employed in "experimental" areas in both districts, so as to make observations under more diversified conditions.

The Delta District experienced problems peculiar to most new districts, but the one of utmost concern was that of obtaining vehicles. We were able to build our fleet up to four vehicles: three half-ton trucks and a jeep.

There are no major problems in the area. The region is characterized by an elaborate network of ditches, small marsh areas, and farm reservoirs. Improper irrigation practices, namely over-irrigation, constitutes our main problem.

This over-irrigation occurs chiefly in relation to alfalfa fields and permanent pasture land.

Throughout the season we have frequently sought advice from other districts. We have benefited from the technical service rendered by representatives of the Mosquito Control Section of the California State Department of Pulbic Health.

Our plans include continuing the use of DDT, introducing the exhaust generator for emergency control in the exoanded areas, and furthering entomological survey with emphasis toward more efficient mosquito control.

Mr. Washburn: Thank you, Ted. The next group of papers covers various new techniques and developments in mosquito control. The first will be by Ted Raley on ground application of thermal aerosols.

Mr. Raley: I have already sweated out one report, so I will simply talk about this one. I first want to introduce Bill Miller, who has done all the back-breaking work on our aerosol generator. If any of you are worried about DDT, just take a lock at Bill. I think he has absorbed more DDT than any one will ever dream of. He has worked up to fifteen hours a day and has been just bathed in the stuff, but we couldn't kill him off with either DDT or hard work.

I think many of you have seen our aerosol generator which is attached to a truck exhaust. We have done a lot of work in developing it and it has cost quite a little time and money. We studied demonstrations put on by equipment manufacturers, and got the specifications of the generators used by the Army. By continuous experimenting we finally developed our present rig. We were striving for something which we could use on our present equipment, was not expensive, and which would kill both larvae and adults. With this exhaust generator, which is made from ordinary pipe and fittings, we have been able under favorable conditions as to wind and time of day to get larval kills up to 400 feet distance, though usually we do not try to work that far. Usually we go into the field, right into the middle of the situation, and attack on the spot.

One great advantage is that one man with this generator covers five times as much area in the same time as two men with a power sprayer. This is quite an important factor. The time thus saved can be put into better inspection, into ditching to reduce breeding areas, and onto house spraying.

When we are not using the generator we can detach it and operate on the regular truck exhaust. One man has suggested that we use a "Y" on the exhaust, with gate valves, so that we can operate either on the generator or the

normal exhaust by simply opening one valve and closing the other. We always welcome ideas of that kind. I would be glad to answer any questions.

Mr. Gray: Have you made any observations on its effect on the truck engine?

Mr. Raley: We have seen no evidence of carbonizing in the engine. It is true that we lose a certain amount of engine efficiency, which can be reduced by installing a change-over valve system. But with the increased efficiency we are getting in our work, I would say that we can afford to install a new engine in the truck each year if necessary. It would be well worth that due to the savings in labor and materials cost.

Mr. Anderson: We have used a similar generator, and have tried butterfly valves for the switch over.

Mr. Gray: Have you had any engine trouble, or corrosion?

Mr. Anderson: No; none as yet.

Mr. Washburn: Thanks very much, Mr. Raley. Those of us who have seen your generator in action know that while it may look like a Rube Goldberg it really works. The next paper will be presented by Art Geib on the use of thermal aerosols applied from airplanes by the Dr. Morris District.

DR. MORRIS MOSQUITO ABATEMENT DISTRICT

AIRPLANE WORK

by

ARTHUR F. GEIB, Manager

Problem

The Dr. Morris Mosquito Abatement District encompasses 764 square miles, much of which is open pasture land and nearly all of it under irrigation. In the case of the pasture land, during the spring and early summer as much as ½ section or more may be flooded at a time. This condition together with the large acreage of alfalfa and other crops under irrigation and the spring flood of the Kern River, which inundates a number of square miles, gives rise to a great Aedes problem. In this area during the hot season the period from egg to adult may be as short as 3½ to 4 days. Due to the nature of the problem with large and often not too accessible areas to be covered in a very short time, it was felt that aircraft application of either dust or liquid larvacide was the best possible solution.

Last years work:

At the beginning of the 1946 season attempts were made to obtain the use of an airplane equipped for liquid spraying. However since none were obtainable it was decided to undertake experiments on aircraft application of DDT dusts. Dusts ranging from 1% to 7% DDT content were applied at rates of 0.1 lb to 0.4 lbs. per acre. This work was curtailed and finally abandoned for several reasons; foremost being that the cost of the dust and its application was prohibitive. As to effectiveness little in the way of concrete conclusions were reached. In some instances excellent control and in some negative results were obtained. Air movement appeared to have a pronounced effect; also the type of cover probably effected efficiency. Further work would have been indicated using different dust diluents and possibly wetting agents if the cost had not been so high.

Early in May it was learned that Mr. Pearson of Reedley was equiping a plane for liquid spray application. He was contacted and agreed to send his plane to the Bakersfield area for use in experimental work. The ship was a Stearman PT-17 capable of carrying 100 gallons of spray liquid. The spray system consisted of a gear pump driven from the motor by V-belts and capable of generating 100 lbs. pressure; a pipe boom extending along the lower side of the bottom wing with nozzles and valve assemblies. The valves were opened and closed by a cable arrangement operated from the cockpit. The nozzles were simple disc type with spring valves such as those found on some 3 gallon garden sprayers. This spray assembly was found to operate at best efficiency with a no. 57 drill size disc openings and 90 lbs. pressure. This gave about 1½ gals. per acre in 50 ft. swaths.

On the 7th of August the pump shaft on this ship broke and since replacement was not available and the ship was in need of repairs it was grounded and a newly equipped plane was furnished.

The new plane had a centrifugal pump driven from a clutch on the rear of the motor. The boom mounted 20 clusters of nozzles, 3 nozzles to the cluster. The valve arrangement was such that any desired single nozzle or cluster of nozzles could be used, the setting being made on the ground by turning off and on small valves at each nozzle and disconnecting or connecting cluster valves. In the air the cluster valves were controlled by a cable operated from the cockpit. The nozzles were Chicago Spray Systems cone type.

This spray apparatus was much more versatile than the original system in that the nozzles were easily interchangeable, allowing a greater selection of particle size and liquid output.

Unfortunately during the past season the personnel of the district were so busy that no one man could be assigned to oversee and evaluate the aircraft work. This lead to some errors and inequalities in reporting by different persons. Also after examination of the reports it appears that more accurate data on wind velocity, temperature and relative humidity in the immediate area to be sprayed might be of value. However much valuable experience was obtained and considerable progress made.

