PROCEEDINGS AND PAPERS

OF THE

SIXTEENTH ANNUAL CONFERENCE

OF THE

California Mosquito Control Association

Held at Agriculture Hall
University of California
Berkeley, California
February 12, 13, 14, 1948

EDITED BY

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The Sixteenth Annual Conference of the California Mosquito Control Association was called to order at 9:15 a.m., Thursday, February 12, 1948, in room 113, Agriculture Hall, University of California, Berkeley, California, by President Arthur F. Geib, who introduced Professor E. O. Essig, Chairman of the Division of Entomology and Parasitology, who presented the following opening address:

Professor Essig: The Division of Entomology and Parasitology is always pleased to welcome all of you who are concerned with the development and administration of Mosquito Abatement Districts. It is right that you should come to this institution and to this building to hold your annual convention. Because it was here that Professor Herms, Dr. Freeborn, and their associates, including many of you leaders in this room, conceived and brought to existence the first Mosquito Abatement District in this state. Therefore, welcome to you! Our chief concern is that your meetings will be most pleasant and profitable, and we will do all we can to make them so.

We in the University have much in common with officials of mosquito abatement districts. We are all concerned with the same general problems: the control of pestiferous insects! To this end we may very greatly aid each other in laying our experiments, in testing all the new promising insecticides, in developing suitable aerosol, dusting and spraying machinery, in making insect surveys, in determining all the various species of insects involved, and in doing all we can to control the destructive insect pests without upsetting too much the natural balance of beneficial animals that are everywhere aiding in the elimination of the very ones we seek to destroy.

We share alike the responsibilities of accomplishing these ends with the least possible damage to growing crops, and to eliminate the use of all insecticides that are likely to leave residues that may cause injury to wild and domestic animals and to human beings. In the determination of insect specimens and in certain recommendations for the use of new insecticides and equipment we may be able to help you. In furthering the progress of our California Insect Survey you can assist us very greatly.

Your group can very materially aid in the training of competent graduate students by furnishing employment, wherever possible, during the summer vacation months.

These varied endeavors form an extremely large and important assignment which will require all of the knowledge, wisdom. and ingenuity of the combined efforts of all of us. Let us then unite our activities to further the cause of public health, which is so vital to every one of us and to the world at large

Mr. Geib: Thank you, Professor Essig. It is now customary for the President of the California Mosquito Control Association to deliver a short message.

President's Message: I wish to welcome all of you to this 16th Annual Conference of the California Mosquito Control Association and invite you to participate in the discussions following the various papers to be given here. We all wish for this Conference to be an informal one, designed to allow for general participation.

We have with us many out-of-state guests and visitors. These people are not only from neighboring Pacific Coast States where they have mosquito control problems similar to ours, but some are from across the Continental United States. We are most happy to have you here with us and wish to offer our sincere appreciation to all of you who have traveled so far to participate in these meetings.

In years gone by it has been common practice for the President to review briefly the history and activities of the California Mosquito Control Association. This year, however, due to the conspicuous progress made during 1947 in the advancement of the Association as an organ of service to local mosquito control agencies, this entire evening will be devoted to discussion of its activities and of plans for the future. It is the belief of many of the districts that a strong, active Association is our best answer to furthering California mosquito control and in unifying mosquito control activities at the local level.

Following this message we will hear about the growth of mosquito abatement in California during 1947, so I will not go into any detail on that subject. However, I will attempt to give you a very brief history of mosquito control in California starting with the passage of the Mosquito Abatement Act in 1915.

During the 30 years from 1915 to 1946 there were 39 mosquito and pest abatement districts established in the State of California controlling mosquitoes over a total area of 4,645 square miles.

In 1946 six new districts were formed and an additional area of 6,353 square miles came under control. This spurt in growth was continued in 1947, until at the present time there are 41 mosquito abatement districts in California controlling mosquitoes in an area exceeding 16,000 square miles. Several other areas are now in the process of organization of mosquito abatement districts.

Factors contributing to this tremendous growth in two short years are many, but probably some of the most important are:

Impetus and publicity as a result of World War II in the control of disease-bearing insects.

The discovery of highly effective insecticides resulting in new control techniques and operations at reduced costs.

Grants from the State Legislature in the form of Subvention to mosquito abatement districts and other agencies engaged in mosquito control.

I have brought to your attention this very brief history of the growth of mosquito control in California so that you will realize the tremendous spurt of activity that has taken place and the magnitude of the control problem that is now confronting the mosquito abatement districts of this State. Ours is a responsibility and a challenge that will not be easily fulfilled. In addition, many eyes will be turned this way to evaluate the practibility of mosquito control on a scale that is now being undertaken here and which is promised for the future.

At the present time over $1,500,000.00 is being spent annually for mosquito control in California, and it is most likely that this amount will be increased in the near future. With mosquito control activities here becoming so widespread and on such a large scale, it seems highly important that we have a strong, active Mosquito Control Association to further the work of local mosquito control and to act as a clearing-house for all individuals and agencies interested in mosquito control activities. This evening's discussion will serve to amplify this important consideration.

Next on the program we will hear from Dr. W. L. Halverson, State Director of Public Health, whom we all welcome as a friend, interested in our Association's activities.

CALIFORNIA MOSQUITO CONTROL STRIDES DURING 1947; THE OUTLOOK FOR 1948

By Wilton L. Halverson, M.D.

Director of Public Health

At your last Annual Conference it pleased me to have the opportunity to address you on this subject of mutual concern — mosquito-borne disease control. Again I consider it a personal pleasure to reassure you of the vital interest of the State Department of Public Health in furthering organized mosquito control.

In December of 1946, when your last conference was held, our mosquito-borne disease studies and demonstrattions, and subvention assistance for mosquito control were in the beginning stages. Today we are in a position to discuss the outlook for 1948 by evaluating our experience of the past 20 months.

The responsibility vested with our Department by the State Legislature in 1946 in this program required administering an annual expenditure in excess of a half million dollars. Our efforts have, in turn, been balanced by expenditures of mosquito control agencies in excess of a million dollars. This overall effort has required changes in administrative organization and supplementing of technical guidance. Our own staff, expanded to shoulder the various phases of new activities, received invaluable help from the Mosquito Control Advisory Committee, this year augmented and known as the Vector Control Advisory Committee. The members of the past years committee were:

Dr. Karl F. Meyer, Director, Hooper Foundation
Dr. W. McDowell Hammon, Hooper Foundation
William C. Reeves, Encephalitis Study Unit, Hooper Foundation
Stanley B. Freeborn, Asst. Dean, College of Agriculture, University of California
William B. Herms, Professor Emeritus, U.C., Consultant to State Dept. of Public Health on Entomology
Harold F. Gray, Executive Office, Alameda County Mosquito Abatement District
John J. Sippy, M.D., San Joaquin County Health Officer
E. Chester Robinson, Mgr., Eastside Mosquito Abatement District
Arthur F. Geib, Mgr., Kern Mosquito Abatement District

Their collective outlook as experts in this field materially asisted us in planning the program.

Our task in mosquito-disease studies, demonstrations, and subventions, has been a diverse responsibility, involving four of the five Divisions of this Department — Administration, Environmental Sanitation, Laboratories, and Preventive Medical Services. In addition, the year 1947 saw organization of the Bureau of Vector Control, designed to perform broader vector control services. This Bureau combined the Sections of Mosquito Control and Rodent Control within the Division of Environmental Sanitation.

The objectives of our mosquito control activities as stated in 1946 have persisted to the present with few modifications, and we anticipate their extending through 1948. The philosophy of this Department is to recognize the place of the local agency in achieving results in operational programs such as yours. Our relationship remains an advisory one to the mosquito abatement districts and local health departments engaged in mosquito control. Briefly, some of the objectives and accomplishments of the program are as follows:

1. Subventions have been continued in areas and with agencies which have shown active pursuit of sound mosquito-vector-control. (A precept of the subvention program was the need for effective mosquito-vector accomplishment continuously over a number of years, in order to demonstrate the effect of adequate mosquito control upon the encephalitis and malaria rates.) In this regard, agencies continuing with the subvention program have been expected to provide:

(a) Proper administrative and technical supervision over their operations to effect more reliable results;

(b) Adequate office and depot facilities to make for necessary relations between the agency and the public and to organize administrative and operational activities for the maximum of efficiency;

(c) Bookkeeping, audit, and inventory systems to assure that operations are conducted on a business basis;

(d) Records on control operations and mosquito occurrence to supply facts concerning the costs and results of control measures employed; mosquito species and their significance within the area under subvention; as well as aid in guiding the likely costs and needs of future operations.

2. Newly-organized mosquito control agencies are expected to qualify for subvention assistance on the basis of mosquito-borne endemicity and vector prevalence. The degree of assistance will be determined upon the recommendations of our Vector Control Advisory Committee.

3. Contracts with mosquito control agencies during the current fiscal year provide for State assistance, dependent upon a prescribed quarterly operational plan. The effect of State money being available only after expenditure of committed local funds has made for more precise planning

by the individual agency of both budget and operations. To be sure, seasonal variations (in which the year 1948 seems to be unusually unusual) can make for an element of error. However, provision has been made for adjustment of "just" departures from the requirements of the contract.

4. In many of the areas, improved relations are needed between mosquito abatement districts and local health departments, agricultural commissioners, private physicians, veterinarians, schools, and service clubs. All have functions dedicated to community service and advancement. By meeting together and becoming apprised of your mutual objectives, much can be gained to aid each in doing his job a little better. We encourage you to make the most of these associations as part of your mosquito-disease control program.

5. The expansion of organized mosquito control is a continuing movement throughout California. Today the area under organized mosquito control in California is approximately 16,250 square miles, of which 5,250 square miles have been included since your last Annual Meeting. The outlook for 1948 is that an additional 4,000 square miles of area will undertake organized mosquito control. This movement will continue as irrigation practice, industry, and population increase throughout the State.

6. Details of physical accomplishments of the mosquito control activities during the past year will be presented to you by members of our staff later in this Conference. The magnitude of the total mosquito control effort has been tremendous. Overall expenditure of State and local funds has exceeded $1,600,000 on the subvented programs for fiscal year 1946-1947. In addition, $230,000 has been expended by the State, assisted by some United States Public Health Service funds in carrying on its mosquito-borne disease studies, demonstrations of mosquito control, and directing the subvention program. Aside from the two foregoing totals, an estimated $250,000 has been expended by other mosquito control agencies in the State of California. Thus, the estimated total expenditure in this field of activity during the past calendar year has been over $2,000,000. As stated last year, this is big business and a big responsibility.

7. Our staff has also been occupied during the past year in various forms of operational research. In this activity we have endeavored to work cooperatively with local agencies to achieve our common objectives. Airplane operations, use of ground aerosol, treatment of sewer farm and winery wastes, and other miscellaneous activities are being evaluated to determine their place in the overall scheme of mosquito control methods. The studies will continue during 1948, supplemented, as the need arises, by new undertakings.

8. In accordance with the recommendations of the initial Advisory Committee, we have again requested continuation of the $400,000 Subvention Fund during the next fiscal year. Tentatively, we are proceeding on the basis of, subvention assistance to agencies with whom contracts have been in existence over the past two years. We anticipate that a lessened ratio of assistance will be the characteristic pattern followed. A new area under organized mosquito control and eligible for assistance can receive subvention in keeping with its degree of eligibility. Areas not under control will be given advisory assistance in organizing the necessary agency to undertake mosquito control. Emergency assistance will be given in event of outbreaks of mosquito-borne disease.

9. Mosquito-borne disease studies conducted concurrently with the subvention program have been a major activity of the Acute Communicable Disease Service, the epidemiological branch of our Department. A progress report on medical studies of the mosquito-borne diseases, malaria, encephalitis in humans, and equine encephalomyelitis in horses, will be given by Doctor J. A. Moore, Chief of the A.C.D. Service, later in the program. Our encephalitis study has utilized the diagnostic services of the State Virus Laboratory, employed medical officers to study the disease in humans, employed veterinarians to study the disease in horses, and presented the problem to local health departments, medical societies, and veterinarians.

The foregoing statements on the related mosquito control activities are a part of the overall Vector control responsibilities of the Department. As brought out earlier in this report, the reorganization of the Bureau of Vector Control directs the attention of this Department toward vector-borne diseases involving arthropods other than mosquitoes. It is not unlikely that in the future they will be attacked by approaches similar to those used against mosquitoes.

Rodents as hosts of the vectors of plague, murine typhus, tularemia, relapsing fever, and Rocky Mountain Spotted Fever, warrant organized control action, including control of the ectoparasites themselves. Flies, including gnats, are linked in the transmission of numerous diseases, both directly and indirectly. Some of your districts, I understand, are giving serious consideration to expanding your mosquito control measures to include the housefly, with the desire for pest control being the motivating force. This will constitute an important public health move as well, I can assure you.

How far this movement in the control of other vectors will carry, only time will reveal, but it is likely that as the public recognizes the value being received from its tax dollars spent on mosquito control, it wll incline to want like results on rodents and other noxious arthropods. This, of course, will demand that science and the personnel engaged in this specialized field, provide the public with assurance of the economic practicability of each undertaking. This, we feel, can best be assured through utilizing professional services to supply technical guidance to these activities.

Our participation in other vector-borne diseases does in no way point to a lessening of our relationship with mosquito control. We are attempting to render services in this field which will prorate the degree of service to the significance of the disease. In this regard, mosquitoes and their control still rank as a number one problem.

In summarizing let me state that we are prepared to advance side by side with the local mosquito control agencies toward the effective and economical control of mosquitoes. This Department remains ever ready to assist in any way possible, emergency or routine, to render services in the field of vector control. All of us in this rapidly growing State are confronted with a changing set of conditions. Our aim is to keep abreast of the changes and to do what we are able to direct toward betterment of the public health and comfort.

Mr. Geib: Thank you, Dr. Halverson. The part that the State Health Department has played in the development of California Mosquito Control, is recognized by all of us, and we sincerely appreciate the interest which you have shown in our work.

Another speaker who is becoming recognized and regarded by all of us as a perennial to our annual conference is Dr. W. McDowell Hammon, who will address us on the "Advances in Knowledge of the Vectors and Arthropod Reservoirs of Certain of the Encephalitides."

ADVANCES IN KNOWLEDGE OF THE VECTORS AND ARTHROPOD RESERVOIRS OF CERTAIN OF THE ENCEPHALITIDES

read by

W. McD. Hammon, M. D.

From the Neuropathic Virus Unit, George Williams Hooper Foundation, University of California, San Francisco, Calif.

Original research work reported was performed in collaboration with the Commission on Virus and Rickettsial Diseases, Army Epidemiological Board, Office of the Surgeon General, U. S. Army; the California State Department of Public Health; and the United States Public Health Service, Communicable Disease Center and Research Divisions; aided by a grant from the National Foundation for Infantile Paralysis, Inc.

The epidemiology of the arthropod-borne encephalitides occurring within this state has been worked out to a stage where it appears to be the most complicated of any of the known arthropod-borne diseases. Therefore, to the epidemiologist, this group is most fascinating. To the public health administrator who is responsible for the organization which is expected to control it, it may appear as a nightmare. To the mosquito control operators it has meant both a challenge and a business boom. To the layman it is just plain confusing!

Unfortunately, our knowledge, though advanced in respect to these encephalitides beyond that in many other diseases, is still of such nature that simple statements regarding the identity and relative importance of vectors, hosts, and reservoirs can seldom be made without complicated qualifying explanations. Epidemiological investigation and reasoning have progressed by a series of deductive and inductive steps, as in the case of most diseases. The evidence is an interwoven series of hypotheses, deductions, observed and experimental facts. Those who fail to consider all aspects of the evidence can challenge if they choose — and with apparent justice — several links in the chain of evidence. For example, we have been told repeatedly that we have failed to prove that these encephalitides are transmitted *to man* by the mosquito, as was done so well in the new classical experiments of Walter Reed with yellow fever. We feel that such a dangerous experiment is not justified or necessary for the encephalitides, in the face of all the other evidence available. It was pointed out to me just recently that for plague, such an experiment with the flea has never been carried out. Yet do we doubt the role of the flea in transmitting plague to man? So long as we have suitable experimental animals, why insist that man also be used as a guinea pig?

This introduction, however, has not been made to apologize for any lack of knowledge regarding the human vector. The role of the mosquito as the principal vector here has been adequately established as for most other mosquito-borne diseases. The purpose has been to indicate that though the role of certain other vectors and hosts must still be considered tentative and needing further proof, the extensive mesh of intertwining evidence available is of such a convincing nature as to allow us even now to draw certain conclusions with a great deal of asurance that they will be borne out by subsequent experiment. Why do we not wait until the experiments are concluded and we have incontrovertible proof? Because human life, suffering, and a large public burden of expense for life hospitalization of those with permanent brain damage, together with a serious economic problem regarding horses, justifies application at the moment of the best available knowledge. Moreover, certain essential experiments are of such a difficult nature that at present they defy accomplishment.

Let us briefly review the development of our knowledge of the epidemiological cycle of St. Louis and Western equine encephalitis.

The earliest mosquito-borne concept was simply this:

SLIDE NO. I

When man was known to be affected, it became this:

SLIDE NO. II

In the East, pigeons and pheasants were found dying of the disease and it became this:

SLIDE NO. III

Triatoma were found infected and were shown capable of infecting guinea pigs by biting, so we conjectured this:

SLIDE NO. IV

Then our group, beginning in 1941, made repeated isolations of virus from *Culex* mosquitoes, principally *Culex tarsalis* (now totalling 138); found neutralizing antibodies in domestic and wild birds (highest rates in domestic); found large quantities of virus circulating for a few days in the blood of inoculated chickens, though no signs of illness were observed; transmitted the infection to chickens by *Culex tarsalis* and infected the same species of mosquito by permitting them to feed on infected chickens. We now have this cycle:

SLIDE NO. V

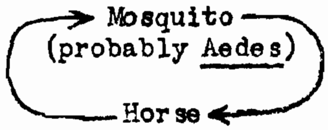
Triatoma found in California and Washington could not be implicated experimentally or epidemiologically so we have omitted them, for local consideration. You will note that *Culex tarsalis* replaces *Aedes* since *Culex* principally, rarely *Aedes,* were found infected. Man and horse are tentatively removed from the cycle since there was little or no experimental evidence available to show that virus of a titer such as was found necessary to infect a mosquito in the laboratory had been found in the blood of horse or man. In fact, though incomplete, most evidence available then, suggested that such quantities of virus were rarely, if ever present.

Then came repeated failure to find virus in winter-caught mosquitoes, and a chronic or latent stage of infection was not found in chickens or other vertebrates. Thus, no true reservoir was known. The next gleam of hope to come was the announcement that these viruses had been found in chicken mites by Smith and her collaborators, and by Sulkin. Thus the cycle changes to this:

SLIDE NO. VI

Then it was announced that the virus was transmitted congenitally from the mite through the egg to generation after generation, and the lost link in the cycle seemed complete, for now he had a *true reservoir*. It was also a vector, but only to chickens. Here is the cycle at this stage:

No. I



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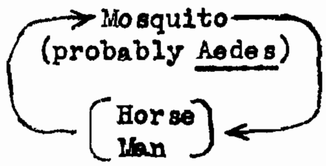

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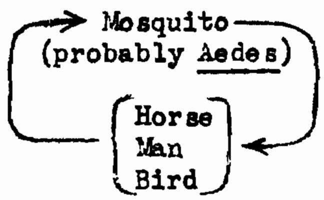

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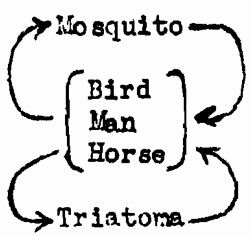

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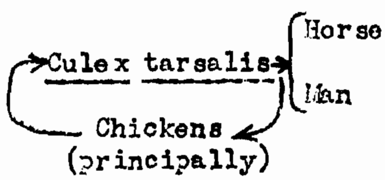

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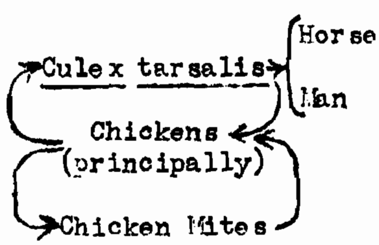

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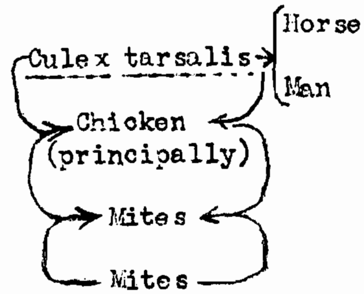

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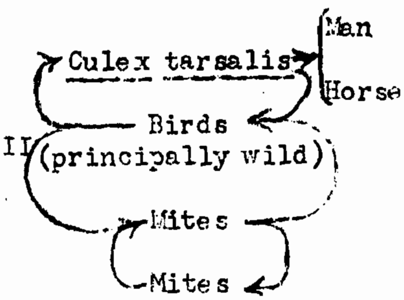
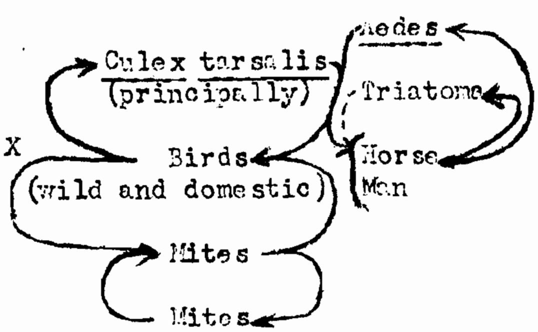


No. IX

No. X



SLIDE NO. VII

Mites, then, were probably responsible for initiating infection in chickens in the spring, and mosquitoes as they appeared could then take up the principal vector role and carry the infection to other birds and to man and horses.

However, proof was not complete. We could not find infected chicken mites in the Yakima Valley, Washington, nor could we find the chicken mites themselves in the lower San Joaquin Valley. Neither could we experimentally infect or transmit these viruses by chicken mites in the laboratory.

Finally ,Smith and her co-workers announced that they had effected experimental infection of chickens by both naturally and experimentally infected chicken mites. That report, however, we look upon very critically and wait for further confirmation. We view it thus not entirely because we ourselves were unable to demonstrate such transmission, but because in every instance the evidence of infection in their work was based on a blind passage of materials. For example, after chickens had been bitten by infected mites, the blood from those fowl could not be shown to contain virus at any time by direct inoculation into the brains of mice. Instead, the blood had to be passed through eggs, then the egg material inoculated into still other eggs and finally, after two such blind passages, virus could apparently be demonstrated in mice by inoculation. Blind passages of this nature are subject to many possible laboratory contaminations and conclusions based on these alone are liable to be in error. Furthermore the authors do not report finding antibodies in chickens following infection, though these antibodies can usually be demonstrated regularly in infected chickens. This missing evidence would have lent great support to the experiments. Furthermore, in their one trial they were able to reinfect a chicken and "demonstrate" viremia the second time (again by this same blind passage technic). The chicken was reinfected 32 days after the original infection. According to our experience, this would be a very unexpected result. Since in our hands chickens inoculated with most minute amounts of virus circulate sufficient virus to infect mice, even when the blood is diluted 100 to 10,000 times, it is hard to accept this other type of evidence of infection. Nevertheless, we fully expect that mites will be demonstrated as capable of infecting chickens in some manner.

Next, we will consider the role which apparently is played by wild birds. By developing special precipitin sera it was discovered that many *Culex tarsalis* had fed on wild birds, but it was not practical to determine by this means on which species they had fed. An attempt to reduce encephalitis infection rates in mosquitoes and in chickens in two large experimental areas in Kern County in 1944, by applying residual DDT in chicken houses, failed completely. Among other things this failure suggested strongly that birds other than chickens were playing an important role. Then, avian malaria was used as a tool for further study, and finding malaria infection rates in Kern County approaching 100 per cent in two species of the most common small birds, together with rates of about 10 per cent in *Culex tarsalis* gave further specific evidence that encephalitis vectors fed intensively on the most common small wild birds. Further, encephalitis neutralization tests on sera of these small birds showed relatively high infection rates. Next, large numbers of these small birds were inoculated in the laboratory and it was found that in the blood of the house finch, at least, virus appeared in higher titers than in the blood of inoculated chickens. Thus, it became apparent that wild birds were possibly, or even probably, more important sources of infection than the chicken. Where we carried out surveys in certain dry-farming areas of the Middle West, we found little evidence to incriminate chickens, on the basis of blood antibody surveys. Possibly the wild birds alone were involved in those areas, but of this we have no positive or negative evidence, except that Brown in Michigan found very low rates of infection in geese swans, turkeys, ducks, and cranes in a bird sanctuary. These were all large birds, probably more comparable to the chicken than to house finches.