Both emulsions and DDT-oil solutions were tested, however the oil solutions were less expensive and already used with success, and so tested more extensively. The best solution tested to date is a 5% solution of DDT in gas oil (a light diesel) with 14 oz. of B-1956 emulsifier to the hundred gallons. This solution was applied at the rate of approximately $\frac{1}{2}$ to 1 gallon per acre, of .2 to 4 lbs. DDT per acre. This concentration is probably higher than necessary and tests with lower concentrations will be made. The presence of an emulsifier was found to aid greatly the spreading of the oil on the water surface and to maintain it in a fine film. Without it the oil either did not spread well or tended to draw off the surface too rapidly to get an effective kill.

Wind velocity had less effect on the spray operations than were anticipated. Light to moderate winds apparently had little effect on the efficiency of the operations provided the pilot made necessary allowances for drift. It seemed most advisable to fly with and against rather than across it when possible.

Cover apparently had little effect except in such cases as heavy matted alfalfa or thick clumps of mesquite No spray work was done in the tree covered river bottom. A more accurate classification of types of cover than that used may give better information concerning this factor.

Information on the effect of temperature and relative humidity is very sketchy since on the job readings were not taken. However the results were considered in relation to mean daily temperature and relative humidity taken by the weather station at the Kern County Airport. This indicated that there are certain ranges within which this work may be more effective. On the job readings will have to be taken before these ranges can be determined.

A few attempts were made in adult control using this spraying equipment. Kills were 98% to 100% in all runs, however not enough of this type of work was done to give any data as to relative efficiency under different conditions. A 5% solution in diesel oil at the rate of 2 qts. per acre of very fine spray was effective.

Flying was done at heights of 10 to 100 feet as necessary to clear obstacles and with swath widths of 50

to 100 feet. The wider width principally for adult control.

Aerosol:

Shortly after we began using the first plane Mr. Pearson was prevailed upon to install an exhaust aerosol apparatus for trials. In all 3 different types were tried, the last being a copy of that used by the TVA. Little work was done with the first two installations, since they were unsatisfactory. The plane was grounded so soon after the installation of the TVA model that little could be done. The most hopeful work was done just after the apparatus was adjusted and calibrated, and the same day that the ship broke down. In this flight a 100% kill of 4th instar Aedes larvae -- some of which pupated before dying -- was obtained using 20% DDT in light extractives of oil, with B-1956 added, at the rate of 2 qts. per acre.

During the season the district used three different ships, all 220 HP biplanes. The early dusting work was done by the Atwood crop dusters of Salinas, California at a plane cost of $1.00 per acre. Spraying and Aerosol applications were carried out by Roland Pierson of Reedly, California on two different bases. The first applications being charged at .50¢ per gallon of spray. This method did not prove satisfactory and was discontinued in favor of a charge of $40. per plane hour flight time. Costs of liquid applications, including larvicide, ranged from a minimum of 12½¢ per acre to $1.75 per acre.

Mr. Washburn: The next will be a paper by Chester Robinson on his opinion on the value of DDT after two years' use in the East Side District.

TWO YEARS USE OF DDT
by
E. CHESTER ROBINSON
Superintendent

The use of DDT by the East Side Mosquito Abatement District in 1945 was primarily experimental, and was covered in a report made at last years Conference, so I will not burden you with repeating the results of those experiments.

The 1946 control program operated by this district found us using DDT almost exclusively. We used 2,300 gallons of 25% emulsible DDT.

In residual spraying we used 635 gallons of 25% emulsible DDT, applied at the rate of a 4% solution. We sprayed 2306 buildings, covering an agricultural area of approximately 100 square miles, and requiring 1,551 man hours. This residual spray program was of great benefit to the district

from a public relations standpoint. It killed all the mosquitoes in the shelters and those coming into the shelters for a period of four to eight months. It also kept the fly population at a minimum for a period of from three to six months. The cost of this program was small in proportion to the beneficial public reaction. The unknown factor is whether this program will stop or retard the spring migratory flights of Anopheles freeborni. This can not be determined until the spring of 1947.

In our work on ladino clover and permanent pastures, which are normally irrigated every eight to fourteen days, we sprayed with a solution of one gallon of 25% emulsion to 35 to 49 gallons of water. We used the heavier concentration where the vegetation was light and the lighter concentration in the heavier foliage. The reason for this was twofold. First, we felt that a heavier concentration of DDT on pasture foliage might in some cases cause a sickness in the cattle, and secondly, that we would get a greater penetration of DDT into the water underneath the foliage. This solution was applied at the rate of from three to five gallons per acre and resulted in not having to spray the same fields again until after the second and fourth irrigations, depending on the temperature at that time of year. The reaction of the farmers in our using DDT instead of diesel oil was excellent in most cases, since the use of DDT in the South Pacific was so well advertised. On a gallonage basis of this solution the cost was approximately one-fifth the cost of diesel oil and by not having to spray after every irrigation, the reduced cost of material and man hours saved enabled us to do a better and more thorough job of abating mosquitoes.

The use of DDT in orchards was comparable to that of its use in permanent pastures, with the exception of when the orchard was cultivated between irrigations. Then it was necessary to spray it again. However, when the orchard was not cultivated between irrigations, we had the same residual effects as in permanent pastures.

The use of DDT in irrigation ditches for the control of Anopheles freeborni was again successfully used this year. It appears from our observations that the vegetation growing along the sides and into the irrigation canals absorbs or otherwise depletes the amount of DDT in the water. A few examples of these operations are as follows: On April 12, 1946, there was 476 second feet of water going down the main canal of the Modesto Irrigation District. Three gallons of 25% emulsible DDT was discharged into the ditch, taking aproximately one and one-half hours. This completely killed all of the larva in 75 miles of irrigation canals.

On June 6, 1946, there was 950 second feet of water going down the ditch. We used five gallons of 25% emulsible DDT, with the same results.

On July 23, 1946, there was 1,010 second feet of water going down the ditch. We used 10 gallons of 25% emulsible DDT, controlling 100 miles of irrigation canals. The average larva count before application of DDT was 4 per dip, with 200 dips being made in varying locations along the main canal and the 7 lateral canals. After application in No. 4 canal there was 1 pupa to 50 dips; in No. 3 canal, no pupae or larvae; in No. 2 canal, no pupae or larvae; No. 1, 2 larvae.

To do this same work with diesel oil would require two men and pressure equipment at least 12 days and between 2,000 and 3,000 gallons of diesel oil.

During 1946 we used 7.900 gallons of diesel oil as compared to 63,000 used previously on two-thirds the territory covered by DDT. Most of the diesel oil was used in burning brush and ditch clearing operations, except that used by plane. We anticipate a greater utilization of airplane in our operations next year. We used the airplane only twice this year. A flight of mosquitoes from the Stanislaus River bottom was beginning to emerge and take flight toward Modesto. The airplane was used, using a 3% DDT solution in oil, at approximately 1 gallon per acre in a wooded area. There was an apparent reduction of 75% of Aedes vexans and this operation stopped the dispersal flight and no vexans were found over 2½ miles from the river. One hundred acres of the ladino clover were also treated by plane using aerosol method and there was 95% to 98% adult knock-down, except for one corner of the field where the pilot had to veer away because of trees obstructing the flight of his plane. This small section was covered by ground crews, and the entire area adequately controlled. The district's publicity, following the use of the plane, with approximately 3 quarts of 5% DDT solution in oil, was most encouraging.

We are well satisfied with our use of DDT in comparison with diesel oil, both from the standpoint of public relations and the efficient and economical operations it made possible.

Mr. Washburn: Thank you, Chester. The next paper will be presented by Harold Gray, concerning their experience with DDT in Alameda County.

Mr. Gray: I have two papers. One is a series of practical suggestions as to the conduct of meetings of Boards of Trustees which I will offer for insertion in the Proceedings, but not read for lack of time.

HINTS ON THE CONDUCT OF MEETINGS OF A BOARD OF TRUSTEES OF A MOSQUITO ABATEMENT DISTRICT

by

Harold Farnsworth Gray, Gr.P.H.,
Engineer
Alameda County Mosquito Abatement District

The operations of a mosquito abatement district in California are governed by a Board of Trustees, consisting of five or more Trustees. The Trustees in turn are controlled in their operations by the powers and duties imposed by Sections 2200 to 2398 of the Health and Safety Code, and various other laws relating to administrative boards in general.

The Trustees serve without pay, though their expenses may be defrayed from District funds. Usually the Trustees are men with substantial businesses or professions of their own, and it would be unreasonable to expect them to give large amounts of time and attention to the details of the work of the District. In particular, the work of the meetings of the Board should be so organized as to require a minimum amount of time on their part, but at the same time insuring that all necessary actions are taken in a legal manner, and properly recorded in their minutes.

In a number of Districts in the past it has been apparent that many actions have been taken without following safe legal procedures, and such actions could be questioned in court by a suit entered by any taxpayer, with resultant embarrassment to the Trustees. This is particularly true with regard to the procedure in paying money for services and supplies furnished to the District.

Section 2312 requires that money shall be paid out of the District fund (held by the County Treasurer) only upon the warrant of the Board of Trustees. The warrant must be signed by the President of the Board and countersigned by the Secretary. Furthermore, because of other laws governing the payment of money out of the county treasury, each warrant must be signed by the County Auditor before it can be honored by the County Treasurer. It is obvious that the Board of Trustees can only authorize the payment of money as a result of action duly taken at a regular or special meeting of the Board.

The Board is required to provide for the time and place of holding its regular meetings. This presupposes that there will be regular, stated meetings, which of necessity must be held at least monthly, and if employees are to be paid on a bi-weekly or semi-monthly basis, then at least two

regular meetings per month will be required. These meetings must be open to the public. In order to conduct a meeting, a majority of the Trustees must be present.

The first thing necessary to be done for the convenience of the Trustees, and to insure as far as possible the presence of a quorum, is to arrange for regular notification of each Trustee sufficiently in advance of the time and place of the next meeting of the Board. This should be done by the Secretary of the Board of Trustees, though frequently he may delegate to the Superintendent the duty of sending out written notices by mail, signed by the Superintendent in the name of the Secretary. These notices should be mailed three or four days before the meeting date. In addition, it is advisable for the Superintendent to call each Trustee on the telephone a few hours before the meeting to ascertain if he will be able to attend. If it is obvious that a quorum cannot be attained, each Trustee should be notified by telephone, so as to avoid an unnecessary trip. An adjourned meeting should be arranged for at a later date when a quorum can attend.

Prior to the actual time of meeting, the Superintendent can schedule the work of the meeting, and have all necessary documents in order, so that the meeting can proceed with despatch and accomplish all the work required.

In the first place, all warrants should be properly prepared with their supporting purchase orders, invoices or payroll attached, so that as soon as they have been examined and approved by vote of the Board, the warrants can be signed by the President and Secretary. But in addition, there should be furnished a list of the warrants, giving the number, the payee, the purpose for which paid, the amount of each warrant, and the total of all the warrants. It is further desirable to show on the list of warrants the cash balance on hand after paying out the total of the warrants. It is desirable that <u>each</u> Trustee be given a copy of the list of warrants, together with the sheet listing the business of the meeting. The latter is usually called an "agenda".

The agenda is simply a schedule of the work of the meeting of the Board. A normal agenda for a Board meeting would have the following items:

1. Roll call
   Trustees present
   Trustees absent

2. Reading of Minutes of the last previous meeting, and approval or amendment of these minutes.

3. Approval of payment of the warrants due and payable at the meeting.

4. Brief report by Superintendent on any important matters: don't bother the Board with minor details. Secure authorization in advance of any large or unusual expenditures.

5. Discussion of and action on any special matters of business, each of which should be described briefly on the agenda.

6. Adjournment

If a list of warrants has been prepared, it will be unnecessary to type the list into the Minutes; instead, the list can be designated with an exhibit letter, such as "A", "B", "C", etc., and attached to the Minutes. Any resolutions passed by the Board can also be designated as exhibits and attached.

If an agenda has been properly prepared, it can be used by the addition of notes, entered thereon in writing, as the basis for preparing the Minutes of the meeting. The time of opening and closing the meeting should be shown; for each motion or resolution there should be noted the Trustee who moved and who seconded, and the vote thereon.

As soon as possible after the Board meeting, usually the next day, the Secretary should dictate the Minutes of the meeting, and they should be typewritten, following a general pattern. There should be stated first the date and place of meeting, and the time when called to order; secondly, the Trustees present and absent, and third; the reading and approval or amendment of the Minutes of the previous meeting. Thereafter there should follow seriatum the various actions taken by the Board, including matters discussed without action, or matters discussed and postponed as to action. Finally, the time of adjournment should be stated.

The Minutes, when typed and the exhibits attached, should be signed by the Secretary. When approved at a subsequent meeting of the Board of Trustees, the Secretary should endorse thereon the date and fact of approval, or approval as amended. Corrections or amendments should be initialled by the Secretary.

In some Districts the writing of the Minutes is delegated by the Secretary to the Superintendent, subject to review by the Secretary before presentation to the Board. In one district the Minutes when prepared are duplicated (except for exhibits) and mailed to each Trustee, within a few days after each meeting.

The Minutes, with all exhibits, should be kept in the District office as permanent records, and should be bound in some satisfactory manner.