At the same time that we were carrying out the wild bird malaria and encephalitis studies, their nests were searched for other arthropods. In many nests heavy infestation of mites was found, principally *Liponyssus sylviarum* and *Dermanyssus americanum*. The former have now been found infefcted in ten instances (principally Western equine virus, but we eventually obtained St. Louis virus after laboratory manipulation of one virus isolation). Thus the cycle as next conceived for Kern County, California, was this:

SLIDE NO. VIII

Information regarding the ability of these mites to transmit the virus both by bite and through the egg must wait until methods have been developed to colonize the mites. Until the present, this appears to be possible only in the presence of baby nestling birds. Mites appear in large numbers on the nestlings, and then as the young birds are about to leave the nest, the mites migrate elsewhere — where we do not know — nor do we know where they lay their eggs or further complete their cycle. However, these mites appear to fit in as this missing link, the reservoir, so well that we feel justified in proceeding cautiously on the assumption that mites are vectors and reservoirs.

Now let us add one other likely portion to this cycle before putting it all together. Since *Aedes* mosquitoes have been found infected occasionally, since they transmit readily in the laboratory and feed much more frequently and viciously on men and horse than do *Culex* (though rarely on birds), and since they may appear occasionally in such terrific numbers, we must consider their possible importance. It is quite likely that if the infection rate of Aedes were one hunderd, or even one thousand times less than that of *C. tarsalis*, *Aedes* still would be just as important as vectors to man and horse. At present our actual figures are 3 isolations from *Aedes*, with 134 from *C. tarsalis*, a ratio of 1 to 45. The numbers of each species tested have been approximately equal. Although the available experimental data on horses is all too scanty, given only an occasional horse with a reasonable titer of virus in the blood for only one evening, hundreds or even thousands of *Aedes* might become infected and a very important local epidemic could ensue. Obviously, a few days later, after becoming infectious, many of these mosquitoes would probably feed again on susceptible horses or men. With this possibility, or probability, in view, we add this portion to the hypothetical cycle:

SLIDE NO. IX

Now let us look at all the probabilities as envisioned at present:

SLIDE NO. X

Next we may ask, what practical application do we have for all these data on such a complex cycle? What can we do about wild birds and their mites? To the last question at present we must answer — nothing' However it does lead to sober reflection in planning. For example, it suggests that through effective mosquito control we probably cannot *eliminate* these viruses from a community, though we can probably *prevent all, or most all human and equine infections.* The virus itself may remain dormant for years in mites and birds, without any visible evidence, until the mosquito vector again gets out of hand. Thus, eternal vigilance in respect to mosquito abatement would appear to be essential. It would also appear that these viruses may not have been introduced recently into the many communities where they have appeared in epidemic form, but that they have become apparent, simply because a suitable mosquito vector developed in adequate numbers through changes in agricultural practice or by other man-made alterations. This we believe has actually happened, and will happen elsewhere.

Consideration regarding the role of *Aedes* should keep this potentially serious vector constantly in mind. Alone, without *C. tarsalis* or another bird-feeding mosquito, they are relatively harmless, for the birds on which *Aedes* seldom feed appear to be the chief sources of virus. But, in the presence of large numbers of those mosquitoes which may serve as vectors from birds to horses, the *Aedes* may occasionally prove to be of great importance. *Aedes* cannot, therefore, be relegated to the place of pests alone, in an area where other vectors, reservoirs, and hosts are present.

In conclusion, the epidemiologist delivers his opinion that from now on — and possibly forever — mosquito abatement personnel must assume responsibility for the control of encephalitis in man and horses, through control measures of such broad nature that they will include almost all mosquito species. This problem is not one of controlling a single species, nor of elimination of the virus as is now envisioned for malaria for as yet we have no plans for an effective attack on the reservoirs and on the other hosts and vectors. Therefore, it becomes the duty of the health department to educate the tax payers and the legislators to realize that long-continued support of your work is essential.

Mr. Geib: Thank you, Dr. Hammon. We rely upon your annual contribution in this highly specialized field to keep us posted and to guide us regarding the mosquito-disease phase of our activities.

We will now have another paper on mosquito-borne disease in California presented by Dr. Joseph A. Moore, of the State Department of Public Health.

Dr. Moore: I have taken the liberty to present a paper on malaria in California in light of the preceding paper by Dr. Hammon.

MALARIA MORBIDITY IN CALIFORNIA

JOSEPH A. MOORE, M. D.

Department of Public Health
California State Department of Public Health
Division of Preventive Medicine,

The subject of malaria is an old story both to the world and even to this Association, which had its origin in the control of the disease. Today, it still remains a great problem for some counties, but for California, the bottom of the barrel is now in sight. For certain members in the audience, a sense of satisfaction must well up as this morbidity approaches the vanishing point. And at the same time, these very men would advocate continued campaigns, vigilance, and improved techniques against the intermediate host of this parasite. The past history of the disease is still young in California, and new breeding grounds for the vector are being started continually in our great central valley. The problem of equine encephalitis is not yet solved. Hence, I would like to review briefly with you the more recent epidemiology of this disease in California during the past ten years.

EPIDEMIOLOGY

The epidemiology of malaria is a collection of many factors which are interrelated in various patterns throughout the world. According to the National Research Council,[1] the most important of these are the following:

I. The prevalence of the infection in man, the true reservoir, and the type of plasmodia which he harbors.

II. The species of anophelines in the area; their abundance; their feeding habits; their habitats for reproduction; their susceptibility as intermediate hosts for the plasmodia.

III. A susceptible population must be present.

IV. Local climatic and hydrographic conditions.

V. Medical care and control measures.

VI. Other controlling influences which are combinations of the first five phenomena.

If we can omit for the moment the human reservoir and review the other points, we learn that California has two anopheline vectors; i. e., *Anopheles maculipennis freeborni* and *Anopheles punctipennis* (Say). The important data on these two species has been presented in past meetings and in other publications by members of this Association. Suffice it to say that these vectors are widely distributed in the Sacramento and San Joaquin valleys and have many habitats close to man. Soper[2] points out the importance of domesticity in maintaining close and constant contact between a disease vector and the human victim. The feeding habits of *A. maculipennis freeborni* show that ingestion of human blood is quite frequent. Both mosquito species are susceptible hosts for plasmodia, but in experimental feeding tests, the *A. maculipennis freeborni* seemed to be a more efficient vector.[3] Whether such information can be carried over entirely into field conditions is doubtful, but the past history of malaria in California would tend to corroborate this evidence, i. e., *A. maculipennis freeborni* is the principal vector.

California has a susceptible human population. Past records point to the ease of spread once malaria was established. And the record of California citizens in the past war in the South Pacific did not demonstrate a remarkable immunity when compared with other victims.

The peculiar cycles of rainfall in California together with irrigation systems and impounded waters, as well as optimum temperatures and humidity at times, make ideal conditions for the vector in our central valleys.

Balancing the above situation are two important considerations. First, the State enjoys a quality of medical care which compares favorably with the rest of the United States. Prompt treatment of cases would be the rule rather than the exception. I need only to mention the Agriculture Workers Health Insurance schemes and the Veterans Hospital Administration ,as well as our large county hospitals and the recent migration of young doctors to our coast. Secondly, the intensive malaria control measures, which have been present in an increasing amount through the years since 1915, now rank among the most important in the United States.

To return to the number one item of the factors, a human reservoir, I would like now to discuss this part of the problem more completely.

Prevalence

There has been reported to the California State Department of Public Health in the past 10 years (1938-1947), 2,298 cases of malaria. For the first 5-year period (1938-1942), there were 1,074 cases of malaria, or slightly less than one-half the cases. And in the second 5-year interval, 1,224 persons were so classified by the Department. A more circumscribed look at these records shows that in the first period only 92 of these 1,074 cases were in the non-allocated group and the 982 remaining cases were charged to specific counties throughout the State. Residence in the county for 14 days put the case in the county unless stated otherwise. Actually, 21 counties had 10 or more cases in this period, 11 of these had more than 25 cases, and 4 had greater than 50, and two (Yolo and Tulare Counties) had over 100 each. Of these last two counties, we have proof that there were definite epidemics in the camps which housed migrant workers. And throughout the great valley region, true endemic malaria existed. Los Angeles County, on the other hand, is charged with 78 cases and San Francisco with 23 cases. Some of these were in "drug addicts" and transfusion accidents, but in others, insufficient data were gathered to allocate the case to other areas. Development of sporozoites in mosquitoes at the temperatures in San Francisco is not to be expected on the basis of experimental work in the past.

I believe that you will agree with me that if some errors were recorded in allocation in such cities as these two, there is an exaggeration in the figures for many of the other counties as well. Examination of the records shows this to be true, but failure of the local area to supply adequate information is the main fault. Where allocation would be made. Mexico was the source 14 times; Oklahoma, 11 times; Texas and China, each 7 times; and the Canal Zone and Arkansas, each 6 times. Examination of Contra Costa and Alameda Counties cards showed that many of the cases were in shipyard workers from our southern states. And relapsing South Pacific cases were already beginning to appear by the end of 1942 in the United States.

The second 5-year period (1943-1947) shows more cases, but here 953 cases out of 1,224 cases are in the non-allocated group. Hence, we have a group of 271 cases for the specific counties — a little over 50 cases per year, as compared to an average of 196 cases previously. Even some of these can be allocated back by a careful review of the records. Naturally, the great bulk of non-allocated cases are in World War II veterans, who received prompt treatment. I would call your attention to the fact that in this second period, Los Angeles is still the second highest county after Yolo County. but no cases have been reported in the past three years. The morbidity records show incomplete epidemiological data, for many former residents of Oklahoma are among the Los Angeles cases. Thus, there has been an error introduced in this second 5-year series as well. But despite the incompleteness of data, the downward trend of the disease is quite apparent when we realize that only 7 counties had more than 10 cases in this period, compared to the 21 counties during the previous five years.

A brief comment should be made about the relapsing World War II veterans. In 1945, 231 cases were reported, and in 1946, 532 cards arrived. This last year, 1947, only 77 such cases were reported. Although we would expect a decrease in such cases as the second year of freedom from exposure is approached, we would not anticipate such a steep decline. Review of the reports shows that the veteran hospitals which formerly reported quite well have ceased to do so, and verbal conversations confirm the fact that many cases are still treated. Wheras the figures for 1945 and 1946 World War II cards are probably low, the 1947 veteran cases are far too low.

Seasonal

Both 5-year periods show that the majority of allocated cases occurred in the five months, June through October. For 1938-1942, 73% of the cases were in this summer period; wheras, only 58% of the cases were found in these same months during 1943-1947. Both May and November seemed to have a greater proportion of the cases during the second 5 years. Whether the mean temperatures were different has not been determined. The peak month is either August or September, however, in both periods. With the onset of low endemicity, the seasonal character can be expected to be masked and even lost.

Age, Sex, and Race

Age, sex, and race are said to play a minor role, if any, in the occurrence of malaria. During the last three years, over three-quarters of the allocated cases have been in persons older than 25 years. No predominance of sex has been noted. And approximately 60% of true endemic cases have been in white patients.

Diagnosis

Of the 78 cases in the past three years, only 45 had confirmation by smear, according to our reports. A similar trend for the cases in veterans was noted. Poor reporting is part of the fault here, but an element of inaccuracy must be admitted, which lowers further our confidence in the morbidity records.

Conclusion

In conclusion, therefore, we can make certain statements about malaria in California. The disease is still primarily found in the areas where it was noted 90 years ago. Despite some inaccuracy of reporting and record keeping, the trend of the disease is toward the vanishing point as regards endemic cases. The prediction of Dr. Sawyer[4] in 1944 that the return of the veterans from World War II would inevitably bring some increase in malaria in civilians has not been borne out. Better epidemiological records from local health officers and more accurate laboratory diagnosis by physicians are needed. Stricter regulation of blood donors by the blood banks is in order. With malaria so low, the stimulation of local mosquito abatement districts would well be applied in their educational campaigns to improve the above situation. Thus, we could end our chapter on this subject with a scientific performance as accurate as that of our engineers and entomologists who carry on the work of prevention.

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Mr. Geib: Thank you very much, Dr. Moore, for your splendid coverage of malaria in California.

It was intended that Arve Dahl should present the next paper, on the "Objectives and Scope of the New Bureau of Vector Control," but due to his illness, Frank M. Stead, Chief of the Division of Environmental Sanitation, will present that paper for Arve.

Mr. Stead:

OBJECTIVES AND SCOPE OF THE NEW BUREAU OF VECTOR CONTROL

BY A. H. DAHL

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I. INTRODUCTION

The State Department of Public Health has always been, and still is extremely interested in the mosquito control activities in California as a basic environmental sanitation activity. With the formation of the Bureau of Vector Control and the placing of the responsibility for mosquito control with that Bureau, it is important to review the objectives and scope of the new Bureau of Vector Control and illustrate to you how the control program for mosquitoes is fitted into the overall program of this new Bureau. There has been no lessening of intensity of interest, but a consolidation of effort on the part of the Department. The first part of this paper is to describe the objectives and scope of this new Bureau, followed by a review of the past year's activity and proposed mosquito control activities for the coming year.

II. OBJECTIVES AND SCOPE OF THE BUREAU OF VECTOR COTROL

On July 1, 1947, the State Department of Public Health established the Bureau of Vector Control to study and control arthropods of medical importance. This new Bureau consolidated within the Division of Sanitation two independent sections of Mosquito Control and Sanitary Inspections, working respectively in the fields of mosquito control and rodent and plague surveillance. As noted on the attached organizational chart of the California State Department of Public Health, Figure 1, the Bureau of Vector Control is shown as one of the fundamental Bureaus of the Division of Environmental Sanitation. In Figure 3, attached to this report, the activities of the consolidated sections have been organized in a graph which shows the Department's activities in rodent control beginning in 1916, and the activities of the Mosquito Control Section in 1946, although the latter were taken care of previously by the Bureau of Sanitary Engineering.

A. *Analysis of Vector-Borne Diseases in California*

With the establishment of the new Bureau, it was necessary to may out a new plan of action. As a first step in this process, a review was made of past vector control activities. This study revealed these pertinent facts:

1. More emphasis has been placed on endemic surveys than on control demonstrations or control programs.
2. The greatest amount of endemic survey work has been on the reserviors and vectors of plague and tularemia.
3. The major emphasis of control demonstrations and control programs has been on the mosquito vectors of encephalitis and malaria.
4. Minimal emphasis of control demonstrations and control programs has been on the rodent reserviors of plague, typhus, and relapsing fever.
5. On several of the nine diseases listed in the accompanying table, no work, or very little work has been done with respect to endemic surveys, control demonstrations, or control programs.

With this information in hand, vector-borne diseases in California were critically reviewed and nine vector diseases having the highest potential in California as of July, 1947, were analyzed as a basis for planning vector control activities. These diseases were encephalitis, fly-borne diseases, malaria, plague, Q fever, relapsing fever, Rocky Mountain spotted fever, tularemia, and typhus fever. The results of this analysis were tabulated on a chart, Figure 2, of this paper, entitled "Analysis of Vector-Borne Diseases in California." The diseases are listed alphabetically, since their relative order of importance may change at any time.

Each disease was considered with respect to: (1) problem in the State, (2) the past and future programs in the State, and (3) needed research.

An arbitrary A-B-C scale was used to indicate comparative values on points considered in evaluating the problem and past program for each disease, with "A" representing a high value, "B" moderate, and "C" a low value.

The "problem" was analyzed as to: incidence in humans and animals; vector knowledge and prevalence; and reservoir knowledge and prevalence.

The State Health and Safety Code does not limit the Department's responsibility to diseases of man, but includes domestic animals; therefore, horses are considered, as in the case of Equine Encephalomyelitis.

Inspection of the evaluation of the disease 'Problem" reveals that as of July 1, 1947, encephalitis and murine typhus are at present the most important vector-borne diseases. This is a varying status, for even now Q faver is considered an "A" quantity. In addition, there are many unknown and weak points in our knowledge of the "fundamental facts," and the "prevalence" of vectors and reservoirs. To obtain the needed "fundamental facts," research must be stimulated.

The past and future State program has been evaluated according to the three basic phases of activities carried out in any vector control program, namely, endemic surveys, control demonstrations, and control programs. Both the reservoir and the vector must be considered in each case. As an illustration of how Figure 2 works, let us follow the analysis of encephalitis through the evaluations of the "problem," "program," and "research."

1. *Incidence:* The actual and potential incidence of encephalitis in man and equine encephalomyelitis in animal was evaluated. A large number of cases occur each year, and

potentially a great number more could occur. Therefore, encephalitis was considered to be one of the most important vector diseases in California. The highest rating "A" was assigned for both humans and animals.

2. *Vector*: Our knowledge of "fundamental facts" on the vector is moderately good, but incomplete, for the circumstances of infection are not known. These facts are rated as "B." To obtain this information, further research is needed on vectors as indicated. Accepting mosquitoes as the vector, the rating of their prevalence is "A".

3. *Reservoir:* With respect to the reservoir of encephalitils, we cannot insert an entry, for we have no definite knowledge on the real reservoir. Accordingly, further research has been indicated for "reservoirs." Continued research is being done on the etiological agent.

4. *Endemic Surveys:* With respect to endemic surveys of encephalitis, work on "reservoirs" in the past has included some collection of arthropods in the field and testing in the virus laboratory to locate the reservoirs, and was therefore given a "C" rating. Considerable effort has been expended on determining the incidence of mosquito species and the rate of natural infection. Vector endemic surveys are therefore given a "B" rating. In the future, it is proposed that a minimal effort be continued on endemic survey for the reservoir, and a greater amount of work be done on the mosquito vector to determine statewide distribution and infection.

5. *Control Demonstrations:* A number of control demonstrations have been conducted on mosquito vectors in the past of an "A" magnitude. It is proposed that the same effort be continued in the future. No work is indicated for the "reservoir" due to lack of fundamental knowledge.

6. *Control Program:* The "reservoir control program" for encephalitis in the State has been limited to horse vaccination by veterinarians, which is assigned a "B" rating due to the extent of vaccinations. This work will be continued. While the horse is not generally considered a "reservoir," it is known to have a positive viremia during the disease. The "A" rating for "control" activities on the vector indicates the activities of local mosquito control organizations supported by State subvention assistance on well-balanced "programs" to the extent of $400,000.00 a year. The future "Vector Control program" calls for a continuation of these activities.

All nine diseases were reviewed in the same manner as encephalitis. Indicated changes in emphasis of the three phases of the "future program" provide guidance for determining the activities which the Bureau of Vector Control should engage in. This plan of "program" development permits long-range planning and continual revaluation.

B. *Bureau of Vector Control Operational Plan*

Accepting the basic responsibilities of the sections of Mosquito Control and Sanitary Inspections, the Bureau of Vector Control developed a fundamental plan of operation expanded in accordance with the "Analysis of Vector-Borne Diseases in California."

This plan called for an advisory committee to guide the Department in evaluating vector diseases and establishing policies and "programs." Such a vector control advisory committee was established with representation from the University of California, the G. W. Hooper Foundation for Medical Research, Local Health Departments, and Mosquito Abatement Districts.

The basic organization called for all activities to be considered as field activities under the direction of the Chief of the Bureau, supported by epidemiological activities of the Department and office services of the Bureau. The field activities fall logically into three major categories following the section on "program," of the "Analysis of Vector-Borne Diseases in California," namely, endemic surveys, studies and demonstrations, services and control programs.

Endemic surveys include all surveillance activities of the Bureau, of a continuing or intermittent nature. They include activities designed to permit continual evaluation of vector-borne diseases of actual or potential danger to the people of the State. These activities also include such surveillance activities as the Communicable Disease Center Activities of the U. S. Public Health Service is obligated to perform in California.

Studies and demonstrations are necessary to improve the work being done and to serve as a basis for our recommendations on such activities. The studies and demonstrations cannot be considered pure "research," for they involve the determination of operational variations of techniques and "programs" used elsewhere. For this reason, they are generally refered to as "operational demonstrations."

Sevices and control programs within the Bureau of Vector Control include all direct operating activities which involve control of vectors either on the State or local level. These activities include: direct services in the case of outbreaks of vector-borne diseases; consultation and recommendations to local health departments, agencies, and individuals engaged in related vector control work; and educational developments for the purpose of improving the quality of work of the Bureau or local personnel engaged in the control of insect vectors.

Having established the functional responsibilities of the Bureau, we can review its personnel staff. This plan is of a long-range and continuing nature, and the personnel available must serve in more than one capacity. Certain studies will be carried on at different periods of the year to facilitate efficient use of personnel on a year-round basis. Besides the staff provided by the State of California, personnel are provided through the U. S. Public Health Service Communicable Disease Center Activities unit in California, which is assigned to the Bureau of Vector Control and forms an integral part of the Bureau organization.

The present State program calls for a staff of over 40 persons, including professional sanitary or public health engineers and medical or public health entomologists and parasitologists, assisted by sanitarians, rodent control foremen, rodent control officers, a secretarial staff, besides student research assistants on temporary employment. In addition are professional field personnel assigned from the Communicable Disease Center. It is anticipated that the maximum number of permanent and temporary, administrative and field personnel will total 62 during the height of the season.

III. The Vector Mosquito Program

The mosquito control activities follow closely the general problem of endemic surveys, operational research, and control programs.

A. *Endemic Surveys*

Major emphasis of our mosquito control operations has been against the vectors of equine encephalomyelitis, which have included the culicine mosquitoes, namely *Culex tarsalis*. Coincident, of course, has been the control of malaria and the anopheline mosquito vector, *Anopheles freeborni*. To learn more about the mosquito vectors of encephalitis and equine encephalomyelitis, live mosquitoes were collected throughout the Central Valley last year and submitted and analyzed in the virus laboratory for recovery of the encephalitis virus. Positive mosquitoes were obtained from Bakersfield north to Shasta County. Details have already been presented to you by Dr. Moore in his report on the Departments's epidemiological study of malaria. To obtain a picture of the prevalence of the mosquito vectors of encephalitis and malaria, the individual mosquito abatement districts have kept adult mosquito collection records throughout the fiscal year. This material is being analyzed together with the other epidemiological data on encephalitis. These records kept by stations at weekly intervals, using standard collecting techniques, give a picture of occurrence of mosquito vectors in the organized districts.

With respect to emergency control in the event of an outbreak of mosquito-borne disease, the procedures in the case of malaria are well known and can be instituted by any local mosquito control organization. The State Department of Public Health, Bureau of Vector Control, is ready to carry on emergency control operations in areas not under existing mosquito abatement or in the event that these local organizations are not capable of undertaking the control effort. With regard to encephalitis, the epidemiological factors under which transmission occurs are not known. Mosquitoes have been demonstrated to be the most likely method of transmission, with positive virus having been isolated from mosquitoes collected in nature; however, the definite source of infection is not known. Accordingly, from the knowledge of encephalitis to date, it appears that man is just the chance victim of encephalitis. Accordingly, only through area-wide mosquito control is it possible to obtain protection against encephalitis, accepting the basic information we have on the problem to date. Collection records over entire districts will enable the Department to correlate any possible relationship between infection and presence of the possible mosquito vector.