Each meeting of the Board of Trustees is conducted by the President, or the Vice-President in his absence. However, the Superintendent can do much to make the work of the Board at its meetings simpler, more effective and expeditious, and busy Trustees will appreciate his efforts in this direction. Part of the Superintendent's job is to think ahead and prepare in advance for various actions which must be taken by the Board, or by other agencies. For example, each November he should prepare letters addressed to the Board of Supervisors or to the City Councils of the cities in his district, notifying them of the expiration of the terms of office of Trustees on January 2nd following, and requesting the appointment of a Trustee for the ensuing two year term. At the November meeting the Board should direct the Secretary to send these letters.

At the proper time, also, the Superintendent should prepare the preliminary budget for the ensuing fiscal year, with supporting data, and preferably should send individual copies to each Trustee about 2 weeks in advance of the date for considering and adopting the budget.

When any special problems of major importance are to come up for consideration by the Trustees, the Superintendent should prepare and send to the Trustees, in advance of the meeting, a special report or memorandum giving all essential information thereon.

If an annexation is to be accomplished, the Superintendent should see not only that all necessary forms are prepared with the advice of the District Attorney's office, but he should prepare a schedule for all the actions to be taken, including publication, and also an agenda for the hearing on the annexation petition.

The suggestions made herein will make it possible to conduct Board meetings in an orderly and efficient method, and the saving in time and energy of the Trustees will be appreciated by them.

Mr. Gray: The paper on DDT will be presented by an Assistant, Mr. McGowan.

TWO YEARS' EXPERIENCE WITH DDT IN THE ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT

by
Thomas F. McGowan, Assistant to the Engineer
and
Harold Farnsworth Gray, Engineer

In December 1943 the Alameda County Mosquito Abatement District performed a limited amount of experimental spraying with DDT and cooperated in laboratory experiments at

the University of California. A sum of five hundred dollars was granted by the Board of Trustees to the University of California for research on this material which was performed under direction of Professor W. B. Herms. It was not until June of 1945 that the District was able to obtain, through the Chemurgic Corporation of Richmond, a small supply of DDT, part of it in emulsifiable form. Purchases at this time netted the very modest amount of fifty gallons of 25% DDT dissolved in 65% solvent with 10% emulsifier added. There was also obtained at the same time twenty five gallons of 25% DDT concentrate dissolved in 75% solvent with no emulsifier added. In July an additional fifty gallons of the 25% emulsifiable DDT was obtained.

Several types of application were started, principally to try its effectiveness on street inlets or catch basins, culverts and bridges. Zones were blocked off for comparative study, one area to receive DDT application, the other area to receive no DDT. Availability of DDT on the open market improved rapidly from June to November and the District was able to purchase a total of seven hundred and eighty five pounds of 100% DDT powder at a cost of $453.00.

Within thirty days after starting the restricted program of catch basin spraying, it was obvious that check observations of zones not treated with DDT were unnecessary since mosquitoes were entirely absent in the treated zones and thriving in the untreated catch basins. Spraying was therefore extended to include the entire urban areas with creek channels and culverts likewise treated. The need for treatment of the underground vaults of the public utilities was recognized, but the type of spray available was objectionable to the utilities companies on account of the volatility of the solvents (xylene and diesel oil). Even the remotest possibility of fire or explosion could not be risked in these underground vaults. It was not until the spring of 1946 that a suitable DDT material (wettable powder) was obtained which was acceptable to the utilities companies.

In March of 1946 the District obtained DDT wettable powder which, when mixed with water, produced a very effective residual. Seven hundred and ten pounds of 40% DDT wettable powder was purchased between the months of March and June at a cost of $285.00. One shipment of one hundred pounds of 50% wettable powder was obtained at a cost of $37.00. The effectiveness of the 50% wettable powder was comparable with the 40%. With availability of wettable powder,, adulticiding became highly effective under a cooperative program with the Pacific Gas and Electric Company and the Pacific Telephone and Telegraph Company. These companies agreed to furnish labor to assist in the application of residual spray to all street vaults in the Oakland metropolitan area. Utilities vaults have in the past been serious offenders producing large numbers of Culex pipiens even during the winter months. A DDT spray for applying

a residual deposit to the walls of the vaults was prepared according to the following formula:

46½ pounds of 40% DDT wettable powder added to

100 gallons of water plus

5 pints Medol light soluble oil.

This produced a suspension of approximately 2½% strength. A heavier suspension was tried but found unsatisfactory due to persistent clogging of spray nozzles. Addition of the light soluble oil greatly improved the sticking quality of the spray and we credit it with extending the effective life of the application.

Our own sucessful experience with urban catch basin, culvert and utility vault spraying coupled with reports from Army, Navy and civilian agencies, prompted extension of use of this material as rapidly as availability permitted. From May to August, 1946 a total of three thousand six hundred and thirty pounds of 100% DDT powder was purchased. Three thousand pounds were procured from Surplus Stocks of War Assets Administration at the very attractive price of twenty four cents per pound for one thousand pounds and twenty eight cents per pound for two thousand pounds. With assurance of adequate quantities of DDT obtainable, a comprehensive plan for spraying cesspools in the rural areas was developed and, using the same control procedure as was already in use with straight diesel oil spraying, cesspools in the townships of Eden, Washington and Pleasanton were completely serviced. A 5% solution of DDT in diesel was used in accordance with recommendations of research agencies for the residual application of one hundred milligrams of DDT per square foot of surface. Results obtained from cesspool spraying were so encouraging that wider use of DDT was planned extending its use to open water areas in the marshes, to creek beds and to artificial water channels. The Meekland Avenue drain in Hayward, which for the past several years had been a prolific mosquito breeder requiring routine semi-monthly oiling with diesel, received an application of a residual spray on May 22, 1946. Inspections of this drain as late as August 6, 1946 showed complete effectiveness. This drain was given a second residual DDT application on October 26, 1946 and to date no form of insect life is present.

In nearly all cases of open water spraying on marsh areas repeat operations were only necessary once in two months. Where repetition of spraying was formerly necessary with straight diesel as often as every two weeks, an immediate drop in this requirement occurred.

With availability of the State of California subvention funds for combatting the vector of encephalitis, a vigorous program was undertaken to reduce Culex tarsalis, particularly in farm buildings. It was intended to accomplish

reduction by application of residual spray to farm buildings, particularly those housing animals which are suspected as links in the transmission chain. Poultry farms and dairies were the principal recipients in this program. Many concentrations were experimented with and for a considerable length of time the 5% solution recommended by federal and state agencies was applied. It became apparent after extended use that the spray could be applied with somewhat less tediousness on the part of the operators and less waste of DDT if a lower concentration was used. It was observed that the workmen would apply enough spray to visibly wet the surfaces, thus over-applying the amount of DDT in a 5% emulsion. In addition to improving the mechanics of application, reduction in concentration resulted in a slight lowering of cost by reducing nozzle clogging appreciably.