B. *Operational Research*

With the development of mosquito abatement districts throughout the irrigated areas of the State, it becomes more important than ever to determine the most economical methods and, in addition, the most effective methods for controlling mosquitoes. The programs of the mosquito abatement districts in the recent years since the War have been largely based upon temporary control measures, i. e., the use of larvicides or adulticides. Also since the War it has been possible to economically cover large areas of land to control the flood water mosquitoes occurring in irrigated areas. The new temporary techniques involving the application of the insecticides such as DDT over large areas, involve problems in logistics and study of factors relating to the effectiveness of DDT in controlling either adult mosquitoes or mosquitoes in the larval stage. During the past year, studies have involved the use of airplanes, ground exhaust aerosol sprays, investigation of sewer farms and winery waste mosquito problems, investigation of control of mosquitoes in rice fields, concentrating on the ecology features and collection of mosquitoes for examination in the virus laboratory. Preliminary reports on these activities will be heard during the conference.

The philosophy of the Department is to carry on these studies and operational research through the most progresive mosquito abatement districts where those operations can best be handled in those areas. Those studies which have to be carried on in an area not under routine control will be carried on by the Bureau of Vector Control outside of existing mosquito abatement districts. Certain phases of the sewer farms problem are typical of this type of activity.

With respect to this coming season' work, it is anticipated that the airplane studies and evaluations will continue, as well as studies on the ground exhaust aerosol phase, sewer farms, and winery wastes. It is planned that the Bureau of Vector Control will assist in setting up standard evaluation practices to guide the districts in carrying on studies. While definite plans have not been completed, the Bureau of Vector Control plans to assist on the following studies: the study of mosquito breeding in ladino clover fields and pastures, and carrying on toxicity studies to evaluate the newer insecticides on the market in actual field tests on mosquito larvae.

C. *Control Operations*

The mosquito control operations of the Bureau of Vector Control are those connected with the subvention program. Details of the subvention program, providing for allocation of funds totalling $400,000 per year to local mosquito control agencies, will be found in the last year's proceedings of the California Mosquito Control Association. Dr. Halverson has already outlined some of the results of the program in the past and objectives of the present and future subvention program. I plan to present the details on the fiscal results of the program which ended June 30, 1947, and of the program during the current fiscal year. Also attached are the working conditions included in the standard contract for subvention assistance, Exhibit I and Exhibit II, the Quarterly Budget to cover proposed operational plans of the program of each district.

Attached are three tables as follows: Summary of Subvention Contracts for Biennium ending June 30, 1947; Table II, Summary of Subvention Contract with Adjustments as of February 1, 1948; Table III, Table of Statistics on Mosquito Abatement Districts, including annexations and new districts.

The primary objective of the subvention program this year, in addition to actually obtaining the best mosquito control possible for funds expended, was to make the local mosquito abatement districts substantially business concerns doing a constructive job of mosquito control. The soundness of good budgeting and accounting methods can not be overestimated. Through application of adequate technical guidance, the control forces assembled by each district can be directed more effectively. Each mosquito control agency is a unit of public service which should be available to the people they are serving and must cooperate with other public units within their area. Accordingly, it is necessary that each district have an office where it could be reached and through which it could serve the public.

With respect to the future of the subvention programs, Dr. Halverson has already stated that the request has been submitted to the Governor in the budget of the State

Figure 1:

ORGANIZATION CHART
CALIFORNIA STATE DEPARTMENT OF PUBLIC HEALTH
JULY 1947

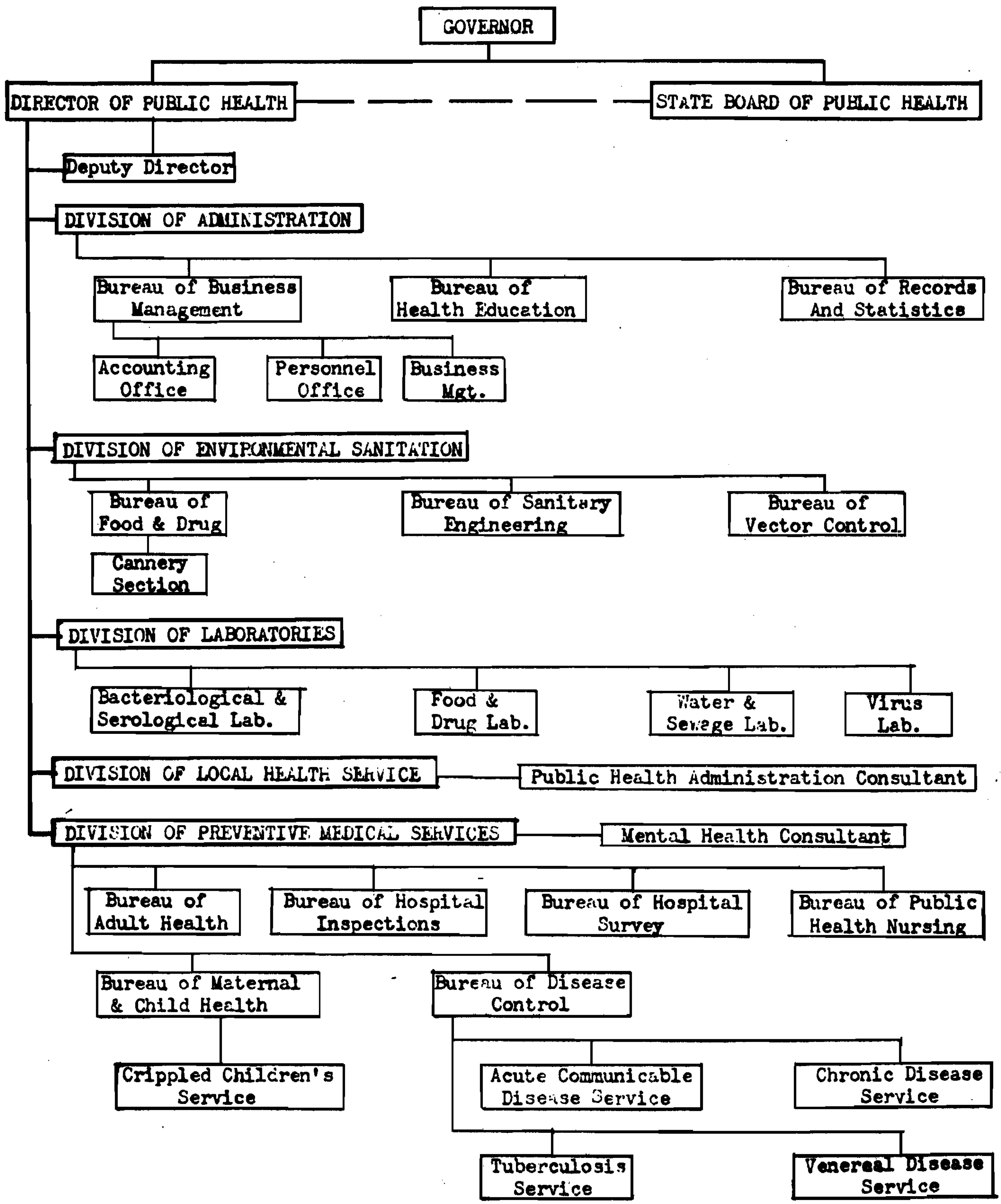

Figure 2:

ANALYSIS OF VECTOR-BORNE DISEASES IN CALIFORNIA
JULY 1947

DISEASE	PROBLEM: INCIDENCE: Human	PROBLEM: INCIDENCE: Animal	PROBLEM: VECTOR: F.F.	PROBLEM: VECTOR: Prev.	PROBLEM: RESERVOIR: F.F.	PROBLEM: RESERVOIR: Prev.	PROGRAM: ENDEMIC SURVEY: Past: Res.	PROGRAM: ENDEMIC SURVEY: Past: Vec.	PROGRAM: ENDEMIC SURVEY: Future: Res.	PROGRAM: ENDEMIC SURVEY: Future: Vec.	PROGRAM: CONT. DEMONSTRATION: Past: Res.	PROGRAM: CONT. DEMONSTRATION: Past: Vec.	PROGRAM: CONT. DEMONSTRATION: Future: Res.	PROGRAM: CONT. DEMONSTRATION: Future: Vec.	PROGRAM: CONTROL PROGRAM: Past: Res.	PROGRAM: CONTROL PROGRAM: Past: Vec.	PROGRAM: CONTROL PROGRAM: Future: Res.	PROGRAM: CONTROL PROGRAM: Future: Vec.	RESEARCH: ETIOL. AGENT	RESEARCH: RESER-VOIR	RESEARCH: VECTOR	REMARKS
ENCEPHALITIS	Act. A Pot. A	A A	B Inc.	A	?	?	C	B	=	<		A		=	B*	A	=	=	+	+	+	*Horse Vaccination & Mosq. Control
FLY-BORNE DISEASES	Act. ? Pot. A	? ?	A	A	A	A	0	0		<				<								
MALARIA	Act. C Pot. C		A	A	A	?	0	C*		=		A		=		A		=				*Incidental to Encephalitis Program
PLAGUE	Act. C Pot. C		A	A	A	A	A	A	>	>	C	0	<	<	B	0	<	<		+	+*	*Seasonal Carryover
Q. FEVER	Act. C Pot. C	? ?	?	?	?	?	0	0	<	<												
RELAPSING FEVER	Act. C Pot. B		A*	C	?	C	C	C	<	<	0	0	<	<	C**	0	<	<		+	+	*Study circumstances of inf. **Dept. Agriculture
ROCKY MTN.* SPOTTED FEVER	Act. C Pot. ?		A	?	?	?	0	0	=	<												*Limited to 3 counties: Modoc, Siskiyou, Lassen
TULAREMIA	Act. C Pot. B	C C	A. Inc.	A	B Inc.	B	A	A	>	>												Even water involved (Muskrat)
TYPHUS FEVER	Act. A Pot. A		A. Inc.	A	? Inc.	B	C	C	<	<	C	0	<	<	C	0	<	<		+	+	Case Density High

Symbols: >- Decrease, <- Increase, = - No Change, Act. - Actual, Pot. - Potential, F.F. - Available Fundamental Fact Knowledge

Arbitrary Intensity Scale: A - High; B - Moderate; C - Low; 0 - None

Figure 3:

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

ACTIVITIES IN VECTOR CONTROL PRIOR TO JULY, 1947

MOSQUITO CONTROL SECTION

1. Established in April, 1946 with staff of public health engineers and entomologists. Department's mosquito control activities originated in 1910 by Dr. W.B. Herms, Dept. Consultant on Entomology, function of Bureau of Sanitary Inspections until 1919 when assigned to Bureau of Sanitary Engineering

2. Assigned responsibilities of mosquito control - April, 1946
   a) Allocate $400,000 in subvention to local mosquito control agencies
   b) Studies and demonstrations
   c) Emergency control in case of mosquito-borne disease outbreaks

3. Communicable Disease Center Activities Unit (USPHS) in California assigned to Section - June, 1946.

4. Advisory-Consultation service on mosquito control to entire State

5. Training program for local mosquito control program

6. Special studies in relapsing fever inaugurated in 1946

SANITARY INSPECTIONS SECTION

1. Established in 1916 with primary responsibility in general sanitation

2. Assigned plague control with outbreaks in Los Angeles in 1925, and in Oakland in 1919

3. Routine plague and tularemia endemic survey started in 1927

4. Emergency control around cases of human plague

5. Rural field rodent control by Department of Agriculture around plague foci since 1909

6. Urban inspections made on request of local health officers - no specific program

7. Collaborated with epidemiologists in field studies of plague, anthrax, rabies, psittiocosis and typhus

8. Eight 3-men plague survey crews, 1938-1946

9. Two survey crews assigned to Mosquito Control Section, June, 1946

BUREAU OF VECTOR CONTROL

Established July 1, 1947

Figure 4:

DEPARTMENT OF PUBLIC HEALTH

Vector Control Advisory Committee

Division of Environmental Sanitation

Bureau of Vector Control

Chief of Bureau

Field Activities

OFFICE SERVICES

1. Secretarial Services
2. Personnel Administration
3. Vehicles, Equipment, Procurement
4. Information Service to Staff

EPIDEMIOLOGY CO-ORDINATION

1. Close alliance with Acute Communicable Disease Service and Division of Laboratories
2. Maintenance of Case Maps
3. Problem Evaluation

ENDEMIC SURVEYS

<u>Fiscal Year Ending 6/30/47</u>

1. Plague & Tularemia
2. Relapsing Fever
3. Encephalitis Vector & Virus Isolations
4. Case Investigations
5. Surveys of Military Establishments for Mosquito Disease Hazard - U.S.P.H.S.

<u>Fiscal Year Beginning 7/1/47</u>

Continue 1, 2, 3, 4, & 5 above

6. Fly-borne Diseases
7. Rocky Mountain Spotted Fever
8. Q-Fever
9. Typhus Fever

STUDIES & DEMONSTRATIONS

<u>Fiscal Year Ending 6/30/47</u>

1. Airplane Study
2. Ground Aerosol
3. Sewer Farm
4. Canals
5. Rice Field
6. Relapsing Fever Tick Investigation
7. Sacramento Rodent

<u>Fiscal Year Begin. 7/1/47</u>

Continue 1, 2, 3, 4, 5 and 6 above

7. Fly Control Studies
8. Rodent Control Studies
9. Ectoparasite Control

SERVICE & CONTROL PROGRAMS

<u>Fiscal Year Ending 6/30/47</u>

1. Subventions
   - a) Field Supv.
     - 1) Administration
     - 2) Engr. & Entomology
     - 3) Operations
   - b) Fiscal & Office Supv. — State level
2. Consultation & Advisory - - Identification
3. Emergency Control Measures
4. Educational Developments
   - a) Training School
   - b) Mosquito Buzz
   - c) Technical Memorandums
5. Rodent Control Supv. Services

<u>Fiscal Year Beginning 7/1/47</u>

Continue 1, 2, 3, 4 & 5 above

Health Department to continue the subvention program during the fiscal year 1949. This in itself bespeaks the fact that the Department approves continuing the program as recommended by the Department's Advisory Committee on Mosquito Control and Vector Control.

VI. Conclusion

In conclusion, let me acknowledge that the Bureau of Vector Control has accepted a tremendous challenge with its plans for vector control in California. This challenge includes responsibility to maintain a current analysis of the vector-borne diseases as well as to adjust endemic surveys, control administrations, and control programs to conform to our rapidly expanding knowledge of the vector-borne diseases in California.

Mr. Geib: Thank you, Mr. Stead.

At this point we are in a position to branch out and consider another vector which many of the districts are controlling in part through their mosquito control programs. I refer to the housefly. To speak on "Some Aspects on Fly Control," we have Dr. John A. Rowe, Scientist, United States Public Health Service, Kansas City, Missouri.

FUNDAMENTALS OF COMMUNITY FLY CONTROL

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During the past three years, there has been a widespread popular demand for community fly control programs. In 1946 and 1947, hundreds of towns and cities and thousands of rural units in nearly all sections of the country participated in activities to control the housefly, *Musca domestica* Linn., and several species of house-infesting blowflies. Indications are that the future will witness still greater participation. Undoubtedly many factors have motivated this great public interest in fly control. Two of those which may have been most influential are (1) the super-effectiveness of DDT and other war-developed insecticides and (2) the popular association of flies with the spread of poliomyelitis. In each of these instances, the facts do not seem to be understood by the general public. Many entomologists and public health workers believe that the use of insecticides in community fly control is being over-emphasized, and medical workers in general are of the opinion that the importance of fly control in the prevention of poliomyelitis is yet to be demonstrated. Nevertheless, in view of the public health significance of houseflies as vectors of filth diseases[1] and the widespread popularity of community fly control programs, a review of the fundamentals of community fly control appears to be worthwhile.

As in the control of any other insect, fly control is based upon the biological characteristics of the particular species concerned. The effectiveness of either preventive cultural measures or applied actions are directly proportional to the completeness of the bionomical knowledge of the species. For many years, the recognition of the effect of flies on the lives of man and animals has motivated sustained research relative to their biologies. A condensation of the reports of this research, although urgently needed, is beyond the scope of this discussion. For those who may contemplate community fly-control programs, however, a few generalities on the more significant features of the biologies of the housefly and blowflies may be timely.

It has been shown repeatedly that the housefly and various species of house-frequenting flies prefer certain substances in which to breed. The preference of the housefly seems to be for horse manure and that of blowflies for the flesh of animal carcasses and possibly garbage. In the operation of control programs, however, the over-emphasis of breeding preferences may seriously affect results. Those flies will breed in accumulations of a great many types of animal or plant substances which present favorable conditions relative to temperature, moisture, and nutrition. The range of the fly tolerance to these three factors appears to be generally quite broad. In the determination and execution of control measures, it is essential that all deposits of animal and plant matter which are or may be rendered favorable for fly breeding be located.

Knowledge of the duration of the immature stages, especially that of the egg and of the maggot, are of prime importance in community fly-control. The length of these stages varies considerably with the species of flies and also with conditions of the breeding material. The housefly egg and maggot stages may total 12 — 14 days in spring and fall seasons, but in mid-summer may require only 5 or 6 days. Under mid-summer temperatures, larvae of certain blowflies, such as *Phoenicea sericata* (Meig), will leave the breeding media less than three days after deposition of the eggs. These biologial features have an important bearing on the effectiveness of fly preventive measures such as garbage and industrial waste collection and disposal. Several species of fly maggots leave the breeding material and migrate into the soil or other near-by dry material to pupate. This habit must also be carefully considered in developing cultural control practices and insecticidal operations.

Flight and dispersal habits of flies are important considerations in determining the over-all boundaries of a community control program and in guiding operations procedures. As a rule, blowflies are quite migratory and tend to range about for food and suitable breeding material. The housefly, on the other hand, seems to be more domiciliary and to remain in the vicinity of its breeding place. Observations indicate, however, that under certain conditions where high population pressures exist, wide dispersals readily occur. The resting habits of the various species are an all-important consideration where residual adulticidal measures are to be used. In general blowflies rest out-of-doors in grass, trees, or other vegetation. The housefly seeks cover and prefers to rest indoors on ceilings and overhead structures. It will, however, rest out-of-doors much the same as blowflies in instances of a high population build-up.

The often quoted astounding figures of the hypothetical progeny of a pair of houseflies for one season, 191 million billions, or enough to cover the earth 47 feet deep,[2] serves to illustrate their huge reproductive capacity. With this astounding ability to reproduce, coupled with other biological capacities, flies are able to maintain themselves even in an area where the strictest sanitation prevails. Also, they are able to increase their population with amazing rapidity at times of sanitation failure or relaxation of control activities.

From the foregoing it seems apparent that effective community fly control is a complex program requiring some form of permanent organization and the sustained performance of a number of properly integrated activities. Certainly these activities should include (1) comprehensive educational efforts, (2) surveys and evaluations, and (3) control operations, which might be divided into (a) preventive measures and (b) insecticidal measures. Whether the program is to be carried on by a regular tax-supported unit or by a voluntary association of civic groups, the effective execution of all these activities is believed to be essential to a most successful program.

The success of a community fly control program, regardless of the type, depends first, on the desire of the people to have a program and second, on their desire to actively participate in it. To effect these desires, it is fundamental that comprehensive educational activities be given major emphasis. Every means should be employed to familiarize the people with the purpose, the objectives, and the operational features of the project. The extent to which public interest is aroused and maintained may determine the success or eventual failure of the program.

Conditions which produce fly populations may vary from week to week within any given community. Programs based entirely on academic values usually prove inadequate to accomplish desired results. Continuous survey and evaluation activities are, therefore, considered fundamental. They will involve (1) the locating, recording, and mapping of fly-breeding places, (2) the evaluation of the various breeding areas in terms of the total problem, and (3) the accumulation of fly density data to be used as a guide for control operations and as a measure of the effectiveness of the program. Field inspections should be such as to produce data of maximum practical value to control operations. Several methods for making adult fly counts have been described. Baited fly traps, sticky fly traps, sweeping with an insect net and counting resting flies on a measured area have all been used. In 1946, Brett and Fenton,[3] working in Oklahoma, measured "active fly populations" by the use of bait cards, and in 1947, Scudder[4] reported a technique which is being widely used by health workers involving the use of a "fly grill." Regardless of the method adopted, techniques should be standardized and the inspectors uniformly trained in their use.

For the most effective and economical community fly control, both preventive and insecticidal measures are essential. Too much emphasis cannot be placed upon preventive measures. These are incorporated in what are known as standard environmental sanitation practices. However, such practices must be specific and directed toward the abatement of all fly-breeding situations insofar as possible. In a typical community, a certain percentage of the fly population will arise from generally distributed breeding places. In addition to these and certainly of great importance to control activities, will be those relatively few breeding foci which produce exceedingly large numbers of flies.

Among the most prolific and widespread of fly-breeding substances in a community are residential and commercial garbage. The importance of garbage in fly production is dependent upon the extent to which it is stored, handled, and disposed of in a fly-proof manner. Many progressive communities have rendered their garbage of little importance in fly production by the adoption of uniform storage practices and efficient collection, together with proper sanitary landfill disposal. Other communities, where sufficient attention has not been given to garbage control, will find good fly control difficult and costly as long as such conditions prevail. Careful and detailed attention to improvements in this community function will pay dividends and go a long way toward reducing fly populations.

Another general source of flies, especially in small communities, is the outdoor toilet. It is needless to emphasize and elaborate on the importance not only to fly control, but to public health in general, of actions toward the elimination or "fly-proofing" of the pits of these buildings. Stables and feed pens are usually fly-breeding "hot spots," and are a major problem in agricultural communities. Poor management practices relative to handling manure, feed residues, and feed spillage, generally result in the creation of very favorable conditions for fly breeding. If these units must remain within a community, they must be operated in line with strictest sanitation practices for maximum fly prevention.

Some of the most vexing fly problems in a typical community are created by the haphazard dumpage or the careless disposal of industrial end-products and wastes. Major fly-breeding foci are often created around stockyards, abattoirs, hide and tallow plants, rendering plants, grain and feed mills and warehouses, canneries and food and milk processing plants of nearly every type. Tremendous numbers of flies may be produced either in the waste accumulations or in the soil around the plants which has become grossly contaminated. The solution of these problems may be difficult. Remedial measures employed should be practical and suitably adapted to the particular establishment concerned. The main point of emphasis is that, given adequate attention, a solution can be found, and it should be one of elimination of the problem rather than insecticidal treatment whenever possible.

In this discussion, space will not permit consideration of the multitude of details which comprise effective fly-preventive activities. Communities are reminded, however, that State and Federal agencies provide the consultation services of specialists in these activities upon request. We should all be reminded that major fly problems are man-made and that our first approach to their solution is to correct the mistakes we are making which permit flies to increase their numbers.

It has been estimated by those engaged in fly-control activities that in the average community, a 50-75% reduction in fly populations can be obtained by the conscientious execution of reasonably extensive fly-preventive measures. It has also been demonstrated that in communities where no preventive measures are in effect, satisfactory fly reduction by insecticidal means alone is very difficult and impractical. Aside from fly eradications, the basic public health objective of community fly control is the elimination of flies from our homes, our restaurants, and other establishments where food is handled or processed. The extent to which insecticides will be needed to accomplish this will depend upon the extent to which a community, consciously or otherwise, practices fly prevention. Communities which require the application of huge amounts of insecticides in order to obtain relief from flies are not ready to receive the benefits which may be realized through the proper use of some of the newer insecticides. On the other hand, those communities which have and conscientiously strive to maintain a respectable level of community sanitation, can, by the wise use of modern insecticides, have their homes and food establishments free of flies.

Both popular and scientific literature are filled with details of the effectiveness and power of the new insecticides developed during and since the war. Wide acclaim is made of the advantages of this or that preparation, and undoubtedly several of these newer materials can be effectively used in community fly-control programs. At the present time, research and extensive field trials indicate that DDT is the insecticide of choice for community fly-control programs. This choice is based upon such factors as effectiveness, cost, availability, and extent of our present knowledge regarding safe application. In the following paragraphs, an attempt is made to describe briefly how DDT has been used in many successful community fly-control programs.

The better programs observed have all utilized DDT as a supplement to a planned and well-executed program designed to eliminate fly breeding places. They have utilized it to destroy adult flies which congregate upon major indoor and outdoor resting surfaces. The objective of spray operations in these programs was the application of a residual spray to: (1) the inside fly-resting surfaces of all food-handling establishments, outdoor toilets, and stock barns; (2) the major outdoor surfaces where flies congregate and rest, such as garbage docks in the downtown district, receiving platforms of dairies, produce houses, and canneries, dump grounds, meat-packing and slaughtering plants, etc., and (3) the front and rear door screens, porches, and garbage cans in residential areas. The resting surfaces in the first category were treated routinely, while those in the second were treated on the basis of need as indicated by field inspection data. The treatments of private homes and garbage cans were made by cooperating home owners. The number of applications per season, as well as the date of the initial treatment, were determined by field inspection. With a few exceptions, inside surfaces required a single annual spray application. In general, outside surfaces required bi-monthly treatment,

Among the various spraying programs, three types of liquid DDT preparations were used, emulsions, solutions, and wettable powder suspensions. Little practical difference was noted between the effectiveness of these types of sprays. Because of staining qualities, suspensions could not be used on most inside surfaces. Their effective use outside required equipment which provided for proper agitation. Kerosene or other oil solutions were seldom used, mainly because of inconvenience of handling the bulky quantity needed, the "so-called" fire hazard, and the objections of spraying crews to the use of oil sprays. DDT emulsions were perhaps the most widely used spray material. Emulsion concentrates were readily available and economical, and could be used for both inside and outside application with many types of spray equipment. Efforts were usually made to obtain emulsions whose characteristics compared favorably with those of the standard DDT-Xylene-Triton emulsion[5] relative to drying time, odor, staining qualities, etc.

In order to simplify spraying procedures, reduce the possibility of costly mistakes due to staining, and for other reasons, it is believed that the average community should use only one type of spray preparation. For all-around use, the emulsion type sems to be most suitable.

The DDT residual sprays were applied at the rate of 200 mg per square foot. In field practice, this meant the wetting of a surface to the point of run-off with a five percent spray. For average papered or flat-painted surfaces, this was accomplished by the application of one gallon of five percent spray to 1000 square feet of surface. Deviations from this rate of application were sometimes necessary to achieve proper dosage. For instance, in many restaurants and dairies having fine, slick surfaces of high-gloss enamel or tile, it was advisable, in order to prevent run-off, to increase the concentration of the spray to 7.5 percent. Again, on very rough and porous surfaces, correct dosages were more easily and accurately obtained by reducing the concentration of the spray to 2.5 percent and applying two gallons per 1000 square feet. In a community fly-control program, the practicability of changing spray concentrations such as described will depend, to some extent, upon the experience and training of the spray crews and upon the spray equipment available.

DDT residual sprays can be effectively applied with several types and brands of commercial spray equipment. Garden-type, hand-compression spray cans of various makes and capacities have been widely used for spraying interior surfaces. Several makes of power sprayers of various capacities proved to be excellent for outside spraying, and were used effectively inside when operated at relatively low pressures.

Probably the most important feature of residual spray technique is the physical nature of the spray emitted from the nozzle. This should be a wetting spray with a uniform fan-shaped pattern. A hand-compression sprayer equipped with a flat nozzle, such as the ¼T 50015, made by Spraying Systems Company* and operated at 35-50 pounds pressure, is probably the most suitable equipment for homes and restaurants. Power sprayers with the same nozzle operated at about the same pressure can be used economically in instances where the dragging of the hose is not hazardous and time-consuming.

For outside spraying and the treatment of rough interior surfaces, such as found in most outdoor toilets, animal barns, etc., a 50-100 gallon power sprayer equipped with a ¼T 6504 or 6506 flat spray nozzle and operated at 80-100 pounds pressure has been used with considerable success. The extent to which power sprayers can be economically used in any particular community, however, will depend upon accessibility of the establishments or surfaces to be treated. If a great deal of maneuvering or hose dragging is involved, it may be more economical to rely upon hand sprayers equipped with a larger nozzle such as the ¼T 5004. It is believed that for the average community, the most economical operations will combine the use of both hand and power equipment.

Field trials are being conducted with several other types of power machines designed for the application of residual and space sprays. Among these are fog machines, mist sprayers, and thermal aerosol generators attached to ground equipment or airplane. Repeated applications covering the entire area of a community by means of certain of these machines has under certain conditions proven effective in controlling fly populations.[6] At present, operations employing such machines seem to be more economical but less effective than those employing hand-operated equipment.

The cost of spraying operations in community fly control will depend upon such factors as (1) the magnitude

*Spraying Systems Company, 4023 W. Lake Street, Chicago, Illinois.

of the task, (2) the thoroughness of pre-operational surveys, and (3) whether the work will be done by voluntary labor or by commercial operators. During the past season, many communities with populations of about 5,000, where good garbage and waste disposal and other sanitation practices complementary to fly prevention prevailed, carried on excellent programs at a cost of $300 to $500, utilizing voluntary labor. Residual sprays were applied twice each season to all food establishments and four to six times to exterior resting surfaces in the alleys, etc. Other comparable communities employed commercial operators for similar type programs at a cost of approximately $750. One city of 60,000 people which maintained a relatively high standard of sanitation, utilized commercial operators at an expense of $2500.[7] In this city, there were 142 food establishments. These examples will serve to indicate the cost of spraying operations in communities which regularly practice good fly prevention. They will not, however, serve the purpose for communities where little or no sanitation prevails.

Experience of numerous communities during the past two seasons seems to justify the conclusion that well-balanced programs which include proper educational efforts, surveys, and evaluations, emphasis upon preventive measures, and the wise use of DDT residual sprays will provide for any community a degree of fly control heretofore believed impossible.

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Mr. Geib: Thank you, Dr. Rowe, for your comprehensive account of this important subject. We will now adjourn for luncheon.

THURSDAY AFTERNOON, FEBRUARY 12, 1948

Mr. Geib: Before we get started, I would like to call your attention to some pamphlets which Mr. Barber, of the Velsicol Corporation, brought. I believe there are forty or fifty copies of them. These pamphlets deal with airplane equipment and the Beskill aerosol generator for mosquito control purposes. This information was used this past season in British Columbia. You are welcome to pick up copies.

I will ask Past President Robinson to preside at this afternoon's session.

Mr. Robinson: Art rather put a surprise over here. I really thought I was going to have the opportunity of sitting down and doing all the listening and none of the talking. However, our first paper this afternoon (which was to have been this morning) is on "Controllable Noxious Arthropods Other Than Mosquitoes, Affecting Man and Animels" by Dr. James Douglas, Assistant Professor of Entomology and Parasitology, University of California.

CONTROLLABLE NOXIOUS ARTHROPODS, OTHER THAN MOSQUITOES, AFFECTING MAN AND ANIMALS

DR. JAMES R. DOUGLAS

The title "Controllable Noxious Arthropods, Other than Mosquitoes, Affecting Man and Animals" was desired by Dick Peters. Fortunately, it is broad enough so that I can talk about practically anything which occurs to me. As a matter of fact, I had prepared a discussion on another subject, which on careful consideration is, in line with previous papers, not too appropriate. Fortunately I have in my pocket the outline of another discussion which I think is much more appropriate, since it follows the presentation by Dr. Rowe on the control of flies. I should like to sub-title my remarks "Considerations in the Selection of an Insecticide" and confine the discussion to residual insecticides. You remember all of the points that Dr. Rowe brought out, the importance of types of control measures and the importance of environmental sanitation. Nevertheless I think you will agree that for some time to come residual insecticides will play a significant part in the fly-control program. As Dr. Rowe brought out, the housefly is a rather good candidate for control by residual insecticides since for a good part of its adult life it is either resting or walking on surfaces which may be treated. To start from the beginning, with fundamentals which we are often prone to overlook, let's consider some of the requirements of a residual insecticide. Obviously the first requirement is that it must kill the insects. Here we have two considerations which are often overlooked. Insecticides have two actions, so to speak; the speed with which they act and the length of time they remain active. Unfortunately, the speed of action and the residual efficiency or the length of time it remains active are independent. Some insecticides kill very rapidly and last a comparatively short time. Others kill comparatively slowly and last much longer. An illustration of this point perhaps would be a comparison of parathion or 3422, and DDT. The LD 50, or dose required to kill half of a given population of houseflies, for an average-size fly is a tenth of a microgram of DDT and one hundredth of a microgram for parathion. In other words, parathion is on that basis ten times as toxic as DDT. If you expose a population of flies to a residue which will give a tenth of a microgram dose to each individual, the parathion will kill the flies very quickly, and it may take hours for the DDT to accomplish the same result. However, parathion has a comparatively low residual persistence. DDT, as we all know, is very good in this respect, and under some conditions will last for months and retain its effective concentration.

In addition to the efficiency of the insecticide which we are considering, it must be acceptable to the individual; not only the individual who is applying it but the owner of the premises to which it is applied. We all know that wettable powder, which leaves a visible residue, is objectionable in many places, and you can't use it in such situations. There is also objection to odors. It is rather important, and I need not dwell on that, except to say that certain formulations of benzine hexachloride are ample illustrations of objectionable odors connected with insecticides.

Such factors as the cost, which obviously must be in line, and the hazards of use, are so obvious that it should not be necessary to dwell on them here exceput to say that the insecticide must be safe for the operator to use and also safe in the particular situation in which it is used, not only to the individual but to housefold animals, pets, etc.

Now so much for the characteristics of an insecticide. Let's consider the selection of the formulation. In most cases we have a fair choice of formulations — such things as solutions, ordinarily in petroleum solvent or some similar material, emulsions which are diluted with water, and wettable powders, suspensions of solid material in water. More recently, there has been marketed so-called colloidal dispersions, which actually are not colloidal at all but are true suspensions.

Solutions, as Dr. Rowe pointed out, are most effective on non-porous surfaces — painted surfaces, masonry surfaces or tile which is non-absorbent. Dr. Rowe mentioned the possible fire hazard involved in the use of solutions in inflammable solvents. I recently read my fire insurance policy — the fine print — and it says if any inflammable material is applied to the structure, the policy is void, which means if you spray a man's barn or his house with kerosene solution and it burned up, he might not be repaid for his loss. That is something to consider.

The solvent in the solutions also affects the toxicity of the residue. It has been shown in general that the more volatile solvents result in more toxic residues. Low boiling point solvents are generally less toxic per unit of insecticide than the high boiling point solvents, and of course the reverse is true.

In emulsions, we have also the problem of absorption in porous surfaces. However, it is not as great as in the case of solutions. The residual efficiency of emulsions in general is rather high as compared with solutions, and in most situations they are not objectionable to use, as they leave no objectionable residue, although there certainly are plenty of instances where spotting, etc., occurs.

Suspensions, usually of 50% inert carrying material and 50% of the active insecticide suspended in water, are not absorbed to any appreciable extent. On porous surfaces such as unpainted wood or masonry, the active ingredient is at the surface, where it will do the most good for the longest period of time. They are, however, under some conditions objectionable to use. They leave a very definite residue, which precludes their use in many cases, particularly within homes.

A consideration in the use of suspensions and one which has not received quite the attention that it should, I believe, is the matter of the size of the particles of the insecticide. In general, the smaller the particles, the more toxic they are to the insect. You get a faster-acting material when it is finely ground. However, the fine particles lose their effectiveness much more quickly than larger particles. The reason for that, I believe, is that the relationship of the exposed surface to the mass of the material is much greater in case of the finer particles than it is in the larger particles, so that they volatilize more rapidly. The volatilization, if you want to call it that, is a function of the surface exposed as well as the temperature. So we must strike a compromise and reach a happy medium in selection of particle sizes which will give you the kill which is desired and remain effective for the longest time possible. I should hesitate to estimate what I consider to be a desirable size particle, but I believe that it will be in the range at least of 3 to 5 microns. Much smaller than that, the residual efficiency drops at a rather high rate.

Now to consider for a moment the colloidal, or so-called colloidal dispersions, which are virtually not colloidal but suspensions. The insecticide is in a finely divided state suspended in a liquid so that when it is applied and the liquid evaporates, you have a 100% active film or residue. On the face of it, this would appear to be more desirable than, say, a 50% suspension of wettable material in which at least half of the solid material is inert and cannot play a significant part in the killing action of the residue. As a mater of fact, in practice, in the fairly limited number of trials that I have run, on an equivalent dosage basis, the colloidal material is much more effective than a suspension. As a matter of fact, a deposit of 200 milligrams of the material per square foot of a colloidal material would be the equivalent of a 400 milligram deposit from the wettable powder. The coloidal materials, by the way, at least so far as I know, are not common on the market. There is one, at least. I have no idea of its acceptance of how widely it is being used. Perhaps some of you can answer that.

Now let us consider for a moment the application of the material, and here we have two questions to answer. How shall we put it on and how much of it shall we put on? I would like to expound at this point on a principle which is more often than not overlooked. Disregarding all other considerations, the effectiveness of an application is dependent upon the concentration of insecticide on the unit surface area. I don't care whether you put it on in a 10% solution or a 1% solution, the amount of material that you get on a given surface is what gives you the effect desired. This is best accomplished, in my opinion, by a wet spray, as Dr. Rowe mentioned. I have not been convinced that it is possible to apply a residual application on a surface other than a surface of water with an aerosol generator. I have never done it myself in a number of trials and I have never seen it done successfully. In my personal experience, the use of a steam-propelled aerosol, or thermal-generated aerosol results in maximum deposition of insecticide on the floor of the structure and a minimum of deposition on the walls — a type of control that is not what we desire.

Early in the development of DDT, it was recommended that sprays, in the case of emulsions or suspensions, contain a half of 1% DDT, that is, half of 1% by weight. In a water mixture, suspension or emulsion, which is applied ordinarily at the rate of about 1 gallon to 300 square feet more or less, that results in an effective deposit of DDT of 60 milligrams per square foot, and in my opinion this is totally inadequate as a residue. I have seen any number of cases of commercial operators who were applying DDT at that rate and accepting money for the job. I followed one through a section of California; in every case I was following him by about four weeks, and in every case his application had failed completely and the owner was very unhappy. They maintained they couldn't spend thirty dollars a month to control flies in their barn. I not only agreed with them, but I put on a residue which I considered to be satisfactory and which lasted for about four months. I wouldn't say that the inadequate application by the commercial men was deliberate; I think probably it was through ignorance.

In my opinion, and bearing out what Dr. Rowe has said previously, I think a minimum residue of DDT should be not less than 200 milligrams per square foot — not less than that. I personally believe 300 milligrams is better, and I have seen a number of situations in which 400 and even 500 milligrams is actually a desirable residue. The concentration of material, in this case DDT, at the surface, governs the effective fly-killing residue. The relationship is something like some figures from an experiment which we ran last year in which treated panels with known concentrations were exposed under similar conditions out doors. Weathering was rather severe, temperatures were high — averaging, or rather reaching, a maximum of 130° F. on the surface of the panels each day. A surface residue of 260 milligrams per square foot gave effective control with the testing methods I used (exposing houseflies and determining the length of time required for the residue to kill half the flies, or knock them down). The effective life of a 60 milligram residue is 35 days. A 200 milligram residue has an effective life of 95 days, and a 400 milligram residue has an effective life of 110 days. The relationship between 60 milligrams and 200 milligrams if plotted on a graph is practically a straight line; the effect is more or less proportionate, but as you increase the concentration at the surface beyond 200 milligrams, you get a disproportionate residual efficiency. The 400 milligrams deposit doesn't last twice as long as the 200 milligrams. But under many conditions, the expense of an application is not so much the cost of material as the cost of labor; in fact, often the cost of the material is rather a minor consideration, and the additional control afforded by a heavier deposit is very often well forth the slight additional cost. I have had considerable difficulty in the past in putting this idea over; in fact, it isn't put over yet by any means.

Now briefly to sum it up with more or less repetition of what Dr. Rowe has said. I agree with him wholeheartedly that DDT is certainly the insecticide of choice for fly control. I would include here DDT and its related materials, the analogs DDD and methyoxy. At the present time I cannot see where any of the other new materials such as chlorodane, parathion, or benzine hexachloride will increase our effective control. Some of them, as I mentioned, are much more toxic on the unit basis than DDT or the analog, but on the whole they do not weather well, and in the long run we are looking for a maximum residual efficiency.

Mr. Robinson: Thank you very much, Dr. Douglas. I think that talk of yours is certainly right down the line. We who are engaged in the actual operations of mosquito control and who are carrying on residual spray programs for mosquito control also find that we are getting compliments for our work on fly control along with it.

Next we have an "Introduction to Two Symposia" by Professor Morris Stewart.

INTRODUCTION TO TWO SYMPOSIA

M. A. Stewart

Professor of Parasitology, University of California

Mr. Chairman, I came in here this noon prepared to apologize for not being able to present at this time a written paper, due to the fact that the urgency of other matters has made it impossible for me to prepare a paper. I came prepared also to promise faithfully to turn such a paper over to the appropriate individual within a short period of time. Seeing this recording device in front of me and beside me fills me with fear, perplexity, and hope. I'm afraid of the thing; I am perplexed as to whether it will be necessary to prepare a written statement of what I would like to say, and I hope that if this is a substitute for what I should have written that I may be permitted to edit what I have said. It is always a dismaying experience to read after speaking extemporaneously what I presumably said, particularly because I sit down quite confident that I have given a scholarly and masterly presentation, and upon reading what I have said I wonder how I ever progressed beyond the fourth grade.

My colleague, Dr. Douglas, actually has given a better introduction to the two symposia scheduled for this afternoon than I am going to give. Selfishly, I regret to confess that it's a better presentation than I'm able to give.

A few years ago symposia were desirable luxuries in a meeting of this sort. Today such symposia are urgent necessities. The two symposia scheduled for this afternoon are very closely related. They are: "New Insecticides — Their Place in Mosquito Control," and "Toxicities and Tolerances of New Insecticides."

A good many of us in this audience recall when our insecticidal problems, referring exclusively to the insecticides in mosquito control, were relatively simple. We didn't have to know very much about chemistry, which was very fortunate since actually we didn't know very much about chemistry. We were not faced with the very important questions with which we are now faced, namely not only the selection of a chemical but the devising of appropriate methods of application and the development of adequate equipment for the various kinds of application. Thus we find that we are inevitably combining with the need for a knowledge of chemistry some need of engineering principles. With our simpler insecticides of the past, we were not nearly so much concerned with physical phenomena as we are today. When we were using Paris green, we were working with a simple compound. When we were stumbling around with our oils of a few years ago, we ignored many physical phenomena in blissful ignorance, and we could afford to igonre many of the physical phenomena which are of paramount importance today. One has only to look at the blackboard here to see how heavily we are taxed with the necessity of some appreciation of organic chemistry. One only has to recall what has been said earlier in the day with reference to diluents or solvents to realize that we are now not only involved with organic chemistry once more but with physical chemistry. And one ony has to think of the phenomena of residua to realize that we are dealing with something new and strange and something that is changing rapidly. Thus the importance of the first symposium seems to be well established. Personally I rather shudder at the wisely chosen title, "NEW insecticides." I sometimes believe that if we could legislate a forty-eight-hour day and educate ourselves away from the need of rest and sleep and eating that I might be fairly well abreast of the new insecticides. And I strongly suspect that I am not alone in this embarrassing position. The justification of the second symposium, "Toxicities and Tolerances of New Insecticides," is self-evident. We have always been concerned, *of* course, with the toxicity of the insecticide to the mosquito larva or adult. That is self-evident, as was pointed out a moment ago by Dr. Douglas. We recognized years ago that some caution might be necessary with reference to such insecticides as Paris green, so far as the human subject was concerned. But with the development of these new organic insecticides, and the development of new methods of application, we have been forced into a keener appreciation of toxicities to man and domesticated animals as well as to the arthropods, far in excess of our earlier necessity. Correlated with toxicity is, of course, tolerance. All of you are thoroughly familiar with the still unanswered and still baffling problem of tolerance on the part of man and his domesticated animals, so far as some of these new insecticides go.

The emphasis is on new insecticide, and they are so confoundedly new that those concerned with toxicities and tolerances of various animals are quite unprepared to answer our questions when we present those questions, through no fault of their own. That is to say, our progress has been literally appallingly rapid. With the development of some of these new insecticides, our interest with reference to toxicities and tolerances exclusive of mosquitoes is becoming, and perhaps already has become in some instances, a determining factor. I trust that these particular points will be well developed in the two symposia today. What I mean is merely this — in the application of many of these new insecticides we are concerned with the industrial hazards encountered by the person making the application; we are concerned with possible toxic reactions on the part of those who subsequently come in contact with the insecticide, the householder for example. We are concerned with the effect of these new insecticides upon both wild and domesticated animals which may come in direct or intermediate contact with these insecticides. We have been aware of that necessity in the past, but never so acutely as today.

We must also be aware of the potential danger of delayed or indirect contact. For example — in the widespread dissemination of DDT with resultant contamination of forage plots, what may be the ultimate consequence of prolonged feeding upon such crop material? Obviously this problem has become accentuated as we deal more with residual insecticides of greater longevity.

We are concerned with toxicity to wild animals, including those protected by law. We are concerned, as all entomologists recognize, with the possibility of disturbing seriously the balance of nature through the action of insecticides applied against the noxious insects, destroying forms beneficial to man. Now I think you will all agree that in some instances the latter danger has been over-emphasized and exaggerated. But we are also agreed that it is not being entirely dissipated. What I have been attempting to do in opening these two symposia is to refresh your memories with two things: the necessity of keeping abreast in understanding economic poisons which are of very great value to us in the control of mosquitoes; also to refresh your memory with the magnitiude of the problem of toxicities and tolerances that have arisen in recent years, and which give every promise of continuing to rise as we progress in the develoment of new organic compounds to be used for insecticidal purposes. Dr. Douglas has pointed out to you the question of solvents, which adds to our complications. All of us know that we have encountered difficulty with solvents because of their toxicity to the person using them or to those coming in later contact with them. I think that what earlier speakers have said better than I have said, and what I have said less well than they have said, substantiates my statement that symposia on such subjects as these under consideration this afternoon are no longer merely desirable but actually necessary, and I believe that your Program Committee has selected a battery of men who will help you appreciate and solve some of these problems, but above all will impress upon each one of us the great importance of these problems and instill in each one of us the determination to give them the consideration they demand in field application of the laboratory findings.

I understood Chet was carrying the ball this afternoon, but Harold tells me that is not the case, but that I am to call upon the gentleman who is to lead the first symposium. I assume that confers upon me the privilege of turning the rest of the symposium over to him. I really don't believe it is necessary to introduce Mr. A. W. Lindquist to you. He is, with due apologies to our good friend Vannote, temporarily an exile from California. He and I were friends together in Texas before both of us left (not upon request) the State of Texas. I take great pleasure in urging to come before you without introduction Mr. A. W. Lindquist, in charge of the Corvallis, Oregon, Laboratory, United States Department of Agriculture, who will lead the first symposium, "New Insecticides and Their Place in Mosquito Control."

NEW INSECTICIDES — THEIR PLACE IN MOSQUITO CONTROL

A. W. Lindquist

In Charge, Corvallis, Oregon, Laboratory,
United States Department of Agriculture

Thank you, Dr. Stewart, members and friends of the Association. I am only supposed to guide this symposium, I believe. There are three speakers and I think they should sit up here on the rostrum prepared to give their talks and also prepared to answer questions — Dr. Hoskins, Dr. Isenhour, and Dr. Michelbacher. Officers and workers in mosquito control districts are aware that many new compounds are being discussed for possible use in mosquito control. They hear and read of preliminary tests with several of the promising compounds. They seek advice and assistance from State and Federal workers as well as representatives of industry. The companies that are producing these materials are vitally interested in the compounds. They have an investment at stake.

Nearly everyone is familiar with DDT. It probably cannot be classed as a new insecticide since it has been in use since 1943. Benzine hexachloride has been known for two or three years, but has not been widely used in mosquito control. Other compounds are in the preliminary testing stage or are partially available. You will see this list of some of the materials as indicated — DDT, benzine hexachloride, and a material referred to as TDE or triple D — I don't know which is the correct designation. That goes under the trade name of Rothane. Then we have chlorinated camphene which goes under the trade name of Toxiphine. The toxichlore or the metoxic analog of DDD. I think one trade name is Marlane. We have chlorodane. The accepted short name for that particular compound is marketed under at least two trade names — possibly several others — toxichlore or Velsicol 1068. We have one of the very latest materials known as parathion. Formerly it had a number — number 3422 — but the common name for that material is parathion. Then, of course, we have derivatives of pyrethrum, one of them being piperonyl butoxide. Pyrethrum with detergents is sometimes considered for adult mosquito control. All of these have been tested in the laboratory on various species of mosquitoes and a few of them have been given preliminary evaluation in the field.