The present use of 2½% to 3% solution seems to be optimum for our equipment and operators. For spraying farm buildings or interior surfaces, attempt is made to conform as closely as possible with the theoretical recommendations of one hundred milligrams DDT deposited per square foot surface covered. By applying a 2½% to 3% spray in such quantity as to result in a visible wetness of the surface, the required deposition is readily accomplished.

We felt before embarking on a county-wide undertaking of residual spray that public acceptance might be hesitant. The reverse was true. Following our completion of a half dozen spray jobs, our activities became widely known through local farm organizations and a list of prospective jobs was at once compiled. In a very short time we had more applicants for residual spray than we were able to schedule. In addition to private individuals, municipalities expressed interest in the program and requested assistance for obnoxious conditions existing particularly at garbage dumps. The Oakland garbage disposal plant was the only place of this character that we felt we could materially benefit. It is entirely enclosed and in the summer flies have been so great a nuisance as to seriously handicap personnel employed there. Residual spray was applied in this plant on July 20, 1946 and subsequent inspections as late as November 13, 1946 revealed that the DDT was still very effective. Other open garbage and refuse dumps, particularly those receiving the wastes of San Leandro and Hayward, were not treated, although we do feel that a definite need exists for fly abatement and that a DDT spray program can be designed which will be economical and effective.

Another problem of somewhat similar nature occurred with request for DDT spray of the San Pablo Livestock Sheds on the outskirts of San Lorenzo Village. The owners of this hog ranch had purchased fifty gallons of Shell "Barntox" (a 5% DDT emulsion). They were considering various procedures for applying this solution and requested technical advise of the District. It appeared advantageous for us to apply this solution with our own equipment. Flies on this ranch were so

numerous that it was practically impossible to work about the place without a mask. The interiors of vehicles parked even for short periods at the ranch were infested by so many flies that several days after completing work at the ranch the cars were still harboring flies. Spraying was performed on June 25, 1946 and subsequent inspections at monthly periods as late as November 12, 1946 revealed no recurrence of this intense infestation. At this hog ranch we really demonstrated the "miraculous" power of DDT as a toxic agent against flies.

The Fairmont Hospital appealed for DDT spray of their dairy barns and chicken sheds. Chickens were infested with lice and flies were nearly as much a nuisance at this ranch as at the San Pablo Livestock Sheds. Residual spray operations were commenced on June 8, 1946 and due to their requirement for transfer of fowl during spraying, several visits to this ranch were necessary before the entire place was sprayed. Almost immediately gratifying reports came to us that chickens formerly ailing were showing a remarkable return to healthful condition. Mites and lice and flies completely disappeared from the sheds.

We have found by actual demonstration that it is not necessary to remove the birds from chicken sheds while spraying, as the DDT does not damage them even if the spray comes directly in contact with them.

In Alameda County there are several commercial agencies engaged in pest control and they include in their corrective practice the application of DDT as a toxic residual, principally for combatting flies. Some objections by these agencies were expressed when we initiated our residual spray program, but they gradually became adjusted to our activity in this field, apparently satisfied with our explanation that a threat of encephalitis was the reason for our work. They found some degree of satisfaction in our prediction that widespread use of DDT in Alameda County by this District would materially benefit their future activities.

EFFECTIVENESS

The preceding explanation of uses of DDT in this District serves to indicate our general favorable opinion of this material. We believe that within the next year sufficient data can be accumulated to demonstrate impressive reduction in cost of control when specific areas are compared which formerly were treated with repeated applications of diesel oil. The following tabulation of inspections made in the Hayward area reflect the results being obtained throughout this District.

RECENT INSPECTIONS OF PREMISES TREATED
WITH RESIDUAL DDT -- 1946 SEASON

DATE		TYPE OF JOB				
Inspected	Treated	Dairy	Drain	Cesspool	Name and Location	Findings
August 5	June 3	x	x		Martin Dairy	Entirely free of mosquitoes and flies
August 5	June 3	x	x		Bucher Dairy	Entirely free of mosquitoes and flies
August 5	June 8	x	x		Camengind Dairy	Entirely free of mosquitoes and flies
August 6	May 22	Leckland Ave. Storm Drain, Hayward Sprayed interior of pipe with 5% DDT residual				No insects of any kind inside pipe
September 6	April 16			38	Castro Valley and Hayward Highland	9 Breeding 4 New 5 Failures all Open type *
September 12	August 12	Alvarado Gun Club, Open Marsh Area Sprayed with 1/2% DDT in Kerosene				No breeding

RECENT INSPECTIONS OF PREMISES TREATED WITH RESIDUAL DDT — 1946 SEASON

DATE		TYPE OF JOB				
Inspected	Treated	Dairy	Drain	Cesspool	Name and Location	Findings
September 13	May 13			49	Ashland South San Leandro	4 Breeding 2 New 2 Failures both Open type *
September 14	May 14			95	Hayward, Tennyson, Valle Vista	9 Breeding 7 Open type * 2 New
September 16	June 3	x	x		Bucher Dairy	No Breeding Very few flies present. See inspection of August 5
September 16	July 9	x	x		Don Pedro Dairy	No flies; no mosquitoes. Completely effective
September 16	June 3	x			Mt. Eden Dairy	No flies; no mosquitoes. Completely effective

RECENT INSPECTIONS OF PREMISES TREATED WITH RESIDUAL DDT -- 1946 SEASON

DATE		TYPE OF JOB				
Inspected	Treated	Dairy	Drain	Cesspool	Name and Location	Findings
September 16	May 15			98	Mt. Eden, Tennyson, Valle Vista	20 Breeding 3 New 17 Open type *
September 17	May 17	x	x		Horat Dairy	No flies; no mosquitoes. Completely effective
September 17	May 17			73	Russell City South San Leandro San Lorenzo	12 Breeding All open type *
November 12	July 16	Arnold Chicken Hatchery				No flies; no mosquitoes. Completely effective
November 12	June 8	Fairmont Prison Farm (Alameda County) Dairy and Chicken Farm				No flies; no mosquitoes. Completely effective
November 12	June 25	San Pablo Livestock Sheds (Hog Ranch) Shell "Barntox" 5% Residual to Exteriors Used				Some flies present but tremendous reduction
November 13	July 20	Oakland Garbage Disposal Plant				Some flies present but tremendous reduction

* "Open Type" Cesspools are open excavated pits without any roof or wall construction of any kind.

FAILURES

The number of failures in cesspools were very few and the reasons therefor were in most cases due to climatic conditions, rain, mist and general wearing of the surfaces treated. In some cases cesspools were alternately flooded, resulting in destruction or loss of residual deposit. In urban areas, some catch basins had to be treated twice during the summer and fall of 1946 and the reason for this is believed to be sluicing from gutters due to washing of vehicles in the street or testing of hydrants whose flow was permitted to drain to the catch basins. In general, a very small number of these failures occurred. The utilities companies advised us of several vaults they found harboring mosquito adults. A re-check on these in all cases showed that these vaults had been missed on the first tour and that actually no failures in DDT on these enclosed vaults occurred during the spring, summer and fall of 1946.