For practical mosquito control, a new insecticide must be evaluated from several viewpoints. In the first place, we must consider the effectiveness of the compound on the particular species of mosquito to be controlled, or group of mosquitoes. The first tests are made in the laboratory, and the question arises — How does it compare with DDT? Also, a particular compound may be somewhat more specific in its action and produce a higher mortality than DDT on one species but not be especially effective on another. The second viewpoint will be the safety of the material, which will be discussed in the next symposium. The third consideration is, of course, cost and availability. Practical mosquito control must consider cost. Generally we use the lowest-priced material, but it is possible that a higher-priced material may be safer to use, and the extra cost may be fully justified. It is hoped that the speakers on this symposium and the members of the Association will discuss their experiences with the various new materials on different species of mosquitoes. This exchange of information will lead towards possible explanation of failures, and perhaps stimulate further testing and evaluation of these materials. The first speaker on this symposium is Dr. William Hoskins, Professor of Toxicology, University of California.

NEW INSECTICIDES — THEIR PLACE IN MOSQUITO CONTROL

By W. M. Hoskins

Professor of Entomology, University of California

The practical control of mosquitoes affords one of the best examples from the whole field of entomology that the final test of an idea is whether it works. The complications that may arise, ranging, for instance, from local politics to the vagaries of the weather, are too numerous to permit precise extirpation from a small-scale test to full-size operation. It would be presumptuous on my part to attempt to evaluate procedures which have been tried by various experimenters, for many here know of these matters by personal experience. Rather, it may be of interest to mention a few results obtained under controlled laboratory conditions, in the hope that some application may suggest itself.

Interest continues to center on the organic insecticides. Among these DDT receives the lion's share of attention. A hasty survey of the papers published last year on mosquito control, as reported in *Review of Applied Entomology*, indicates that in about ninety per cent of the investigations DDT was concerned, usually exclusively. Mention of DDT as a mosquito repellent has been made by numerous speakers and writers.

Usually, unequal distribution of the insects between treated and untreated surfaces, cages, rooms, etc., was given as the criterion for repellency. Recetly this matter was investigated carefully by Kennedy (1947), and the conclusion was reached that the toxic action of DDT toward adult mosquitoes, as revealed by their hyperactivity, begins so soon after contact with a treated surface that an unequal distribution results from their increased movements. Thus it is a case of deterrency, i. e., the beginning of toxic action as defined by Campbell (1932), and true repellency, which is a chemasensory reaction, is absent. Often the effect is that biting does not occur, at least, at the particular moment, but it does not follow that the insect will not recover and return to bite another time. In other words, does contact with DDT sufficient to cause hyperactivity give a lethal dose to the mosquito? In many cases it does not, as shown by Kennedy and also by Ribbands (1947), especially if light or old applications are touched. This seems to suggest that so far as killing mosquitoes is concerned, it is better to use a heavy application on limited areas, especially those parts of a room where mosquitoes tend to congregate, than to use the same amount of DDT in a light application everywhere. This affords a good example of a theory whose truth and limitations must be established by more trials.

Out of this may be deduced another subject for investigation: Can the nature of a deposit of DDT or of other toxicant be modified so as to change the ratio between uptake of lethal amount and onset of the excitant effect, or are these phenomena inseparably connected? One very interesting point has been made by Parkin and Green (1947) in England, who discovered that a crystalline deposit of DDT was more toxic to houseflies than an equal deposit which had not crystallized. Whether the same situation holds for mosquitoes does not seem to be known. Their experiments were made with 0.2, 2, 5, and 10 percent solutions of DDT in Pool burning oil (a crude kerosene) applied to wallboard to give a total deposit of 80 milligrams per square foot. Houseflies were exposed after four days and after four weeks. Two points of interest were noted: (a) at both times the more concentrated sprays were insecticidal, and (b) whereas the 0.2 and the 2 per cent spray deposits decreased in effect as time elapsed, the 5 and 10 per cent ones were more effective after four weeks. Point (a), the higher toxicity of deposits, from the higher concentrations, probably is to be expected on the ground that the smaller volumes of spray allowed less penetration into the wallboard, but the changes in effectiveness with time are contrary to the idea that DDT which is first carried into the surface, comes out again as the solvent returns to the surface, for if this were the case the deposits from the more dilute solutions would show this behavior rather than the concentrated ones.

It was observed that the deposits all appeared to be liquid in nature except those from the more concentrated solutions after they had stood for some time, and especially after flies had walked on them. That is, agitation from insects or from a tuft of hairs brought about crystallization, and then the toxicity was greater. If the crop of crystals was removed by rubbing with a cloth, the toxicity was greatly reduced. After several days a new crop of crystals formed in some cases and the toxicity was restored. As a working rule it was found that when the product of concentration in per cent by deposit in milligrams per square foot exceeded 150, crystallization would occur. Flies killed by exposure to crystalline deposits had fragments on various parts of the body, as feet, legs, abdomen, wings, etc.

If the observations of the English workers are confirmed, they present a problem in interpreting how a crystal can be more effective than a supersaturated solution. One might imagine that the liquid would make contact with a larger area of the insect's surface and hence penetrate in larger amounts. DDT crystallizes from various solvents with differing readiness. From acetone it comes out very readily, but if a little heavy oil is present no crystals form. No thorough study has been undertaken of this matter, and some very practical discoveries doubtless are only waiting to be made.

The nature of the surface to which insecticides are applied often has an effect upon their efficiency. This has been studied further during the past year with DDT. The English workers previously mentioned applied a solution to wallboard and found that penetration carried much of the DDT from the surface, with consequent reduction in effect on houseflies. A detailed study has been made by Clapp, Fay, and Simmons (1947) of the penetration of DDT-xylene solution into white pine boards. Application was made at 200 milligrams per square foot, and after drying, the surface was planed off in 0.01 inch layers. The results when mosquitoes were exposed were: surface, 95 per cent mortality; 0.01 inch, 45 per cent; 0.02 inch, 10 per cent; 0.03 inch, 3 per cent; 0.04 inch, 0 per cent. Somewhat similar results (but in terms of DDT recovered) were obtained with poplar wood by Schmitz and Goette (1948), except that penetration was deeper, both with a kerosene-DDT solution and the same emulsified. Penetration into white oak, longleaf pine, and southern cypress considerably exceeded that into poplar, and red gum, ash, and white pine were comparable to poplar. As might be expected, the penetration was reduced when wood was thoroughly wetted with water first, but this did not occur if the water and DDT solution were applied in quick succession. Similarly, the water in an emulsion may not act to interfere with penetration. With a more volatile solvent such as xylene, penetration was less. The importance of these results for cases in which DDT solutions are applied to bare wood is obvious. The results with wet wood may have a bearing on the possibility of using residual sprays on mud walls such as are widely used in houses in the Orient. It has been found repeatedly that application of residual toxicants in solution to such walls is almost useless even in extravagant amounts. The results with wet wood indicate small promise that dampening mud walls would be useful. To a somewhat less extent the same applies to brick and other surfaces widely used in this country. This, of course, does not argue against the use of wettable suspensions, but they have their own limitations.

Recent investigations with toxicants for mosquitoes have not been limited entirely to DDT. Ribbands (1947) in an article mentioned previously has reported that benzene hexachloride has a strong repellent as well as a toxic effect upon mosquitoes. The repellent effect is exerted at a distance and was sufficient to keep mosquitoes from entering coolie huts when the eaves only were treated. Doubtless this effect is possible because benzene hexachloride has an appreciable vapor pressure, and as a gas is perceived by the incoming insects. Such an effect would be especially valuable with species such as *A. maculatus*, which often enter and bite without alighting on a wall or ceiling.

Information on other new organic toxicants for mosquitoes is so scanty that I shall not mention them. Doubtless personal experiences with some will be related by other speakers. There is one point which I would like to stress. DDT has seemed to be such an answer to the mosquito abatement worker's prayer that there is a tendency to avoid practical trials with other materials. However, there is still a large element of doubt in the minds of toxicologists regarding the long-continued consumption of DDT by man and animals. This is involved especially in the dairy and meat industries. It is becoming common practice to apply DDT to corn, peas, and alfalfa, all of which are important feeds for milk and beef cattle. Since DDT tends to collect in the body fat and to be secreted in the milk, it is easily possible for a person, especially an infant, to ingest DDT at the rate of several parts per million in the diet. Control of mosquitoes by broadcasting of DDT on pasture land makes a substantial contribution to the total amount eaten by cattle. Whether this condition eventually proves to be a serious, or only a possible, health hazard, it is obvious that some very unfavorable publicity can occur. This is one reason why no time should be lost in seeking substitute chemicals. These may well be better than DDT, and in that event the mosquito control program would naturally extricate itself from the DDT residue problem.

A second reason why no time should be lost in finding a practical substitute for DDT is the finding by workers of the Federal Bureau of Entomology and Plant Quarantine that after exposure of several successive generations to DDT, houseflies show a decided tolerance to that chemical. Previous experience with arsenic and other poisons gave cause to expect this result, and there is every reason to believe that it will show itself with mosquitoes. There can be little doubt that from the chemical point of view the chief problem in mosquito control today is the finding of a stand-in for DDT and development of means for its practical use if and when that becomes necessary.

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Mr. Lindquist: Thank you, Professor Hoskins. We will now hear from Dr. L. L. Isenhour, representative of the chemical insecticide industries.

NEW INSECTICIDES—THEIR PLACE IN MOSQUITO CONTROL

L. L. Isenhour

It would be somewhat superfluous for me to spend much time during this meeting discussing specific insecticides for mosquito control. Most of you know that I am convinced of the superiority of dichloro-diphenyl-dichloroethane, otherwise known as DDD or TDE, for larvicidal purposes. That choice is selected from the compounds that are currently available or on which we have some performance data. I wish to discuss in detail some of the factors which we should keep in mind when evaluating the many new compounds which will be offered for your consideration during the months and years to come. The development of new compounds should give us increasingly greater efficiency in the control of mosquitoes.

When we look for new insecticides to replace DDT, TDE, oil, pyrethrum, etc., there are four factors which we must keep in mind. There is a tendency to over-rate the first factor in the list I have made. Actually the four are so interdependent that we cannot afford to proceed without granting to each its proper value.

1. The material must be a potent insecticide against mosquitoes.
2. The insecticide must not create new and objectionable hazards to beneficial insect, plant, or animal life.
3. The method of handling to obtain the best results must not present any impractical factors.
4. The cost must be low or at least within practical limits.

We can dismiss the cost factor quickly. Based on available budgets a treatment for mosquito control simply cannot cost more than the funds which are available. We have both DDT and oil costs to serve as a basis on which to judge the efficiency of new proposals. A lower cost is the goal. A slightly higher cost could be justified only on the basis of an improved safety factor or because it permits a saving on labor or some other operation.

Each of the other points should be considered in some detail. In the first place, what constitutes effective control? For our purpose in eliminating mosquitoes we need to kill 100% of the larvae, adults, or eggs in any selected area. This concept dictates that first we must have 100% distribution to permit the insecticide to do its work. With that requirement fulfilled, the insecticide must be distributed at a concentration to give the kill. It doesn't really matter whether that effective concentration is 1:100 or 1:1,000,000,000 if we also fulfill the requirements of adequate safety and economical cost. I believe that research workers in both industry and government have placed too much emphasis on insecticidal effectiveness at astronomical dilutions. Increased high potency does offer an obvious way to reduce costs, but it should not be considered an end in itself. A more desirable goal would be high specific toxicity to mosquitoes and relatively low toxicity to other insects, plants, and animals.

The safety factor is far more important to California Mosquito Abatement Districts than it may be to control agencies in other areas. Larvicidal applications are made on large acreages of crop lands. Here the situation is different from what it is on waste swamp land, where side reactions are of minor importance. We justify our mosquito control measures in part on the basis that we are reducing or eliminating the hazard of disease, encephalitis, for example, to our human population. This benefit will cancel itself out if we upset our farming economy on these crop lands or create in some way a toxic chemical hazard. These factors must be given prime consideration every time some one hands you a wonderful new insecticide.

I would like to suggest a specific example of one ideal treatment. Most of you when treating irrigated pastures expect to make new insecticide applications after each irrigation. The mechanics of the problem make it improbable that we can apply DDT or anything else and have it redispersed properly after repeated drying and reflooding. This is a mechanical or physical problem rather than one of insecticidal potency. Under such circumstances you can feel that you have done a good job of you kill 100% of the larvae present at the time of each irrigation. DDT, however, is most notable for its long residual properties. In the soil it lasts a long time, and an accumulation of more than 20 lbs. per acre is known to be toxic to many plants. It presents some recognized hazards when present on foodstuffs of animals or humans. When you study new insecticides for use on irrigated pastures the safety factor should be a major consideration. I would favor a product that is quickly effective and just as quickly dissipated. The other choice would be a product with a high degree of specificity against mosquito larvae and a relatively low order of toxicity against plant and animal life.

When some one offers you a new insecticide you still have the problem of formulating it. If you use DDT as a standard the same solvents and emulsifiers may not be at all adequate for anything except its close analogs. Depending upon its physical properties, and the purpose it is to serve, a new insecticide will require special consideration as to the most effective way to handle it. I learned this fact the hard way when Rhothane D-3 was offered as a mosquito larvicide. There were several unfavorable reports from the field before I realized that the formulation was incorrect for use in the manner emulsion concentrates are generally handled in California. This simply emphasizes again that a good insecticide is not enough. Neither does it need to be effective in infinitesimal concentrations. It must above all things be properly handled, and it should not create any new hazards to replace the ones we are trying to alleviate.

Mr. Lindquist: Thank you, Dr. Isenhour. The final paper in this symposium will be presented by Dr. A. E. Michelbacher of the Division of Entomology, University of California, who has had considerable experience in experimental use of new insecticides through the medium of the University.

POSSIBLE EFFECTS OF NEW INSECTICIDES USED IN MOSQUITO CONTROL ON ECONOMIC ENTOMOLGY

A. E. Michelbacher

The use of DDT in mosquito control may result in some serious problems as far as agriculture is concerned and those who are in charge of mosquito control projects should bear this in mind. In the first place, there is danger is serious contamination of pasturage and forage crops with DDT. Investigations have been conducted which have shown that DDT can be recovered from the milk of dairy cows which have been fed foods contaminated with DDT. The hazard involved appears to be so great that many economic entomologists have felt it it unwise to recommend the use of DDT on pasturage or forage crops, and further, that refuse from crops treated with DDT should not be fed livestock. At the recent Seventh Annual Meeting of the Pacific Northwest Vegetable Insect Conference, the entomologists present recommended that crops treated with DDT should not be used for livestock feed.

In mosquito control, amounts of DDT used per acre are frequently sufficiently high to contaminate forage crops with enough DDT so that there is a possibility of its being recovered in the milk if cattle are fed the treated foods. This is most likely to occur where DDT is used as residual sprays.

Another factor that must be given some consideration is the possible effect of the insecticides used in mosquito control on agricultural pests. Applications of DDT and its related compounds under certain conditions are known to result in the increase of some destructive agricultural pests. Destructive populations of such pests as aphids, scales, and mites have occurred following the use of these materials. The reasons for these increases are not entirely known. In part they are the result of the destruction of natural enemies by the insecticides, although other effects are apparent. These probably involve physical, chemical, or combination of these factors which in some way affect the environment and make it more favorable for the particular pest concerned. Where DDT is applied at low dosages, the increase of injurious pests to destructive levels is not nearly so likely to occur as where the insecticide is used at higher amounts. Although low dosages are generally used in mosquito control, amounts sufficiently large to allow for the increase in population of certain pests are sometimes applied.

During the past season many agricultural pests occurred in unusually destructive numbers. It is believed that these outbreaks were probably associated with dry weather conditions which were very favorable to the winter survival of the several pests. However, the possibility that the widespread use of DDT might have had some effect should not be overlooked. Certainly, investigations should be conducted to determine whether the use of DDT in mosquito control programs has any adverse effect upon insects and related pests attacking agricultural crops.

The rate of decomposition of DDT in the soil has not been determined. It probably varies for different soils but in no case does it appear to be very rapid. In some soils as little as 20 to 25 pounds of actual DDT per acre is injurious to certain plants such as tomato. Serious contamination of the soil with DDT does not appear to be likely at the rates this insecticide is used for mosquito control. However, DDT is widely used for the control of a number of agricultural pests, and the amount used for this purpose plus that used for mosquito control might in time and under certain conditions build up destructive amounts in the soil. This problem warrants further investigation.

The cleaning out of equipment should be done with some caution. Care should be exercised to see that DDT waste or concentrated sprays are not allowed to drain into pools, streams, or other locations where serious loss of fish or other aquatic forms of life might occur.

Mr. Lindquist: Let us consider for a moment the toxicities of some of these compounds to mosquito larvae of various species. Are any of them equal to DDT or any of them better? There are several members of this Association and visitors who have tested these compounds in the laboratory and also in the field. I think it would be well to hear of their experiences. What do they think of them? Do they have promise of being effective? If anyone has any thoughts on the subject, I am sure that we would be glad to hear them. Dr. Richard M. Bohart, I understand that you have been testing these materials in the laboratory. Do you have any particular information in regard to how they compare with our standard DDT?

Dr. Bohart: Everyone else has declined to stick their necks out any farther than DDD, and so I am hesitant to do so, but I have for the last year carried on larvicide tests in the laboratory with most of the new materials, some of which are commercially available. These were, briefly, Chlorodane, DDT, DDD, Peptichlor, Parathion, Toxithene, and BHC. I tried them out against eleven species of California mosquitoes and a total of sixty-four 8-hour tests in which I used about 30,000 mosquito larvae which I individually reared and mollycoddled to get them to react. I don't intend to say very much about that. I found that all of these materials except benzene hexachloride were very toxic to mosquito larvae. Even benzene hexachloride is toxic, but it is somewhat below the others in toxicity to the fourth instar larvae. All of the others were highly toxic. Until recently I had thought that DDT and DDD were of about equal toxicity. I still think they are of about equal toxicity and best of the lot — the most toxic and probably the most promising. Recently I had an opportunity to try parathion and regardless of whether or not it will be an appropriate insecticide, it is extremely toxic to larvae — much more so than any of the others tested. Its residual toxicity probably wouldn't be so good. I haven't had a chance to test that.

Speaking of possible substitutes for DDT, I would say that any of the other materials could be substituted if it were necessary to do so on the basis of acquired tolerance of the pests, of a mosquito concerned, if the costs were down to a point where it was feasible. DDD, which Dr. Isenhour mentioned, has been shown in repeated tests to be at least the equal of DDT. As far as I am concerned, its only disadvantage is the mater of cost, and maybe that isn't so great. So if you concede that DDD has other advantages, why maybe it is just the material to use, and, so far as that goes, the chlorodane and toxiphene are very similar. They have very good residual properties and very high toxicity.

Mr. Lindquist: Thank you, Dr. Bohart. Our experiences have been somewhat similar. My colleague, Mr. Yates, has done quite a bit of work on comparing various new materials on different species of insects, and he has a paper for us on that tomorrow. I think that he feels somewhat like Dr. Bohart. A lot of these other materials are very promising, and they can be used as a substitute material for mosquito control at some future time. I understand that there are some mosquito control districts which have already tried out at least one of these compounds in practical field tests. I also believe that TDE is going to be used in a practical way this summer in California. I believe that Mr. Robinson has done some work with this compound in a practical way. Is that correct, Mr. Robinson?

Mr. Robinson: Yes.

Mr. Lindquist: I was wondering if you could tell the group something of your experiences with this?

Mr. Robinson: I think most of the information we have on that will be presented Saturday by Dr. Markos. We have done some primary control work in rice fields by plane. Certain fields we did exclusively with DDT and others with Rhothane, and others with a combination of BHC and DDT. We got much better results with DDT and DDD than we did with the combination of BHC and DDT. We had several experiments which were carried out during the year in one area exclusively on clover fields using Rhothane, and we felt that it was comparable at least to the DDT.

Mr. Lindquist: Thank you, Mr. Robinson. Are there any other people here who would care to discuss their experiences with the new insecticides? I am sure that every worker in mosquito control would like to hear about it; to know what the results were.

Question: Can you tell us something about Clear Lake gnats?

Mr. Lindquist: That's kind of getting away from mosquitoes. We have been called on to help the people in Lake County with their gnat problem. Everyone is thinging of new insecticides. Could these miraculous materials rid Clear Lake of the gnats? Needless to say, it is a very, very difficult problem. We have a body of water there that contains a great deal of animal life of all sorts besides the gnat, which we consider a pest. We also must consider the fish in Clear Lake — the fish directly, and their food supply indirectly, and we must not upset the balance of the economy of this lake. so I believe that we can all realize what a difficult problem it is. However, we felt that we should at least try to see what these larvicides would do to the Clear Lake gnats. We chose a small neighboring lake in which to experiment last fall. This was in cooperation with the California Fish and Game Commission. The insecticide we chose, based on limited tests, as far as the toxicity of the compound affects fish, was TDE, commercially known as Rhothane. It seemed to have less effect on fish than DDT in preliminary tests. I might say that there is a great deal of information needed on these various materials on various species of fish. Well, to make the story short, we sprayed this little lake with an emulsion of TDE late in the fall and found that we killed a pretty good percentage of the Clear Lake gnat larvae, but the control was not deemed adequate. In thirteen days we had destroyed some 85% of the larvae. Of course most of you understand that the larvae of this gnat inhabit the bottom mud during the daylight hours and make migrations upward into the water at night. There is a great deal of seasonal variation on this. We made our test at the time when the vertical migration was very, very weak. Theoretically, if they would all have come out of the mud on the first or second night, they would have succumbed to the treatment. I believe that is about all I can say on this. The dosage that we finally figured out on the volume of water was one part of active ingredient to 45 million parts of water. The material disseminated through about twenty feet depth of water.

The time is drawing short. I think it is evident to the mosquito control workers that the various speakers have brought out that we should use these new compounds, including DDT, with a degree of caution. We should also try to test a number of these new materials in limited field tests. Are there any further questions that any if you wish to ask these gentlemen?

Question: Is there any information available on absorption by plants?

Mr. Lindquist: I think there is. I think perhaps Dr. Knipling has some information on that, and I am sure there is some here at the University of California. I don't know off-hand.

Dr. Knipling: Dr. Allen and his associates in Wisconsin have done quite a bit of work along that line, and I was fortunate enough to be present at the Chicago meeting last fall and heard their papers. I can't remember all of the details, and if I could it would take too much time, but there is definitely an absorption of DDT and these other chemicals, varying with the species of plant and varying with the type of soil. Some plants are definitely injured with DDT when the DDT content gets up to a number of pounds per acre; some plants are definitely stimulated by DDT. They think now that the tremendous increase in yield of potatoes, for example, where DDT has been used is partly due to stimulation — the greater yield being due in part to DDT rather than entirely due to control of the insects. That is about all I can take time to say.

Question: May I ask one further question?

Mr. Lindquist: Yes.

Question: Is there enough information available to put some of these materials that are equally toxic to mosquito larvae in the order of relationship to the degree with which they retain or manifest residual action?

Mr. Lindquist: I am sure there are several here who have some information. My colleague, Mr. Yates, if I may take the liberty of calling on him, may be able to elucidate that question.

Mr. Yates: I don't know of any official work done on residual effect of the different materials on the larvae. We have done work on the residual effect on adult mosquitoes.

Mr. Knipling: I might just say that of course we have done a great deal of work on all these materials against both larvae and adults at our Orlando laboratory. I don't believe, though, that we want to take time from this other symposium for such discussion. We have not found any that are as good as DDT from the standpoint of lasting effectiveness against adults, with the exception of parathion, which varies as Dr. Douglas has already indicated. There again it depends on the surface. If it is an absorbent surface such as certain woods, parathion is absorbed and then liberated and will give a long life of effectiveness. Perhaps the work that Dr. Douglas tells about was done on some less absorbent surface. We have also tried these materials as a pre-flood treatment, and none of them equal DDT in persistence or residual effect against larvae.

Mr. Lindquist: We will now terminate the discussion and call for a recess.

TOXICITIES AND TOLERANCES OF NEW INSECTICIDES

M. A. Stewart
Professor of Parasitology, University of California

During the first symposium, I sat in the front row profiting by the erudition of the panel and admiring its manly beauty. I have a somewhat larger panel to present to you in this second contest of knowledge and beauty. I suspect that the reason I have one more member is that the leader of the preceding symposium was somewhat unethical in view of the fact that he went outside of those whose feet are in the public feed trough in order to increase the beauty of the panel. I am going to ask my team of contestants to come up here so that you may see what they look like and hear what they have to talk about. Mr. A. B. Lemmon, Chief of the Bureau of Chemistry, California State Department of Agriculture, in Sacramento. Dr. D. B. Furman, Assistant Professor of Parasitology of the University of California. Dr. O. B. Cope, who is here in place of Mr. E. E. Horn of the U. S. Wildlife Service. And finally, Dr. R. L. Usinger, Assistant Professor of Entomology at the University of California.

The purpose of this symposium and its goal have already been defined. There may be, in fact there should be, some overlapping of material presented. This team has not been coached in view of the fact that I have been out of town. I don't know precisely what they are going to discuss individually or collectively. I do know, however, that each one of them is far better prepared than I.

The first speaker in the second symposium has been introduced as he came down here, and now I am going to ask Mr. Lemmon to present the first part of this symposium.

STATUS OF NEW ECONOMIC POISONS UNDER THE AGRICULTURE CODE

A. B. Lemmon
Chief, Bureau of Chemistry
State Department of Agriculture

In California each economic poison must be registered under the Economic Poisons Article of the Agricultural Code before being offered for sale in the State. The term "economic poison" includes any material used for pest control. Before a manufacturer can legally offer his product for sale he must submit application for registration, copy of proposed labeling, and any information necessary to substantiate his claims, together with proper registration fee. If the material has been previously used, or is a common formulation, there is usually sufficient material in the literature and in our claim files to enable us to judge the reasonableness of the proposed claims for the product. If it is a new product for which we have no information, the applicant is requested to submit his data to substantiate his claims.

Section 1072 of the Agricultural Code provides that registration shall be withheld for products that are of little or no value for the purpose intended, which are detrimental to vegetation, except weeds, to domestic animals, or to the public health and safety when properly used, and require such practical demonstration as may be necessary to determine the facts. Accordingly, when a manufacturer's data are not sufficient to warrant registration of the product, he may be requested to put on a practical demonstration.

The law provides that the label of an economic poison must give the name of the product, proper statement of ingredients, adequate directions for use, necessary precautions and poison label, if needed, and the name and address of the registrant. There is some confusion with regard to legal requirements concerning proper statement of ingredients. Under the California law there is an option. On the application for registration there must be stated the name and percentage of each active ingredient and the total percentage of inert ingredients. The same statement is preferred on the label, but in lieu thereof there may be stated the name and percentage of each inert ingredient. It is obvious that it is of little value to the user to have a label state "Inert ingredient, water, 10%" or "Active ingredients 100%" as the case may be, but these may be legal statements if the product does not contain other inert ingredients than those declared, or if it does not contain any inert ingredients. When a percentage is stated it means percentage by weight.

At present there are over 7,000 different economic poisons registered for sale in California, and applications for registration of new products are received at the rate of about 150 to 200 products a month. The types of new products for which we have received application for registration seem to go in cycles as the new organic chemicals are developed for pest-control uses. The big rush began with release of DDT for civilian use, and there are several hundred DDT preparations licensed for sale in the State. As more information has become available there have been changes in the labeling requirements for DDT products. At present labels must carry warnings such as, "DDT is toxic and when in solution can be absorbed through the skin. Avoid inhaling dusts and mist from spray. Avoid contamination of foodstuffs and feedstuffs." In California the State Board of Pharmacy has ruled that if a product contains DDT in solution or liquid preparation more than 5%, the label must bear the skull and crossbones and the word "Poison" in red on a white background and suggested first-aid treatment. For powdered materials the limit is 60%. The different requirements for the liquid and powdered form are necessary because there is more chance of injury through absorption or accidental drinking of materials in liquid form.

Insofar as licensing and labeling requirements are concerned, the other chlorinated hydrocarbons are generally regarded in about the same class as DDT. DDD is usually considered somewhat less toxic, but it as well as benzene hexachloride, chlordane, and chlorinated camphene are all regarded in the same class with DDT, and although there is some variation in toxicity of the different materials and some are more specific against particular pests than others, all carry a possible spray residue hazard and the labels must carry adequate warning.

Although not directly used in mosquito control work, the 2,4-D products may have some connection with your work. These are growth-regulating substances and are quite commonly used as weed killers. As of January 1, 1948, there were about 127 different 2,4-D products offered for sale in the State. These materials are not considered hazardous to man, but are exceedingly toxic to vegetation even when used in small amounts. There are many reports with regard to injury to tomatoes and other valuable plants through small amounts drifting onto them. We observed several cases of serious drift where 2,4-D products were applied by airplane to rice fields for control of weeds in the rice as a selective weed killer, and the wind carried the spray material on adjoining tomato fields and in one case a prune orchard. The broad-leaved plants absorb more of the material and are killed while rice and other grains are quite tolerant and are not injured when the material is applied to control weeds contaminating the grain.

The organic phosphate materials, such as hexaethyl tetraphosphate and tetraethyl pyrophosphate are exceedingly poisonous and dangerous to handle. They do not leave a residual effect, so there appears to be no spray residue hazard. As these materials break down in a matter of hours, they would seem to have little value in mosquito control work. Parathion is a new organic phosphate material that is being developed. It is quite poisonous, has some residual effect, and will probably find quite wide use in agriculture. So far it is only in pilot plant production, and those products registered containing this ingredient have been restricted to use on non-edible portions of crops.

In addition to the requirements of the Economic Poisons Atide concerning registration and labeling of these materials necessary for pest control, the Spray Residue Article of the Agricultural Code prohibits sale of produce carrying spray residue in excess of the quantities permitted under the law. The Spray Residue Article applies only to fruits and vegetables, and does not apply to alfalfa, hay, or other forage crops. The amounts set up in the law as permitted tolerances are: lead, 0.050 grain per pound; arsenic, expressed as arsenic trioxide, 0.025 grain per pound; fluorine, 0.049; and DDT, 0.049. The tolerance for DDT and for fluorine of 0.049 grain per pound is the same as 7 milligrams per kilogram, or 7 parts per million. The Federal government has announced a tentative tolerance for DDT as applying only to apples and pears, but in California the tolerance is written in our law as applying to all fresh and dried fruits and vegetables. Even though there is not a specific law with regard to permissible amounts of toxic ingredients on forage, great care should be taken not to contaminate alfalfa, hay, or other feed with DDT or other poisonous substances. DDT is reported to be excreted in the milk of dairy cows. Every year there are a number of suits instituted by dairymen against sellers of hay which contains poisonous ingredients usually incurred through accidental drift from application of these materials to adjoining fields.

It takes time to work out the toxic limits of the many new products used in pest control, but we have been informed that it is expected that the Federal government will carry on a research program in this field. The data are far too meager to set definite tolerances for the numerous new materials; and the tolerance for DDT that is in our State law is based on the best information available, but may be modified by later data. It has worked quite well as a legal tolerance in that under most conditions a farmer can apply sufficient DDT to control his pests and at the same time not have excess spray residue at harvest time. Those cases where action has been necessary against products carrying excess spray residues have been due to gross mishandling or carelessness in the application of the insecticides.

Dr. Stewart: All of us recognize that the work Mr. Lemmon is directing commands the respect and gratitude of all of us because he does keep us all in mind and affords us protection which we might sometimes overlook. Dr. Lemmon has laid, it seems to me, a sound basis for the ensuing discussion, by first defining the law and implying the underlying reasons for it, and secondly by pointing out in some detail the status of the many economic poisons in which we are interested. Finally, he gave us a word of caution and I think also a word of encouragement with reference to investigations in the near future.

The second speaker on this symposium, Dr. Furman, has been actively interested in research on some of these newer compounds, and during the war was actively engaged in the Army in malaria work.

TOXICITIES AND TOLERANCES OF NEW INSECTICIDES

D. B. Furman

Assistant Professor of Parasitology, University of California

We have been given quite a range of choice this afternoon for our topic, the title of which is "Toxicities and Tolerances of New Insecticides." Therefore, I exercise the liberty of restricting the particular subject on which I am going to speak to one very small segment in that field, with which I am more personally familiar, namely the toxicity and tolerance of benzene hexachloride. This is thought of as a new material, but actually it is not new. It has been known since 1825. However, it has not been until recently that we realized it really has an important insecticidal value. The French, in 1941, discovered this fact. Then, again independently, the British discovered the same thing in 1942. It is not a very complicated type of material. It consists primarily of a benzene ring with hydrogen and chlorine on each of the carbon atoms of the ring. Theoretically it is possible to have quite a number of differently reacting compounds based on the special arrangement of the hydrogen and chlorine atoms on each of the carbon atoms. Of this theoretically rather large number, however, we have to date five. These we are particularly interested in because there is a great deal of variation in the toxicity between the various isomeric compounds, namely the alpha, beta, gamma, delta, and, more recently, the epsilon isomers. In 1944 Cameron and Burgess ran some tests on relative toxicity to mammals of pure gamma isomer, which was at that time aparently the most effective isomer against insects, and made comparative tests between that isomer and DDT. Citing only one of the animals which they used—a rabbit—they found that the LD 50 of the materials expressed in terms of milligrams per kilogram of body weight, were in many respects quite similar. Using a 10% solution of the gamma isomer on one hand and the DDT on the other, and applying it to the skin, they found that the LD 50 was the same in each of these materials. The 300 milligrams in this particular instance per kilogram of body weight would constitute the LD 50. When the material was injected subcutaneously in a liquid paraffin, in a 5% solution, the gamma isomer proved to be considerably more toxic, 75 milligrams per kilogram of body weight constituting the LD 50 for the gamma isomer, whereas it took 200 milligrams per kilogram of body weight of DDT to produce the same effect. Upon oral administration, they found that there was not so great a difference when it was applied in the same type of preparation. 200 milligrams per kilogram of body weight was the LD 50 for the gamma isomer, whereas with DDT is was 300 milligrams per kilogram of body weight.

Now from this and from other tests which they ran, it is apparent that as a rule the gamma isomer was more toxic than DDT but not alarmingly so, particularly when you consider that as a very broad statement 5/10 of 1% concentration of the gamma isomer is roughly equivalent to 5% of the DDT in insecticidal value.

Slade, in 1945, delivered a lecture which received wide distribution. In this lecture he pointed out, citing other lectures, that there was a wide variation in the toxicity of the four isomers when tested on rats. In summary, he found that the gamma isomer was six times as toxic as a mixture of benzene hexachloride isomers containing only 12% of gamma isomer. It was by far the most toxic of any of the isomers known at the time, of which there were only four. One of the disturbing features of poisoning by benzene hexachloride is the fact that it is not like DDT; it does not show any premonitory symptoms of poisoning which would appear in time to allow you to either cease the exposure to the material or provide symptomatic treatment. In DDT poisoning it is more often the case that you are able to detect symptoms of developing poisoning and correct the situation.

To date there has been quite a bit of work on the toxicity to domestic animals of benzene hexachloride, but it still leaves much to be done. The picture is by no means complete. Earlier, benzene hexachloride was unfortunately tested against several animals using materials of unknown isomer percentages, so it is a little difficult to make an intelligent interpretation of the results, but we can at least make some generalizations.

We found in the early reports that the rabbit and the cat, sheep, chickens and the pigeon showed a relatively high resistance or tolerance to benzene hexachloride. In the work which we have done here, we have applied benzene hexachloride as a suspension in sprays and dips and found that the toxicity of such materials was of a relatively low order. These tests have been carried out in the laboratory primarily on mice, and in the field we have done some work with cattle. In both of these groups of animals we found the toxicity of the material when applied as a spray or a dip to be less when the animal was prevented from licking its coat, indicating of course that some of the toxicant was picked up orally. The results of our work, particularly on laboratory mice, indicated that there was no marked toxicity to the animals from small dosages of benzene hexachloride applied over a period of a month at a time. However, this does not mean that there was not some storage of the material in the body, particularly in the body fat. We tried some feeding tests on cattle to decide whether we had a reasonable safety level so that we could go ahead and run dipping tests without fear of killing off someone's prize cattle. We found that there were no ill effects following administrations of as high as 88 grams of benzene hexachloride. By the way, it was not straight benzene hexachloride but a 50% mixture — the preparation which you so commonly see on the market. That was roughly 0.074 grams of benzene hexachloride per kilogram of body weight. That is equivalent to 2 gallons of 0.5% dip so we felt fairly safe knowing that the animal would have to drink two gallons of the dip to even approximate the figures we had obtained and found safe.

In laboratory tests on the comparison of feeding pure gamma isomer and a mixture of isomers, we found that the toxicity to animals is apparently due to more than just the gamma isomer, which was what we had expected. However, we cannot say that it is equivalent to the sum of the toxicities of the individual isomers, because we know that the gamma isomer is a stimulant to the central nervous system while the alpha, the beta and the delta isomers are all depressants, so there may be actually some antagonism between one and the other of the isomeric materials.

To return to the possibility of contamination of animal food products, with this material we find we have a very definite problem. Corey pointed out that it is stored in animal fat and we know that it is absorbed from the skin of cattle. When they are prevented from licking their coats we can still find evidence that it has been absorbed. We know that it appears in the milk on the day following treatment with a water suspension, spray or dip. You can actually smell the material in the cream, and if you smell it in your coffee cream in the morning you are not apt to enjoy it. We also know that it is in the flesh of the animals, primarily in the fat. One animal, a cow, was slaughtered ten days after a spray with 5/10 per cent BHC suspension. The meat was distributed among a number of individuals who were not told what the prior treatment had been, but were merely asked to give an oral statement of what they thought of the meat. We received definite indications that they all thought it had an off smell.

So far as longer periods go, we have tested up to thirty days and we can still detect traces of the benzene hexachloride in the meat after that period of time, although in a far lesser quantity than at the ten days period.

So we know we have some particular precautions to take. In other words, we are not going to recommend at present that a farmer spray his animals or dip his animals with BHC if he is going to slaughter them in a few days or if he has a milking dairy herd. It wouldn't be good practice. We also know that we must take particular care in the use of benzene hexachloride around poultry houses. Some of the results that have come out of this have been controversial so I am not going to make any broad claims. We have done a little work on it here and we know that it is OK to use in paint on roosts in preliminary tests. At least one report I have in mind appeared recently indicating that the reporters obtained similar results when benzene hexachloride was used as a paint or spray on the roosts only. This is not the case, however, when it is used as a general spray in a poultry house or when it is sprayed directly on poultry. I think probably a lot of you fellows read the article in Science where a marked flavor was found in poultry when subjected to similar treatment, and it was found that eggs picked up the odor. We placed eggs on strips painted with 10% benzene hexachloride for a period of 24 to 48 hours and, while they did have a very definite odor of benzene hexachloride on the shells, I was unable to detect any off odor when they were fried and served up as any ordinary egg would be. Maybe my olfactory sense isn't quite as good as some but it is at least reasonably on the average side.

We know that benzene hexachloride is quite effective against a wide range of insects among which is the hog scab mite. However, we don't have very much work to date, at least that I am well aware of, showing its effect on the hog flesh. Just to draw deductions from the work on other animals, you would expect to find the odor of benzene hexachloride penetrating into the flesh of hogs. It is a very fatty food product. A recent report from Dr. Lehman of the Food and Drug Administration indicated that he had treated an animal one day with benzene hexachloride and the next day slaughtered the animal and distributed the meat. Almost everyone thought that the meat was perfectly all right. This was just in the nature of a preliminary investigation and is not to be regarded as conclusive.

In conclusion then, there are no premonitory symptoms of poisoning with benzene hexachloride. It has, as an adverse feature, a very pronounced musty odor. Some day we hope to get away from that and maybe we will. It may produce a very pronounced nausea in man. If any of you have worked around it for any length of time you know what I mean. The spray or dust may cause a temporary irritation of the skin and especially of the eyes. You should avoid inhaling the dust vapor or mist wherever possible and also avoid unnecessary contact with the skin or with the eyes. Of course it goes without saying that contamination of food should be avoided.

Dr. Stewart: Thank you, Dr. Furman. I was hoping that something of this sort would be brought out in the symposium. Dr. Furman has presented in some detail the toxicity and tolerance of BHC, and I think above all has pointed out rather clearly the complexities involved in determining what these toxicities and tolerances are for organisms other than the one against which the insecticide is directed. This is, as was Mr. Lemmon's comment, the type of thing that should color our thinking during future investigations and applications.

The third speaker on this symposium will discuss a problem that has pestered us ever since organized mosquito abatement became at all prominent; that is to say, the prevention of undue interference with wild life. I use the term "interference," Dr. Cope, advisedly because it wasn't very many years ago that there was a great deal of conflict in thinking between many people engaged in mosquito abatement and many people engaged in the conservation of wild life. I think that that has disappeared now, thanks to the entrance into the field of wildlife protection of such men as Dr. Cope. Those of us who were controlling mosquitoes were quite convinced that we were more intelligent and more rational in our erstwhile purpose, and we rationalized our feeling by recognizing that in wildlife conservation there was a bad heritage. Many of those people were talking about something of which they knew nothing, and they were guided by sentiment rather than intellect or, in other words, they had nothing else to do except interfere with other people's affairs. That, believe it or not, was good for us because unfortunately we were not entirely right. We did learn, now some years ago, that there are responsibilities extending beyond the mere killing off the noxious organisms. Each year we look forward to receiving more new information with respect to our responsibilities to cooperate well and wisely with those who have the great public responsibility of protecting our natural resources in the form of animals that should be protected.

TOXICITIES AND TOLERANCES OF NEW INSECTICIDES IN RELATION TO WILDLIFE AND FISH

Dr. Oliver B. Cope

Aquatic Biologist, Division of Fishery Biology
U. S. Fish & Wildlife Service, Stanford University,
Palo Alto, Calif.

I wish I were in a position to bring the group up to date on the insecticides which we have listed in front of us here today but it is as much of a job for us to keep up to date as it is for other people interested in insecticides.

The growing tendency in mosquito control to take into consideration more and more factors of importance in the ecology of mosquitoes has focused attention on wildlife and fish and their susceptibilities to larval and adult toxicants. Not only have conservation interests become increasingly aware of the vulnerability of many animals of commercial and sports value, but mosquito control authorities have demonstrated considerable concern over the chances for damage to valuable animals. The problem of determining how much of each of the new insecticides can be tolerated by each wildlife species has been rendered more challenging by the rapid development of not only new insecticides, but of new solvents and new formulations as well. Coupled with the matter of a wealth of new substances with which to work is the extension of control measures into fields which might be considered as related to mosquito control. I have in mind such problems as the control of blackflies in running streams and the revival of attempts to suppress the Clear Lake gnat.

It has been extremely encouraging to note the inauguration of cooperative mosquito control investigations which make use of biologists to determine the toxicities of new chemicals to fish and game species while similar data is being accumulated for mosquitoes. Much useful information, concerning fish in particular, has been accumulated during the past few years by this means, and it is hoped that such work will undergo expansion.

Available information concerning bird and mammal tolerances of new insecticides has to do principally with DDT in various formulations. Testing has been done not only in the laboratory but also in practical field operations involving the low strengths used in some anopheline control programs and in the more substantial quantities dispensed for forest insect work.

Mammals have proven to be somewhat less susceptible to the poisoning action of DDT than birds. During tests at Patuxent Research Refuge in Maryland (Coburn and Treichler, 1946) involving single applications of DDT at rates of from one to four pounds per acre, no significant changes in numbers in the population have taken place. These tests were done against small mammals, as well as some large animals, including raccoon, skunk, opossum, woodchuck, deer, and squirrels, and no mortality was noted. The U. S. Public Health Service, in one study, treated an area once a week for 17 weeks at 0.1 pounds of DDT per acre. The results of trapping in connection with this study indicated that the numbers of cottonrats were comparable in the treatment and control areas during the course of the work. It was also established in this study that survival was about the same in the two areas, that movement in and out of the two areas took place to the same degree, and that the reproductive capacity of the rats in the sprayed area was not affected in any apparent way.

The dangerous level for DDT in oil appears to lie close to 5 pounds per acre, as far as mammals are concerned. Tests conducted at the Patuxent Research Refuge using DDT in oil at that rate resulted in 100% mortality among cottontail rabbits held for the tests. Airplane spraying over forests in Wyoming produced toxic reactions and some mortality among small mammals when two treatments at 3¾ pounds per acre were applied at an 8-day interval.

The food of mammals is sometimes affected by DDT treatments. At the Savanna Ordnance Depot in Illinois in 1945 (Couch, 1946) mosquito control spraying was carried on in a bottom woodland. The rate was 0.5 pounds per acre, and even though the strength was safe, as far as direct effects on the sizeable raccoon population was concerned, the treatment all but eliminated the crayfish, which represented a substantial part of the diet of the larger animal. A food substitute in the form of an abundant supply of acorns was utilized by the raccoon in this fortunate instance, and no damage was observed.

Some wild birds were tested with DDT in the laboratory at Patuxent in 1945 (Coburn and Treichler, 1946). These studies showed that quail would die with the oral administration of 200 mg/kg of crystalline DDT. Most small mammals can ingest up to 2500 mg/kg before death occurs. Birds such as pintail ducks and mallards showed toxic signs at 1000 mg/kg, but no kills were reported. Starlings tolerated up to 600 mg/kg without showing toxic symptoms.

In 1945, a large area near Scranton, Pennsylvania, was sprayed at the rate of 5 pounds of DDT per acre (Hotchkiss and Pough, 1946). It had been determined prior to the spraying that the avian population in the tract amounted to 3.2 birds per acre. Within 48 hours after spraying, 5 birds were found displaying DDT symptoms, as well as 2 dead birds and two abandoned nests. On the third day after treatment only 2 singing males were present in the entire 600-acre area. Two weeks later, the population had recovered to a point where there were 0.5 birds per acre. A year later the density of birds was about 85% of the pre-spraying population, and the species composition had changed to some extent.

In May and June of 1947, 400,000 acres of forest land in Idaho were sprayed in a tussock moth control program. The rate of application of the DDT was 0.95 pound per acre. Prior to the spraying, census work established that the area supported 435 breeding pairs of birds per 100 acres, and that a comparable place outside the treated area had 394 pairs per 100 acres. After the spraying, observations indicated that population declines of 9.5% in the study area and 10.6% in the check area had occurred. These declines were presumably due to completion of nesting, and none of the 44 species of birds suffered any apparent losses due to DDT.

Since the early days of DDT use, it has been known that fish are the least resistant of all the vertebrates to the action of this chemical. In addition, because of the nature of their environment they are vulnerable in mosquito control operations. Some of the necessary research leading to an understanding of the tolerances of fish to insecticides has been done, and we have today a fair idea about how much DDT can be tolerated, in addition to a few notions concerning some of the newer chemicals. There remains much to learn concerning the effects of the more recent insecticides on fish, but it appears that some generalizations can be made in relation to mosquito control activities.

DDT in fuel oil has been tested in the laboratory, in small ponds, and in streams. At Leetown, Virginia, aquarium and pond tests were made at 0.25 pounds per acre (Surber, 1948a). In these tests, bluegill sunfish were killed, while blacknose dace, creekchubs, spotfin shiners, common shiners, and bluntnose monnows were not affected. In stream tests in Alaska (Cope and others, 1947), trout and salmon remained unaffected after a 15-minute treatment period at 10 parts per million of DDT in #2 fuel oil.

Wettable DDT has proven to be less toxic to fish than some other formulations. It has been determined that under some conditions, 1.0 pound per acre of wettable DDT kills black crappies and bluegills, but leaves rainbow trout, largemouth bass, and golden shiners unaffected. In one laboratory test, (Surber, 1948a), wettable DDT was applied at the rate of ¼ pound per acre in 20 liters of water, killing rainbow, brook and brown trout. The same test run with 18 liters of water and 2 liters of settled mud resulted in kills of only a few brown and rainbow trout and no brook trout. The mud played its role here in activating the DDT. In streams in Alaska, wettable DDT dispensed at the rate of 10 parts per million produced no effects on trout and salmon.