Some dairy barns required spraying twice in the 1946 season and the reason for this is that the initial application of 5% solution was made too sparingly and that actually a "wetted surface" was not obtained on the original spray.

A trial of acetone as a solvent was made, and when we attempted to use it as an emulsion difficulties were encountered immediately. Apparently acetone, even though the same amount of emulsifier is added as with xylene, will not produce a stable emulsion. It is satisfactory, however, as a solvent for further dilutions either with diesel oil or kerosene, but has no distinctive merit over these two aside from ability to dissolve DDT at about the same rate as xylene.

An interesting use of DDT occurred in the Castro Valley School where the walls in one wing were re-finished with a paint containing DDT. The manufacturer furnished the paint and the school and the District each paid one half of the cost of painting. Painting was completed in May 1946 and was thoroughly effective through summer and fall and still retains some effectiveness. We anticipate that it will be necessary to re-apply DDT to these walls next spring if the source of the fly infestation is not eliminated. However, subsequent spraying of the exterior of buildings with residual DDT emulsion and general improvement of sanitation in the surrounding area has materially reduced the fly population. It has been concluded from this experience that the economy of applying DDT in paint may be questionable if it becomes necessary to repeat the DDT application prior to the need for redecorating.

It was observed in the treatment of duck club areas, which are flooded in the late summer, that the application of a concentrated emulsion of DDT directly to inflowing water was not successful. The procedure was as follows:

A fifty gallon drum with a small petcock outlet was filled with DDT emulsion and permitted to drip directly into the inflowing water. Thorough mixing occurred in the turbulent flow which occurred before the water ponded in the open marsh area and it was expected to create a residual toxic effect to prevent development of mosquito larvae. A wide range of dosages was tried, varying from 0.01 parts per million to 0.10 parts per million. These dosages were controlled by varying the strength of emulsion in the fifty gallon drum and the rate of chemical application was maintained directly proportional to the quantity of inflowing water. This method was a complete failure. We do not know the reason for the failure but intend to try again next year using 666 and DDD.

After this failure, we sprayed a ½% solution of DDT in kerosene on this duck club, and got excellent results. In addition, the club caretaker told us that there was a startling reduction in the number of sick ducks on the property after the application of DDT. We do not know the reason for this, but mosquitoes transmit bird malarias. An interesting research project along this line could be conducted by the wildlife conservation people.

COSTS

Because of expanded activities, it is not possible to make a comparison of costs between the period in which we used DDT and years in which we did not use it. Many things have happened to complicate such comparison. Extended use of power equipment has changed the application of larvicide both in costs and in area covered during the past three years. It is our opinion that the elimination of repetition such as semi-monthly oiling of cesspools, septic tanks, catch basins and utility vaults has permitted our field crews to extend their activities over a much greater area and to carry on a vastly extended control program. The need for expanding our activities is recognized when the tremendous population increase in Alameda County is considered. The increase in housing in this County has necessitated an increase in area controlled. Another factor of great value resulting from the use of DDT is a greater certainty that field work is positive and lasting.

OBSTACLES

In our experience the major obstacles in the use of DDT is its reputed toxicity to humans, which probably is due more to the solvent than to the DDT. It has been noted that xylene, kerosene and diesel are skin and eye irritants and are all capable of inducing headache. Precautions must be taken with use of these materials in confined spaces. Occasionally the need for spraying in small buildings requires use of protective clothing including facial coverings and for this purpose a standard army gas mask has been found quite satisfactory.

An obstacle which has caused a considerable amount of lost time has been the necessity for transferring fowl and animals from the stock pens during the spraying procedures.. In hog pens and chicken batteries it is not possible in some cases to accomplish an adequate residual spray with animals and fowl remaining in the pens. It is likewise not possible to transfer livestock without a considerable amount of previous planning and scheduling. Several days and several return trips may therefore be necessary before an entire ranch can be completely treated.

An obstacle in all spray operations is the constant plugging of nozzles. Many different types of nozzles have been tried with none being outstandingly good. The most satisfactory that we have found are the D. B. Smith "Mohawk" adjustable conincal spray nozzle and the Spraying Systems Company model #¼-T-6002 flat atomizing nozzle. The latter type is equipped with an internal screen which must be removed for wettable dust suspension spraying.

SPECIAL EQUIPMENT

1. Power Sprayers

Sprayers in use for the usual diesel oil spraying are readily adaptable to use with DDT solutions, suspensions and emulsions. No major changes were required in the positive pressure pump type sprayer which delivers approximately three gallons per minute. It is believe that xylene has a somewhat more deteriorating effect upon pump leathers and belts than diesel oil. Major difficulties occurred in the clogging of nozzles, and this can be alleviated by using lower concentrations. It was found that the mechanical process of mixing the 100% DDT powder in diesel oil without using a solvent such as xylene required a prolonged mixing period to produce a stock solution of 5%. This mixing process was greatly shortened by construction of two mixing tanks with a re-circulating pump permitting the liquid to pour from one tank to another and agitation to continue for a period sufficient to achieve complete solution.

Mr. Peters: Mr. Jones wishes me to remind you that the new revised forms of progress reports are available and a few are here, You may take one now if you like, and more will be sent to you.

Mr. Washburn: The next paper on ditch cleaning was to have been presented by Mr. Murphy, who is not here. I will call on Mr. C. E. Snyder in his stead.

(Note: Mr. Snyder described a ditch cleaning plough made by Mr. Murphy and used in the Redding and adjacent districts.)

Mr. Washburn: This concludes the series of operating reports, and I will now turn the meeting over the President Geib.

Mr. Geib: Thank you, Mr. Washburn. I will ask our Secretary to make a statement concerning Association finances.

Mr. Peters: The Secretary-Treasurer's report, presented yesterday morning shows a cash balance of $157.15 which is much lower than usual, and possibly insufficient to get out the proceedings of this meeting. This low balance results from our having deferred sending out bills for the annual contributions by the districts. The sending of these bills was deferred because there has been considerable discussion of a proposed change in the financing of the Association, with a permanent staff. Under the proposed plan the contributions from the districts would be increased to approximately one percent of their budget.

Some questions have already been raised at this meeting in regard to legal aspects of the proposal, and in any event the matter should be referred by all the Districts to their Boards of Trustees for expressions of opinion as to policy.

Mr. Gray: This matter cannot be properly analyzed at this meeting, in view of the time element. It has many aspects which must be carefully studied, and I therefore suggest that it be left in the hands of the Executive Committee for investigation and report at a later date.

Mr. Geib: If there is no objection, this will be done.

Mr. Pruess: We have had a rather peculiar situation which should be discussed. Perhaps we don't all understand just what the state expects and why. It seems that in order to avail ourselves of the subvention fund we have to prepare a lot of daily reports, from which we compile and submit a monthly report. At the rate things are going and from the appearance of the reports, I am afraid that we will divert the purpose of the fund which, according to my understanding, is to eradicate mosquitoes. It seems to us in the Consolidated District that it takes a lot of man hours to maintain the normal abatement work within a given area. Instead of having the State load us down with statistical reports we should put in as many man hours as possible in field work rather than hire entomologists and accountants to compile and complete our reports. Our real job is to abate mosquitoes, both pests and disease carriers. I would like to hear from some of the other districts on this. How do you feel about it?

Mr. Ed. Smith: I think any of us who have been in the service are sick and tired of paper work. We sincerely want to get away from it. At the same time, I do feel that these reports are important. Perhaps they may lean toward the side of the disease vector but still they are general and include pest

mosquitoes as well. I feel they are leading us into doing our work on a truly scientific basis.

Mr. Gray: I think our District has been carrying on rather detailed cost analysis for more years than any other District. We have developed fairly elaborate reports. Our present monthly and daily report forms have been posted on the wall for your examination. Actually I believe these reports make the work of our foremen not only more accurate but also easier for them to prepare. We want to know what our total costs are and if the unit costs are rising we want to know why. I agree that we don't want to go too far in the matter of detailed reports. There is always a tendency to have the tail wag the dog. We have always tried to keep our foremen from being just report writers. I do not believe their reports take too much time.

Mr. Bendel: Before I was in mosquito abatement work I was a plant and cost engineer for a large concern. The superintendent of that company had been an auditor by profession. He had us making so many reports of various kinds that we didn't have time to run the plant and they finally went bankrupt, though it was a large concern with plenty of money back of them.

Mr. Geib: We are all reluctant to get into a lot of report making. You can't kill mosquitoes with reports. However, we found this past season that it is definitely necessary to have some type of report in order to know what we are doing and what it is costing.

Mr. Washburn: Various superintendents have been appointed on committees. One has been on these reports. A great amount of time has been spent on this problem. Most of the suggestions have been deletions. We are trying to make report forms as simple as we can and yet get the maximum of information for our own use as well as the State. The State cannot justify giving subvention money without reports as to how that money was spent. It may mean spending perhaps five minutes each day on your report. I am sure any of us can make out the monthly progress report forms in a half hour. It is not at all an impossible task.

Mr. Dahl: I am the one who sets up the majority of the forms and definitely says which ones are required. We did not want to go into extensive records this year. I would like those districts capable of doing so to incorporate keeping of entomological records into their program. We believe that there are three forms a district needs. The first is a daily report, which the State does not need to see. It is none of our business whatever except that it is the beginning of your monthly progress report. The second is the monthly progress report, and the third is the monthly entomological report. I find where people understand what we want and why we want it they are quite willing to cooperate. Some of you have suggested things we ourselves had eliminated, feeling it would involve

too much work on your part.

We want to show you the reason why you should summarize your daily activities and see what you are trying to do and what you are accomplishing. You are going to see for yourselves where you have been making mistakes -- we all will -- where certain operations are costing too much. That, in the future, will be the key to your operations. That is why, when we provided you in many cases with 35, 40 or 50% of your money, it may cost you a thousand dollars out of that subvention to keep these reports. The State is paying for information that is really going to be your salvation.

At this conference we have talked about entomological control, and about the value of using entomology; we have talked about engineering problems; but all those things are useless unless we tabulate as we go along. We can't let reports become the essence of our activity, but if we don't know what we are doing, what is the use?

We have asked for monthly progress reports and sent you forms to be filled out. I have had to defend my stand with our business manager and with the State finance department. They say we haven't rigid enough control. My idea has been that this year is the time to organize and I am not going to burden you with more than necessary report making. If we have problems and are not able to solve them, let's bring them up and take a good look at them. Let's see what we have to do, what we have to solve, what the problem really is. I feel that in the coming year we have a great opportunity to go ahead. So far there are three reports we request from you -- the monthly operational report, which is a summary. We furnish a form in case you don't have one of your own. We are only trying to work with you and increase your efficiency and the effectiveness of the work you are doing. That summary report you will find is going to contain basic information. The next thing required is a record of mosquitoes, both adults and larvae. There are two reasons for this. You should know from year to year what is happening in your District. You want to know whether disease vectors are present, and what species are increasing or decreasing, and where. These are also selling points to the Legislature. The third report is the financial report, which is designed and required by the Department of Finance. It is a breakdown of the expenditures according to your budget during the period of operations, certified to by the county auditor or whoever is responsible for your funds. Recently we have taken the attitude that if you will send us the information for the financial report we will even prepare the invoice for you and send it back to you for your signature. I figured it would be quicker to do it myself than to take the time for a lot of letters of explanation.

In granting these subventions the State is trying to bring about not only better mosquito control work in California

but better business practices by the districts and more accurate accounting and recording of their work. It will cost you a little money and effort to get this money, but it is worth while to you.

Mr. Peters: I suggest that this is another matter which can be referred to the Executive Committee, along with the proposal for a stronger central organization. (This was put to motion and carried).

Mr. Geib: Is the Resolutions Committee ready to report?

Mr. Gray: The Resolutions Committee moves the adoption of the following resolutions:

1. WHEREAS, the California Mosquito Control Association has again met at the University of California in its annual conference as the guest of the University of California, for its Fifteenth Annual Conference on December 13 and 14, 1946, now therefore

   BE IT RESOLVED, that we hereby extend to the President of the University of California, the Dean of the College of Agriculture, the Dean of the School of Public Health, the Director of the Hooper Foundation for Medical Research, and to all other members of the faculty and administrative staff whose assistance contributed to the success of the conference our sincere thanks and appreciation for the courtesies and use of the facilities of the University.

2. WHEREAS, the experience of various mosquito control districts in California during the past two years has shown that in dichloro-diphenyl-trichloroethane (DDT) we possess a material which is extremely useful and valuable as a mosquito larvicide and adulticide, with concurrent value in the control of flies, fleas and other homonoxious arthropods, now therefore

   BE IT RESOLVED, that we strongly recommend the use of DDT by all mosquito abatement districts and health departments in appropriate situations; that we find that this material enables us to combat these insects with greater certainty and effectiveness than heretofore; that we are confident that its use will result in economies in operation; and that we find that when properly used by trained and experienced persons the material is harmless to man and domestic animals, to crops and to wildlife.

3. WHEREAS, T. Frank Gainer, Superintendent of the Pulgas Mosquito Abatement District in San Mateo County, California was most unfortunately called by death on July 19, 1946, now therefore

BE IT RESOLVED, by the members of the California Mosquito Control Association, that we hereby express our regret at the loss of one of our members, and that when we adjourn we adjourn out of respect to the memory of T. Frank Gainer.