DDT in xylene-Triton emulsion has proven to be a most toxic formulation. In some recent tests in California, this formulation was applied in laboratory tests at the rate of 1 part in 40 million. The test animals, bluegill sunfish, were all dead on the 3rd day after treatment. Stream treatments in Alaska also brought out the fact that the emulsion formulation is the most toxic known.

DDT in acetone suspensions has proven very toxic in aquarium experiments. Odum and Sumerford (1946) at the University of Georgia observed that this formulation at 0.1 ppm. would kill goldfish, at 0.01 ppm. would kill *Gambusia,* and at 0.001 ppm. would kill *Culex* larvae.

In stream tests in Alaska, acetone suspensions proved to be the least toxic of all formulations except wettable DDT when applied at constant rates for 15-minute periods.

In Idaho on the tussock moth control program mentioned earlier (Hanavan, 1948), DDT in Velsicol and fuel oil was applied at the rate of 0.95 pounds per acre. Even though some areas received more than their share of toxicant, trout, speckled dace, and red-sided bream were not affected. However, sucker, catfish, and cottoids were killed in large numbers.

In passing on to the newer insecticides and their effects on fish, we may first consider benzene hexachloride. In the two studies made on this toxicant and fish, the gamma isomer alone was used. One series of tests, conducted in still water in concrete daphnia ponds and aquaria at Leetown, West Virginia, gave favorable results (Surber, 1948b). The substance was applied at the rate of 1.0 pound per acre (.45 and .18 ppm.), and did not kill any of the fish, which included bluegills, goldfish, creek chubs, blacknose dace, common shiners, fall fish, bluntnose minnows, sculpins, golden shiners, and darters. The other study on benzene hexachloride was done in Alaska streams and involved a 15-minute treatment period at a constant rate. As a xylene-Triton emulsion, the gamma isomer gave no mortality in strengths up to 1 ppm. In similar tests in troughs, all strengths tried, from 1 ppm. to 15 ppm., gave some mortality. In stream and trough tests with acetone suspensions, benzene hexachloride was a great deal less effective against trout and salmon than was the emulsion, causing mortality at 15 ppm. and above.

Toxaphene has also been the subject of some recent studies in West Virginia and in Alaska. Those in West Virginia, conducted in still water, indicated that toxaphene has extremely poisonous effects on fish. Bluegills were killed at 0.01 ppm. or more, and it was fatal to trout at one part in 200 million (.005 ppm.). This easily puts toxaphene at the head of the list of new insecticides dangerous to fish.

The Alaska experiments with toxaphene in running water indicated strong toxicity, but not to the degree that the still water work did. Toxaphene in xylene-Triton emulsion produced substantial mortalities with salmon and trout after 15-minute exposure periods at all strengths over 3 ppm. in streams and over 5 ppm. in troughs. When toxaphene was tested in acetone suspensions, kills were noted above strengths of 5 ppm. Fuel oil solutions and Velsicol solutions were tested at strengths of 2 ppm. and below, causing no significant lethal effects.

Chlorodane has been tested and found to be less toxic to fishes than toxaphene. At Leetown, West Virginia, recent tests at .04 ppm. in still water failed to kill several species of warmwater fishes, including bluegills, goldfish, and several minnows. Toxaphene killed all the fish tested at that strength. Chlorodane at 1 pound per acre (in this case 0.16 ppm.) killed 87% of the bluegills tested.

In streams and troughs in Alaska, Chlorodane proved to be more toxic to trout than DDT and similar to toxaphene in emulsion form in 15-minute treatments. Strengths of 8 ppm. and above caused mortality in this formulation. Chlorodane in acetone suspension was not toxic to trout in any strength tested below 30 ppm. In Velsicol solutions, Chlorodane proved to have no effect on trout in strengths below 15 ppm., and in fuel oil solutions up to 6 ppm. no damage was noted.

Recent aquarium experiments (Surber, 1948b) on tetraethylpyrophosphate showed that bluegill sunfish die at strengths of 0.3 to 0.6 ppm. of the chemical, indicating that these fish are more tolerant of this substance than of some of the other chemicals mentioned above.

As far as I am aware, only one large-scale study of the effects of TDE on fish has been made. That investigation was carried on in November of 1947 by the U. S. Bureau of Entomology and Plant Quarantine and the California Division of Fish and Game at Lower Blue Lake, California. In laboratory tests, it was determined that TDE emulsion was approximately one-fifth as effective against bluegills as DDT emulsion. In a practical treatment in the lake at 1 part in 45 million, black crappies were the only fish to suffer appreciable mortality.

In any consideration of the effects of poisons on fish and game animals, the matter of toxicity to food animals should be investigated. In the cases of the chemicals under discussion today, only meager information is available concerning their effects on food organisms. There are a few cases known in which wildlife was definitely affected through damage to food through the use of DDT. The instance cited above, in which the elimination of crayfish through the use of 0.5 pounds per acre of DDT affected raccoons, is an example in point. At Savanna Ordnance Depot at 0.5 pounds per acre, DDT treatments were shown to be responsible for the disappearance of all swallows in the area. The damage was to the food supply, and not directly to the birds themselves.

A few new insecticides have been tested against organisms serving as fish food in lakes and streams. DDT at the rate for anopheline control, 0.1 pound per acre, is not considered harmful to any part of the food chains that have been studied. It is possible that at the higher dosages used in culicine control, some damage may occur to food organisms. At the rates usually used in forest insect work, DDT has been harmful to aquatic life, and at anything over 1 pound per acre must be considered detrimental. Even at this rate, 50% to 90% of the stream bottom fauna in small streams is usually eradicated.

In the stream work done in Alaska in 1947, it was found that the dominant fish food items, the caddice larvae, were more resistant to every insecticide tested than were the trout and salmon. These insecticides were DDT, benzene hexachloride, toxaphene, and chlorodane, and were applied as emulsions, acetone suspensions, and, in some cases, as fuel oil solutions and Velsicol solutions.

In the case of the TDE work done on Lower Blue Lake, California, fish food organisms were definitely affected in the lake treatment at 1 part in 45 million. A substantial reduction of zooplankton and midge larvae resulted, and some damage to shore fauna was noted.

What does all this mean in relation to mosquito control? Keeping in mind that at the American Mosquito Control Association meeting in 1947, it was generally agreed that 0.1 pounds per acre of DDT is usually adequate for anopheline control and that somewhat larger dosages are required for culicine larviciding, it seems possible to determine whether fish in most waters of moderate depth and game animals are being endangered in some mosquito control treatments.

In the case of DDT and wildlife something over 1 pound per acre seems to be a safe level, while for fish a figure of 0.2 pound per acre would apply.

For benzene hexachloride in mosquito control, it is indicated that up to 1 pound per acre may be safe for wildlife, fish, and fish food organisms.

Chlorodane appears to be damaging to some fish at 1 pound per acre.

Toxaphene has proven to be the most toxic of all insecticides discussed in this paper, and is considered unsafe for bluegills at 0.1 pound per acre and unsafe for trout at an even lower rate.

Tetraethylphyrophosphate is probably much less damaging to fish than DDT.

TDE appears to be about 1/5 as toxic to warm water fishes as DDT.

We have a great need for more investigation on the effects of these and newer toxicants. Until this is done, the picture will not be clear enough for making accurate predictions concerning the fates of fish and game on exposure to mosquito control treatments.

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Dr. Stewart: Dr. Cope has given us some very valuable specific information. Valuable as that is, he has given us something even more valuable. In the first place, he has wisely and scientifically admonished us that if we are to avoid destroying things of value to each one of us we must exercise great caution and employ accurate information. But by no means least, he has given you explicit examples of that thing which Professor Herms has preached to this group — namely, that we must have an ecological appreciation of what we are doing or what we may be doing. Dr. Cope has pointed out very clearly that, unless we think in ecologic terms, we may do very great damage innocently — that is, we may feel that we are destroying, in addition to mosquitoes, only something of no economic importance, and yet at the same time we may be contaminating or killing something of very great importance to the sustenance of these animals we may think we are protecting.

The last speaker on this symposium, Dr. R. L. Usinger, has had a great deal of experience during the recent war as a member of the United States Public Health Service, in the employment of some of these new insecticides to kill mosquitoes in close proximity to humans. Therefore he is a most appropriate member of this symposium.

TOXICITIES AND TOLERANCES OF NEW INSECTICIDES

R. L. Usinger,
Assistant Professor of Entomology
University of California

Mr. Stead found this morning that it would be necessary to alter his remarks according to what his predecessors had said during the program. I am the last speaker of the day, so it is necessary to cross off everything said by anyone else.

Dr. Cope in particular, covered a great deal that I am interested in, some of which I would have had to say had he not covered it. He did leave an area to be developed slightly, namely the subject of the fish food insects. We, as entomologists, are called upon to know what some of the newer insecticides do to whole groups of insects that may be involved in fish food and that come into the picture with other wildlife.

I recall, when I think of this subject, and some of you will recall it too in an amused way, the story late in 1942 or early in 1943 when the first precious allotment of DDT arrived in our hands. At that time M. A. Barber was experimenting with DDT. He applied it with a medicine dropper and reported complete control. The only trouble was that he had difficulty in checking his results because the DDT would contaminate his controls and kill all those mosquitoes too. At that time, the statement was facetiously made that all we would have to do would be to go up into northern Canada with a medicine dropper and treat large bodies of water and then the ducks flying south would carry the DDT and control mosquitoes all the way down. At that time it was very popular to view with alarm the biological deserts that were to be created by the use of this insecticide, so it was with a great deal of trepidation that I tried my first DDT in waters around Savannah, Georgia, at the Carter Laboratory in 1943. My first interest, being an entomologist, was its effect on insects other than mosquito larvae. I was very impressed with the selective action. Fortunately, as subsequent work has confirmed, DDT does seem to select the insects we are interested in.

A great deal of water has gone through the spray nozzle along with DDT since then and it is quite false to state at the present time that we don't know what harmful effects will be caused by DDT and some other of the new insecticides. Dr. Cope has shown the enormity of our knowledge on this subject. Don't be fooled by his remarks and think that you can run to published literature and find all that he said. A great deal of the work he reported has not been published and represents results from his own work within the last few months in Alaska, but there is a great deal that is available in the literature and I am going to call your attention to two or three of these papers which have come out of that same laboratory in Savannah, Georgia, and out of the work of the Bureau of Entomology and Plant Quarantine.

Tarzwell has been in charge of the work on the effect of DDT on aquatic organisms at Savannah since 1944 and has had an excellent opportunity to study the matter from the practical standpoint that interests everyone in this room. There has been a routine malaria control project there for the last seven or eight years, and quite a background of malaria control prior to that time. So when Tarzwell arrived in 1944, they swung over to DDT as a routine malaria control practice. So far as I know, they were the first ones to do that as a routine measure and at this time they have something like three years of routine application behind them, so they have a lot of factual knowledge. The reports are now coming out. The first one appeared in Public Health Reports for April 11, 1947, on the effects of routine DDT larviciding on surface organisms.

I will give you a very brief summary of the results. This is on surface organisms and concerns everyone, particularly in their work on *Anopheles* control because of course the *Anopheles* larvae are at the surface. They found that DDT dust was the safest method of application. One tenth of a pound per acre had no appreciable effect at all on other organisms and it did kill the *Anopheles* larvae. DDT in fuel oil, at 2/10 of a pound per acre, killed fish rather significantly but dropping down to .025 pounds per acre, the fish were not killed and they obtained very effective kill of certain insects. What I wish to stress is what happened to these groups of insects. Certain groups were killed completely; others were unaffected. The dyticids were killed completely at 25/1000 and 5/100 per acre, as were Gyrinidae, Hydrophilidae and Carixidae. Chironomids and Ephemerids decreased while Olisochaeta, Nematoda and Copepoda increased.

The second report on the Savannah project was published by Bishop (Public Health Reports, August 20, 1947). This report is concerned with the effect of routine application of DDT larvicides on plankton organisms. It was found that DDT at the usual strengths had no appreciable effect on plankton organisms.

Finally the work by the Bureau of Entomology and Plant Quarantine by Hoffman, Tonines, Sailer, and Swift (E-702, August 1946) shows that when pond insects are killed the population builds up again within a short time because of the rapid life histories of most pond insects. In contrast to the DDT treatment of streams it decreases the insect population for one or more seasons because the life cycles of many stream insects are very slow.

From a limnological point of view the most important effect of elimination of whole groups of insects is the interruption of essential links in the food chains of aquatic communities. Elimination of such basic herbivores as carixids or Ephemerids may destroy the "key industries" of a community and thus upset the balance of other organisms including the fishes.

Prof. Stewart: I wish to thank the group who have just presented their subject matter so effectively and in doing so I repeat the thought that I made in my opening remarks: symposiums such as this are not only desirable luxuries but urgent necessities. It was hoped that ample time would be left after the presentation of these papers to allow for a large measure of discussion, but I am going to take the liberty of suggesting to the Chairman that the hour and the long exposure to hard seats, be taken into account in guiding his next move.

Mr. Robinson: Well, you're right on the five o'clock, and I want to thank you and your gentlemen here who carried on this symposium very well. From a layman's point of view I certainly enjoyed it. However, I realize that there probably are some questions that may be of value to us while we have these gentlemen here and, if there is no objection, we might carry this on for just about five minutes and then adjourn—if there are any important questions that you would like to ask for just a very, very few minutes, because we have to be back here at 7:30 this evening. If there are questions, we would be glad to have them. Apparently we all want to go home and get going.

Mr. Peters: Just a minute before you go; I want to make this announcement. At 7:30 tonight there will be a meeting of the California Mosquito Control Association. You are all invited to attend, and the Managers of the Districts and Trustees are requested to ***attend.*** Has everybody registered? If not please do so right here before you go out.

Mr. Robinson: The session is adjourned.

THURSDAY EVENING, FEBRUARY 12, 1948

Mr. Geib: The meeting will please come to order. Before we officially get under way, I would like to call your attention to these gray folders before me. George Umberger and Jack Fowler of the Sacramento-Yolo County Mosquito Abatement District, have prepared a report on their district's experiments with DDT aerosol applied to Camellia plants. These copies of this report are for distribution to managers of the various districts. (Note: see page 86.)

While we are waiting for the arrival of some of the late comers, perhaps it would be an opportunity for Dick Peters to touch on the problems involved in putting out the "Buzz."

Mr. Peters: With pleasure. I expect, to the majority of you who receive the "Buzz" each month, its reception is accorded only casual consideration; I asure you that such is not my attitude on this subject. To me it is a question of either including contributions from each of you as they are sent in, if they are sent in, or else I am forced to "dream up" news which may or may not be of interest to the various districts. It is true that I travel about the State considerably, and manage to dig out certain items in the course of such trips, but contributions coming that way lack the district's direct viewpoint and lack continual cross-sectional expression from districts throughout Ctlifornia. Items presented second-hand may not represent exactly what you were originally thinking, so I suggest that those districts having something new going on of interest to themselves, who may think it is of local interest alone, might well send it in. By submitting such for editorial review or interpretation, chances are it may be something that somebody else is doing, and if your little bit is more or less similar to somebody else's little bit, pretty soon it becomes a story of interest to many. In the last issue, I could have filled the entire "Buzz" with items from the Merced County Mosquito Abatement District. For some reason or other, Wes just really did himself proud. On other occasions there has been a complete void from the same district. I don't want to exaggerate one way or the other. For a while, Ted Raley and his staff came through so consistently that there was an overflow of Consolidated items, so that I had to call them "Consolitributions" as you probably at one time saw. Rolland Henderson has come through with some very fine drawings, so he is exonerated. Gregerson came through with something just recently and he made the "Buzz" this time and was even featured. The first time he submitted something he didn't get it in, so I don't know whether his feelings were hurt or whether he wanted to try again, but he nevertheless persisted until he got something in. Herb Herms has been persistent from the Sutter-Yuba, likewise Dick Sperbeck and their elongate improvisor has got two articles in — I refer to Bill Miller. Essentially we haven't got enough news value of personnel other than the actual Managers of the districts or the activities of the districts themselves. I think that if you will dig down deep into your staff you will find that they are doing things that are of interest to the vast majority of readers of the "Buzz." Whether it sounds like something stupendous or not doesn't mean that it isn't worthy of contribution. The thing I want to emphasize is that we can probably use it at some time or another. I have thought, and in fact it has been discussed in the Executive Committee meeting, that we might possibly assign each district a time when they ought to turn something in, but that would make for anything but meaty news. It would be a forced proposition. It wouldn't have the crispness and news value — the human interest. I am not in favor of any forced monthly submission from districts, but I do feel — and I make the appeal to you — that whenever you have anything — it doesn't matter what it is — whether it sounds outstanding or not, try sending it in and give us an opportunity to compile it with other things, and perhaps it will turn out to be something worth while after all. I think one of the things that every district likes to see is first of all their district mentioned, and secondly, the individuals in their district mentionel. Those activities that they are performing are things that other districts begin to wonder about, and pretty soon you find that other districts are going to try the same practices and make use of them. Ted Raley, for instance, got an interesting and very informative outline for his inspectors, which he has passed out to all his personnel. I mentioned this in this issue of the "Buzz," and I think it is worthy of consideration by all of you. That kind of information is initiated within a district, and the way it can be appreciated by all is by getting it into circulation, and the "Buzz" is the best and simplest means. I mentioned in this issue that Wes Ewing has started a supplement to the "Buzz" for individual consumption by his personnel. Since he has a big staff, and since we can't give quite enough attention to his items of local interest, he has taken that course. I don't think it is indicated in every case for each district to do that, but for the smaller districts we can certainly use whatever you have and above all I go for drawings. I think that drawings are extremely desirable. I know that Elmo Russell has been improvising things right and left down there and I have been hopeful that he was going to send some of his creations to the "Buzz" so that they could be featured, but so far we are still waiting for that contribution, Elmo. Likewise Ernie Campbell. Ernie has been doing some things there that are novel. We are still waiting for that, Ernie. So that is the message I want to deliver. I haven't given up hope, but I just merely turn it back to you. If you don't like the "Buzz" the way it comes out, why you'd better do something about it.

Mr. Geib: We've heard about this from Dick Peters and others of us but I do think it's time we ought to get behind Dick and give him a little assistance, and I think perhaps a story once in two months would do it. If he got one every two months from each one of us he would have more than enough to take care of the news for the "Buzz." We can joke about it, but at the same time I think it is really very important. It is a medium of exchange of ideas for the personnel of the districts. It will also surprise many of you to learn about the circulation and the various places to which the "Mosquito Buzz" goes. I don't doubt but what some of you have had the same experience that we have in Kern. There was an article in the "Buzz" about the modification of aerosol on the jeep. We got a request from Virginia for a diagram on the operations and modifications simply because that person was on the mailing list for "Mosquito Buzz" and had seen it there. So it is very important. Let's be serious about it and see of we can't give Dick a hand on it.

Mr. Peters: You will be interested to know that a thousand copies of this issue of the "Buzz" were printed, so you see the circulation is growing.

Mr. Ewing: I am very much interested in district exchange of information on their activities and would like to see that developed. I think a lot of other people would, too. However, not all of us have the necessary facilities. With the equipment I have I believe I could agree to send a copy of any new innovations to anyone interested.

Mr. Geib: Either that or send it in direct to the "Buzz" and let the information be circulated in this way.

Mr. Ewing: Much of it is too lengthy.

Mr. Geib: In that case it would be very appropriate to distribute it through the districts. I am sure that most of the districts would be interested in the report that Ed Smih prepared on the airplane activities in Merced County. Is that report mimeographed or typewritten?

Mr. Ewing: Typewritten.

Mr. Geib: Well, I think we have waited just about as long as we can wait to get this thing going here. The next thing on the program is the "State of the Association" by myself. Actually it is the report of the Executive Committee.

ACTIVITIES OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION — 1947

By A. F. Geib

The 15th Annual Conference, held December 14 and 15, 1946, covered a period of only a day and one-half, and a minimum of time was devoted to business affairs of the Association. If you care to go through the last proceedings you will note this to be the case, and also that most problems of the Association brought before the membership were referred to the Executive Committee for study and action. This procedure has been the practice in the past and will probably continue in an organization such as this, that meets only once a year for a two or three day period.

The members of the 1947 Executive Committee at their first meeting, held January 28, 1947, at Berkeley, quickly learned that they were in for plenty of work in attempting to do justice to the affairs of the Association for 1947. Among the many factors which made it necessary for the Committee to devote so much time to Association business a few were:

The custom of conducting Association business only once a year.

The phenomenal growth of mosquito control activity in California.
The use of new insecticides.
New control techniques and equipment.
The need for legislation.
Requirement of districts in fulfilling the obligations of effective mosquito control and adequate reporting under the State Subvention program.

You will recall that during the past two years there has been considerable interest on the part of members of the Association concerning the possibility of establishing the Association on a more formal basis than now exists. The interest also extends to the possibility that the Association incorporate and support a full-time Secretary to conduct the business affairs of the Association on a year-round basis. In view of this interest probably the most important business and perhaps the most controversial was the appointing of a Committee to draw up a Constitution and By-Laws for the Association. All districts have received copies of the proposed constitution and by-laws submitted by the Committee, and consideration of these documents will be held later on in this meeting. The proposed Constitution and By-Laws have been studied, discussed at length and adopted in principle by the Evecutive Committee. The Committee goes on record as recommending that the Constitution and By-Laws be followed during the calendar year 1948 as the structure for the Association's functions, with the further recommendation that if they prove satisfactory they be adopted by the Association at the next Annual Conference (1949).

I would like to continue this message by reading to you in detail the minutes of each meeting held by the Executive Committee this past year, but I am afraid we would be two hours or more doing so and time will not permit. Therefore I will mention in sequence those things that were discussed and acted upon and briefly elaborate where advisable.

FIRST MEETING, BERKELEY, JANUARY 28, 1947

1. *Rate of Assessment for Fiscal Year 1946–47.* A rate was set at $1.00 per $1,000.00 of local budgeted funds, as the old rate assessed districts was insufficient to support the cost of publishing the proceedings.

2. *Meeting of Members of Boards of Trustees.* Chet Robinson acted as host at a meeting held at Modesto, May 17, 1947, for Boards of Trustees. It was hoped that such meetings would be of educational value to Board Members.

3. *Association News Sheet.* It was agreed that another method of keeping Board members informed about mosquito control activities could be accomplished by publication of a paper. Such a paper would act as a clearing-house for information to districts and other agencies. Consequently the *Mosquito Buzz* emerged and took wing, published cooperatively by the Association and the Bureau of Vector Control, State Health Department.

4. *Executive Secretary.* Due to the present attitude of Boards of Trustees concerning the need for establishing a full-time office of Executive Secretary, and in view of the present expanded condition of the State Mosquito Control Section, which allows for partial assumption of the proposed function, it was agreed that action to create this position be postponed for one or two years pending realization of closer cooperation of Boards of Trustees with resultant expected appreciation of a need for such a function, and the possible eventual recession of State participation to the point where the State can no longer continue this function. This matter will be reconsidered from time to time.

5. *Mosquito Control Legislation.* Six Assembly and two Senate bills amending the Mosquito Abatement District Act to benefit individual districts were sponsored and submitted to the State Legislature in the name of the California Mosquito Control Association.

6. *Classification of Mosquito Control Personnel and Functions.* A schedule of functional classification and wage scale was compiled and sent to the districts as a guide for personnel standardization.

7. *Section Plan of Mosquito District Mapping and Recording.* A plan for mapping and recording was developed and sent to the districts to be used as a guide.

8. *Sutter-Yuba Ground Exhaust Aerosol.* It was recommended that Ted Raley publish data regarding his aerosol unit and its operation to protect against possible patenting by others.