(Each resolution was duly adopted.)

Mr. Geib: The business of this fifteenth annual conference of the California Mosquito Control Association being completed, we will now adjourn out of respect for the memory of our former member, T. Frank Gainer.

ADJOURNED

REGISTERED ATTENDANCE AT THE CONFERENCE

MOSQUITO ABATEMENT DISTRICTS:

Alameda County

William B. Herms, Trustee
Harold F. Gray, Engineer
T. F. McGowan, Ass't. Engineer
Margaret A. Prefontaine, Clerk
Roland Bendel, Division Foreman
L. Percy Mapes, Division Foreman
Paul T. Garcia, Laborer
Thomas L. Brannan, Laborer
Harley A. Dennis, Laborer
Herbert Brown, Laborer
Woodrow L. Paxton, Laborer
Ivan Best, Laborer
Jack D. Rowlett, Laborer
Jack Duffy, Laborer
Wm. C. Hanim, Laborer

Ballona Creek

E. J. Bumiller, Manager
H. J. Crawford, Foreman

Carpenteria - None

Coachella Valley - None

Consolidated

Ed Davis, Supt.
A. F. Preuss, Trustee
Donald Merritt, Foreman

Contra Costa No. 1

Ernest Campbell, Supt.

Delano

Noel P. Omlor, Supt.

Delta

Theodore Aarons, Entomologist

Durham

D. C. Crandall, Supt.

Doctor Morris

A. F. Geib, Manager
Gordon F. Smith, Entomologist

Eastside

E. Chester Robinson, Supt.
J. W. Allen, Inspector
Eugene Vernon
Phillip Smith
J. E. Sellers
L. G. Stokes
Marvin E. Johnson
Hollis H. Speight
J. M. Crow
W. T. Brooks
Maurice Sweeten

Fair Oaks - None

Fresno

R. C. Sturgeon, Chief Inspector

Hanford - None

Los Molinos

Joe Willis, Supt.
Ivan Mattoon, Trustee

Marin County - None

Matadero

Gordon W. Mapes, Supt.

Merced County

Wesley C. Ewing, Supt.
Edgar A. Smith, Entomologist
Ann Bono, Stenographer-Clerk
Harold G. Lilley
E. A. Denny
Nelson T. Richards
W. K. Asher
E. R. Hoffman
R. M. Queen

Napa

A. M. Emerick, Supt.

North San Joaquin

Ernest Campbell, Supt.
Clyde F. Duckworth

Oroville - None

Pine Grove - None

Pulgas

R. H. Thomas, Supt.

Redding (Anderson, Clear Creek, and Cottonwood)

Robert E. Hansen
Jimmie Murphy
Stanley Spencer

Solano

H. C. Pangburn, Supt.

Sonoma - None

Sutter-Yuba

T. G. Raley, Supt.
J. F. Knappen, Assistant to Supt.
W. H. Miller

Tulare

R. Henderson, Supt.

Turlock

G. Edwin Washburn, Supt.
Ned R. Caplener

Turlock (con't)

Nelson C. Wagoner
Grover W. Force
V. L. Bell

West Side

R. H. Coburn, Supt.

CITY AND COUNTY HEALTH DEPARTMENTS:

Los Angeles City

W. E. Duclus, Mosquito Control Officer

San Francisco City

Thomas F. Cunningham, Sanitarian

Alameda County

Thomas D. Wright, Sanitarian

Contra Costa County

O. J. Hendrickson, Sanitarian

Monterey County

R. M. Abbott, Mosquito Control Officer

STATE HEALTH DEPARTMENTS:

California

Wilton L. Halverson, Director of Dept. of Public Health
Frank M. Stead, Chief, Division of Environmental Sanitation
Lester M. Breslow, Chief, Bureau of Chronic Disease
Arve H. Dahl, Chief, Mosquito Control Section
Richard F. Peters, Mosquito Control Specialist
R. F. Portman, Mosquito Control Specialist
R. W. Jones, III, Mosquito Control Specialist
Harvey I. Magy, Mosquito Control Specialist
Jack R. Fowler, Entomologist
Morgan E. Stewart, Ass't. Sanitary Engineer
J. Grossman, Public Health Educator
Wesley H. Dickinson, Sanitarian
Philip J. Gillette, Sanitarian
O. J. Hendrickson, Sanitarian
C. E. Snyder, Sanitarian
S. J. Kirkwood, Foreman Inspector
Karl Bartle, Field Inspector
John W. McComb, Field Inspector
Warren F. Stephenson, Field Inspector

U. S. DEPARTMENT OF AGRICULTURE:

Bureau of Entomology and Plant Quarantine

G. E. Bohart, Entomologist, Berkeley, California
A. W. Lindquist, Entomologist, Corvallis, Oregon
C. M. Gjullin, Entomologist, Corvallis, Oregon
Charles S. Wilson, Entomologist, Corvallis, Oregon
A. R. Roth, Entomologist, Corvallis, Oregon
H. H. Stage, Entomologist, Washington, D. C.

UNITED STATES PUBLIC HEALTH SERVICE:

Justin M. Andrews, Entomologist, Senior Scientist
Richard P. Dow, Entomologist
Basil G. Markos, Entomologist
Willis W. Worth, Entomologist
Bernard Brookman, Entomologist
Jack K. Kimball, Entomologist

UNITED STATES NAVY:

R. E. Rock, Commander, Industrial Hygiene Section, Medical Officer
A. G. Keller, Chief Pharmacist

CITY OF PORTLAND, OREGON:

Dorothy McCullough Lee, Commissioner of Public Utilities

ROCKEFELLER FOUNDATION:

L. W. Hackett, M. D. Malariologist, Buenos Aires, Argentina

UNIVERSITY OF CALIFORNIA:

Stanley B. Freeborn, Ass't. Dean, College of Agriculture and Professor of Entomology
William B. Herms, Professor of Parasitology
W. Middlekauff, Ass't. Prof. Economic Entomology
Robert L. Usinger, Ass't. Prof. of Entomology
R. M. Bohart, Ass't. Prof. of Entomology
J. R. Douglas, Ass't. Prof. of Parasitology, Davis
William C. Reeves, Hooper Foundation for Medical Research, Medical School, San Francisco
Harold F. Gray, Lecturer in Public Health, School of Public Health

MISCELLANEOUS:

Los Angeles Chemical Company

J. L. Todd, Los Angeles, California

Niagara Spray & Chemical Co.

Glen F. Rouse, Entomologist, Richmond, California

Paramount Pest Control

E. W. Bushing, Oakland, California

Shell Oil Company

C. J. Boissonou, Entomologist, Oakland, California
Harold Dodge, Entomologist, San Jose, California