SECOND MEETING, BAKERSFIELD, MARCH 20, 1947

1. *Alameda County Mosquito Abatement District Agreement to Contract with California Mosquito Control Association.* Inasmuch as the Alameda County District Attorney ruled that the Alameda County Mosquito Abatement District must enter into a contract agreement with the California Mosquito Control Association, in order to make that district's contribution to the Association legal, Harold Gray submitted a prepared "Agreement" which was approved by the Committee with one minor change. The Secretary was authorized by the Committee to sign the terms of this contract for the Association, and the pattern used in the case of the Alameda County Mosquito Abatement District was approved for use by the Association in the event other districts wish a contract between themselves and the Association.

2. *Appointment of Committees on Constitution and By-Laws.* A letter written by Ernest Campbell, Superintendent of the North San Joaquin and Contra Costa Mosquito Abatement Districts, was read to the Executive Committee with its reply by the Secretary, leading to the adoption of a motion that the President appoint a five-man committee, composed of Managers and Superintendents of mosquito abatement districts, to draft a proposed charter and by-laws for the California Mosquito Control Association, same to be completed and rendered to the Executive Committee 30 days previous to the next conference. Named on this Committee are Ed Washburn, Chairman, Ernest Campbell, Roland Henderson, Dick Sperbeck, and Thomas McGowan, with Pete Pangburn an alternate.

3. *District Investigation Act Affecting Mosquito Abatement Districts.* Regarding the possible reversion of the Districts Investigation Act to mosquito districts 91 days after the close of the current legislative session, the Secretary was directed to inquire of Senator Carter the status of his Committee's action along the lines of removing for all time mosquito abatement districts from the provisions of this Act.

THIRD MEETING, MODESTO, MAY 2, 1947

1. *Need for Association Budget.* In response to a request by Ernie Campbell for an itemized budget of the

Association, a committee consisting of Chet Robinson, Harold Gray, and Dick Peters was appointed to develop a budget based upon the cost of publishing the annual proceedings and the *Mosquito Buzz.*

2. *Operations Manual of the California Mosquito Control Association.* Discussion was held regarding the most practicable way by which individual districts could receive technical memoranda on mosquito control techniques and retain them as a guide to operating procedures. Mr. Dahl offered the services of the Bureau of Vector Control in editing and transmitting to the districts technical and administrative memoranda. It was agreed that binders be issued to member districts and other designated agencies to contain such data and receive additional inserts from time to time. Each insert, though released through the California Mosquito Control Association, will bear the footnote, "Submitted by the Author; Edited and Transmitted by the Mosquito Control Section of the State Department of Public Health." Material before being included in the manual will be approved by the Executive Committee.

3. *War Assets Administration Sales Procedures.* Chet Robinson reported on his investigation conducted here and in Washington regarding the inability of districts to purchase surplus property due to the priority system. He learned that any likelihood of modifying or changing the priority system was very remote.

4. *Mosquito Control Problems Developing from CVA.* A committee consisting of Chet Robinson, Arve Dahl, and Ted Raley was appointed to acquaint authorities in Sacramento with the potential mosquito problem to be created by the Central Valley project and ask for cooperation to keep mosquito breeding to a minimum. The Executive Committee was subsequently informed that once the water enters canal systems of irrigation districts it becomes the responsibility of the irrigation districts, therefore the CVA could be of little help in preventing mosquito breeding situations developing as a consequence of CVA.

Fourth Meeting, Berkeley, July 17, 1947

1. *Amendment to Mosquito Abatement Act Permitting Cities to Annex to Districts by Resolution.* It was decided that such a legislative amendment would be prepared by Harlod Gray and submitted at the next Annual Conference.

2. *Mosquito Control Expert to Follow and Study CVP.* It was recommended by the committee that the Bureau of Vector Control see about obtaining the services of a USPHS Engineer to study and follow the construction of the CVP and make recommendations to eliminate and alleviate mosquito problems developed therefrom.

3. *Legality of Board of Supervisors or City Council Member Serving on Board of Trustees.* Chet Robinson was appointed to investigate and obtain an opinion from the Attorney General in this matter.

4. *Harold Gray Appointed to Investigate Legal Status of League of California Cities to determine steps to gain legally acceptable status for the Association.* Mr. Gray reports that the league offers no satisfactory pattern for the Association to copy and recommends that the Association eventually take steps to incorporate. It was agreed by the Committee not to seek incorporation at present time.

Fifth Meeting, Modesto, October 31, 1947

1. *State Laws Covering Use of Irrigation Water.* Ed Washburn and Chet Robinson were appointed to obtain information regarding laws covering use of irrigation water.

2. *District Assessment Set for 1947–48.* Assessment of districts was set at the rate of $2.00 per $1,000.00 local budgeted funds to support Association activities—mainly the cost of proceedings publication and distribution of the Operations Manual.

3. *Expression of Appreciation to Committee on Charter and By-Laws.* The Secretary-Treasurer was instructed to prepare and transmit to the committee on Charter and By-Laws an expression of appreciation of the Executive Committee for completing its assignment in so comprehensive a manner.

4. *Annual Conference.* It was agreed to hold a three-day meeting in the middle of February.

5. *Evaluation of State Forms Used by Districts.* A committee consisting of Ed Smith, Ed Washburn, and Dick Sperbeck was appointed to re-evaluate State forms used by districts.

6. *Mosquito Control Advisory Committee Re-Organization and Expanding Scope as Vector Control Advisory Committee.* It was agreed that two members from the California Mosquito Control Association serve on this committee, and Ted Raley and Chet Robinson were referred to the State Department as representatives from the Association for 1948.

Sixth Meeting, Tulare, November 13, 1947

1. *Association Financing.* A committee consisting of Ted Raley, Harold Gray, Dick Sperbeck, Ed Washburn, and Jack Kimball was appointed for the purpose of studying the possibility of obtaining financial assistance for the publications and activities of the California Mosquito Control Association.

Seventh Meeting, Modesto, January 9, 1948

1. *Distribution of Operations Manual.* It was decided to confine distribution of the Operations Manual to:

a. Fifty copies for local California mosquito control agencies.

b. Single copies to the following:

(1) American Mosquito Control Association,
(2) Virginia Mosquito Control Association,
(3) New Jersey Mosquito Extermination Commission,
(4) Florida Anti-Mosquito Association,
(5) T.V.A., Wilson Dam, Alabama,
(6) U.C. Division of Entomology and Parasitology, Berkeley,
(7) U.C. School of Public Health, Berkeley,
(8) U.C. School of Public Health, Los Angeles,
(9) U.S.D.A., B.E.P.Q., Orlando, Florida,
(10) U.S.D.A., B.E.P.Q., Washington, D.C.
(11) U.S.D.A., B.E.P.Q., Corvallis, Oregon (inserts only),
(12) U.S.P.H.S., C.D.C. Headquarters, Atlanta, Georgia,
(13) U.S.P.H.S., Training Division, Atlanta, Georgia,
(14) State Health Department Library, San Francisco,
(15) State Health Department, Division of Environmental Sanitation, and

(16) State Health Department, Bureau of Vector Control, Berkeley.

2. *Association Financing.* Ted Raley, Chairman of the Association Financing Committee, reported upon his Committee's activities. His contacts of commercial organizations thus far indicate favorable prospect that they can be obtained as contributing sponsors of the Association. Most organizations prefer to enter into a contract with the Association by which they would receive advertising space in the Association publications. Ted recommended that inasmuch as the finances of the Association appear to be sufficient to assure its solvency through publication of the procceedings and Papers of the coming Annual Conference, it would be judicious to defer actual negotiations with commercial organizations until some time in the future, omitting any advertising in the next Proceedings and Papers. The Executive Committee concurred in this.

3. *Entomologists Committee.* In response to a request by the collective entomologists concerned with mosquitoes and their control, appointment of a committee to further their phase of activities was made. Entomologists of districts, other agencies, and representatives of the Bureau of Vector Control were appointed to this committee, with Ed Smith of the Merced County Mosquito Abatement District as Chairman.

4. *Workmen's Compensation Insurance.* Chet Robinson was appointed to investigate rates assessed mosquito abatement districts by State Workmen's Compensation Fund.

The Secretary-Treasurer, for the President, herewith expresses commendation to the 1947 Executive Committee, individually and collectively, as a group which devoted considerable time and effort beyond normal working hours, resulting in substantial furtherment of California mosquito control. The conciliatory attitude and the straightforward nature of this first Executive Committee of the California Mosquito Control Association make it a prototype worthy of being patterned after.

I wish to thank and express my commendation to the 1947 Executive Committee, individually and collectively, as a group which devoted considerable time and effort, resulting in substantial furtherment of California Mosquito Control. I want particularly to thank Dick Peters, Secretary-Treasurer of the Association, in behalf of both the committee and the entire membership for all the time he has given to business of the Association which he has so capably executed. The amount of time and work he has put in just writing minutes and editing the *Mosquito Buzz* has been very considerable.

In completion I would like to make one recommendation to the next Executive Committee, namely, that a copy of the minutes of each meeting be sent to all members of the Association so that all will be kept currently informed regarding progress of the Association Affairs.

Mr. Peters: As Art has indicated, much activity is involved in the affairs of this Association. I can recall the day — in fact I was Secretary of the Association before most of you can remember, except Prof. Herms and a few others such as Ernie Campbell and some of the others who were here earlier in the day — I can recall those days when being a Secretary-Treasurer was simple. It was just a matter of getting a small conference together. If you could have seen what went into putting this Conference on, you would appreciate that being Secretary-Treasurer is justified on the basis of annual conferences themselves; and the worst of all is that the work is just begun. All this stuff that is going on that little machine right now has to be transcribed and then edited. I don't know whether Harold Gray is going to do it again this year or not, or whether we are going to have to do it. Either way the undertaking is considerable and I think it warrants further consideration. as Art has suggested.

FINANCIAL STATEMENT

By R. F. Peters

Now for the "Financial Statement." When I started to say that this was a larger undertaking I was thinking in terms of two or three hundred dollars, which was about our maximum in days gone by. When I got the bank balance (not that I haven't kept rather close tab on it), I was even a little bit taken back by it, for it read $1712.10 — that is almost enough to keep one man employed all year round in a district. And that isn't yet a completed statement. I have a sad story to tell you. Some of you have not paid your dues. In fact I think I ought to be so indiscreet as to tell you who you are — not because I want to call attention to yourselves but because I think that it is opportune, and probably that letter coming out in cold purple ink, that Ted Raley so objects to, might have been thrown in file 13 before you had a chance to read it, which was probably an oversight.

I will start out by telling you who did pay your dues and the sequence in which they came in just to show you the order of punctuality. Redding Mosquito Abatement District No. 1 — and we haven't even got a representative from Redding here today; Coachella Mosquito Abatement District — who ever heard of Coachella Mosquito Abatement District? It's an area not even controlling mosquitoes. They are after gnats down there; Solano County Mosquito Abatement District — Pete Pangburn; North San Joaquin County and Contra Costa County — Ernie Campbell; Merced County — Wes; East Side — Chet; Alameda County — Harold, Tom, and Ted; Delano — Noel Omlor, not here; Pulgas — Dick Thomas, who isn't here tonight, at least I don't think I've seen him; Sonoma, who has no representative here today, maybe I'm mistaken; Sutter-Yuba — Dick Sperbeck, Herb Herms, and Bill Miller; West Side — I haven't seen Coburn; Consolidated — Ted; Marin County, and Marin County I think is owed particular mention for the nature of the contribution. I think this is the first contribution that has come from Marin County in nigh unto — I believe it is the first contribution from Marin County, period; but it is due chiefly to a rebirth of interest in mosquito control work in Marin County, and it has been stimulated largely by Paul Jones. I think he's doing a fine job. He's getting off to a good start; Fresno Mosquito Abatement District — Greg and Company; Turlock finally came through; Hanford; Orange County, after they had convinced their district attorney that it was a legal contribution on the basis of contractual agreement, which agreement I sent back to every one of you as you paid your dues; and then Matadero, Durham, Ballona Creek, Delta, Oroville, and Madera County, which was the last one to come through before the list got down in black and white.

'Now — those that have not come through but have promised; Tulare and Corcoran — Rolland.

Mr. Henderson: Mr. Secretary, I would like to tell you it was simply an oversight. I thought that it had been paid.

Mr. Peters: We have a gold-embossed assurance from the Kern Mosquito Abatement District that they will send forth their money. We are particularly interested in them because they have a good-sized check coming in. Among the other members that have a promissory note — the Monterey County Health Department which has done the same thing. Those are the ones that I have asked. The rest of you I haven't asked, so I trust that the same situation prevails that I mentioned earlier, that you failed to receive the letter, or buried it somewhere, or it hasn't had action taken on it Nevertheless our bank statement reads $1712.10 altogether, plus the recent contributions which I didn't mention. There is a total cash on hand of $1875.86 at this reading. I understand we are going to pay something for the reels inside the machine that is going now, So I'd better knock off something on that. I think when Chet gives the report ofthe Finance Committee he can tell you what the plans are for this money — how it is to expended, and estimate for you what the maximum amount is that we will obtain on the basis of this $2 per thousand dollars of local funds — $2 contribution or contractual agreement payment for every one thousand dollars of local budgeted funds. In the event a district hasn't got a budget amounting to five thousand dollars, then the amount will be $10 flat. So I appeal to you and hope it won't be necessary to send another letter out. If you haven't sent your contractual payment in, please do so as early as possible so that we can give the incoming Secretary-Treasurer a clean slate to work with so he knows where he stands and so the Executive Committee can function with a definite amount.

Mr. Geib: It really sounds encouraging. I am surprised that the sum is that great. Now Chet Robinson is going to report on what is going to happen to those funds.

REPORT OF THE BUDGET COMMITTEE

By E. C. Robinson

Mr. Robinson: It is a report of the Budget Committee; the proposed budget for the ensuing fiscal year.

Printing of the proceedings and papers of the annual conference. printing of the cuts and transcribing	1400.00
It is anticipated that we will have a nice printed book this year rather than the mimeographed sheets that we have used at previous times. That is figuring on a basis of a thousand copies.	
"Mosquito Buzz," paper, stencils, etc.	100.00
Operations Manual, miscellaneous expense connected with the Operations Manual	200.00
Miscellaneous stationery, stamps, phone, and other incidental expense	350.00
Assistance to the Secretary for work that he cannot do, such as hiring a stenographer in getting out these annual proceedings	150.00

This shows a total of $2200.00 budgeted expense for the ensuing fiscal year. This should leave us from our anticipated returns, when Art Geib and some of the rest of them pay up, two or three hundred dollars at the end of the fiscal year.

Mr. Geib: I guess it is not difficult to understand the increased cost of publication. We have all encountered the increased costs in operation of our districts. Just to get the paper and the printing comes to quite a sum of money. The more this activity continues to grow, the more financial burden the organization is going to have to support. And I wonder how long some of the Boards of Trustees will go along in making payments on assessments to the Association even at the rate we assessed this time at $2 for one thousand dollars of local budgeted funds. The time may not be too far in the distance when the tax dollar is not going to come through so easily, and every bit of money that is spent is going to be scrutinized pretty closely by the Boards of the various districts and by some of the tax experts in the counties in which we operate. When that time comes we may not be able to contribute what we would like to contribute to support the activities of the Association. That brings forth a very important consideration to this body. The problem has been turned over to Ted Raley as Chairman of the Finance Committee and I would like to have Ted report to the Association on that.

REPORT OF ASSOCIATION FINANCE COMMITTEE

By T. Raley

I have made no formal report and I think it might be wise in this particular case if we don't record it. I believe that the State Department of Public Health, Bureau of Vector Control, foresees the time when they must withdraw assistance to the Association. Such assistance as is provided by Dick Peters and any number of the men in the Bureau cannot be continuously given. We must seek other sources for aid.

Mr. Washburn: There is one thing that might assist us in selling our Association to those Boards which are not sold at the present time. I think the Boards should consider that it is a privilege for them to make contractual payments into this Association. The amount of those dues is another matter. There is one thing, however — a number of us who have operated districts for some time have put out informative pamphlets and sometimes at considerable cost. I do believe that if we could go back to our Boards and say, "here, I need ten thousand copies and these are being donated by the advertising in these copies that we have through the Association, and this promotional scheme has saved our district five, six or seven hundred dollars by getting these free pamphlets to put out house to house," there's the answer to several years' dues right there, and I think it is a point that we can well use.

Mr. Ewing: You will probably get several strong objections from other commercial houses in your district if you distribute any pamphlets with advertising of any kind on a house to house basis. I got my fingers very badly burned in the first year of the district by mentioning some of our equipment in a publication leaflet. Competitors objected very strongly.

Mr. Raley: I would like to know what you do think about it so the committee will know which way to move.

Mr. Geib: I think that's something we ought to seriously consider.

So that we might have a broader understanding of some of the problems that we are confronted with and what we have attempted to do in establishing the Association on a more formal basis, so that we could have some procedure to follow in conducting our meetings and carrying on business officially with the Association, a Constitution and By-Laws has been drawn up by a committee with Ed Washburn as Chairman. Without such a Constitution and By-Laws, it is practically impossible to carry on most of these things that we have been talking about tonight, and what Ed has to present here is the result of the deliberation that I believe took about seven months.

REPORT OF CONSTITUTION AND BY-LAWS COMMITTEE

By E. Washburn

Mr. Washburn: You have all received through the mail copies of the proposed Constitution and By-Laws. The committee has worked diligently and I may say hard. We have taken other Constitutions of other organizations and used those as samples or guides. We have followed rather closely the constitution that was adopted last year by the New Jersey Association. We of course adopted it to our own California conditions. We asked, when we sent these out to the districts, for comments from these districts either pro or con. We have received none either way. (Pardon me, Dick just mentioned that one had been received — one adverse. Otherwise we have received none, which we take to mean that this was pretty well accepted in general. We turned this over to the Executive Committee some time ago and it was hashed over by them several times, and I have on the table tonight copies of the most recently revised Constitution and By-Laws. It varies a little from the one we sent to you. Variations are principally in sentence structure and terminology. The basic thought behind the constitution is still the same as it was when it was submitted to you. I don't know whether there are any questions or whether I can even answer them, but the members of the committee are here. The members who served with me on the committee are Dick Sperbeck, Ernie Campbell, Tom McGowan, Rolland Henderson and Pete Pangburn. So if I can't answer some of the questions, perhaps some of these fellows can. I trust there are not too many questions about it. Are there any questions before we go further with this report? If not, then I believe this will come out eventually as a part of your Operations Manual — in fact, I know it will. Mr. Chairman, at this time I would like to present this to the Association and move its tentative adoption in 1948.

Mr. Geib: Consideration of these documents will be held later in this meeting. The proposed Constitution and By-Laws have been studied, discussed at length and adopted in principle by the Executive Committee. The Committee goes on record as recommending that the Constitution and By-Laws be followed during the calendar year 1948 as the structure of the Association, with the further recommendation that if they then prove satisfactory they be adopted by the Association at the next annual conference.

Mr. Washburn: I'll make the motion in that form, in order to get it voted on by the group and accepted by the group.

Mr. Raley: I'll second it in order to make it formal.

Mr. Geib: Question? Have you heard the motion? We have a second to the motion. Is there any discussion?

Mr. Robinson: Are there any changes since it left the last Executive Committee meeting?

Mr. Geib: No. Basically it is still the original Constitution written by the Committee. There were modifications and changes and there was thought of going to the other type of Constitution and By-Laws. However, eventually we swung back to the other one and adopted in principle almost exactly what the committee had originally proposed. Wording is the only change. Any further discussion? All those in favor of the motion say "Aye." Those opposed. It stands as approved, under the aforestated condition.

Ed. on behalf of the Association I want to again thank you and your Committee for all the work that you have put in on this. You have done an excellent job, as I believe everyone will agree, particularly after they have had time to really study it.

Now we have a report from the Program Committee. It looks like I have to report on that.

REPORT OF PROGRAM COMMITTEE

By A. F. Geib

I think most of the program work is rather self-evident. I might elaborate upon that slightly by saying that we attempted to get as many Eastern speakers as possible to this Association meeting. I think we have about three present. At one time it looked as though possibly six or even seven would come out. I think what happened is that most of them feel they would rather attend the Assotion next year when it looks as though the American Mosquito Control Association will have their annual meeting here in conjunction with our own meeting, and most of them are probably planning on coming to California at that time. Dick Peters, Ted Aarons, Wes Ewing and myself sat down and worked out this program. Once again, I forgot to tell you that Dick Peters has borne the brunt of all the work. He, other than contacting the Eastern speakers, contacted everybody on the Coast, had to take care of reservations, and he was busy clearing correspondence on program for two months. Thanks again, Dick. I have nothing further to add on the report of the program committee at this time.

Mr. Raley: Has anything ever been done about naming Dick Peters Executive Secretary?

Mr. Geib: Thank you, Ted. I meant to bring the matter up but I overlooked it entirely. You will see as you go through the Constitution and By-Laws, as adopted tonight for a year's trial, that the members are made up of the districts. Historically, that has been the case ever since this Association began functioning, that the members have the right to vote, that they will put into office a President, Vice-President, and Secretary-Treasurer. But the constitution is now so written that the Committee can appoint an Executive-Secretary and that person can be any individual. Right now I think the Executive Committee would be inclined to appoint some manager of a district if it were possible for some manager of a district to devote his time and attention to it. But we are not in a position to do it. In all likelihood, the Executive Secretary appointment would probably be our good friend, Dick Peters. He doesn't like the idea, but he will have to do a lot of wriggling to get out from under.

Mr. Peters: I would like to say one thing. I haven't mentioned anything about this before but I feel that the State Health Department should come in for a pat on the back, because I get paid by them. So far as I am concerned I like the activities of the Association. I enjoy it and I think it is a very constructive and a very necessary function, but the people who pay my salary, including that third child dependent, are the State Health Department. I feel that they are represented and misrepresented often. I don't think they are as sinister as has sometimes been attributed. Nevertheless, under the circumstances I do think that you are bound, with the present financial limitations of the Association, to utilize their services, whether you wish me to do it or someone else from the State Health Department, such as Arve Dahl, Frank Stead and Dr. Halverson. It's up to you. I'll do the very best I can in this capacity. I think that a measure of thanks ought to be extended to the State Health Department for the use of their funds for the purpose.

Prof. Herms: Do we have a Resolutions Committee?

Mr. Geib: I believe that's one place where the Program Committee probably slipped up. We don't have a Resolutions Committee, so I will appoint one. Ed Washburn, you do a good job, and Tom McGowan and Roy Wilson. You have been appointed on the Resolutions Committee and one of the Resolutions we would like to have before we close is one of thanks to the State Health Department for their assistance and contributions — and to the University very definitely for the facilities that they have let us use here in holding this meeting.

Prof. Herms: I couldn't very well make a motion as suggested regarding the State Health Department because I am one of their consultants, but so far as the University is concerned I can suggest that the University be thanked.

Mr. Geib: I see Ed Washburn is busy with writing already, so I think we will have something.

The report of the Forms Committee will now be given by Ed Smith.

REPORT OF THE FORMS COMMITTEE

EDGAR A. SMITH
Chairman

Mr. Smith: The daily operational report form was devised last year by a joint committee of district managers, entomologists and mosquito control specialists from the State Department of Public Health and was recommended by the association for trial use by the districts.

The committee this year has circularized all of the districts for suggestions as to changes in the form and has incorporated the changes most requested in the revision, samples of which are available for distribution.

The replies to the questionnaire showed a desire on the part of the districts to have an intermediate or summary form prepared for compiling the monthly reports and to have an instruction sheet for use with the daily report. These are being worked on and will be sent out when completed.

Mr. Geib: Thank you, Ed. Ed is chairman of another committee on which he might just as well report right now.

Mr. Smith: This is the report of the Entomology Committee.

REPORT OF THE ENTOMOLOGY COMMITTEE

EDGAR A. SMITH

Section I. Common Names of Mosquitoes.

The subject of common names for the more important mosquitoes in California was first brought up at the Association meeting at Tulare in November, 1947. At that time it was announced that a meeting would be held in Berkeley during December for all those interested in the problem. Fourteen persons attended the meeting representing various mosquito districts, the California State Department of Health, United States Public Health Service, the University of California and the Hooper Foundation. A list of tentative common names was drawn up and sent out to all persons concerned, with a request for comments and additional suggestions. Fifteen replies were received. All suggestions were tabulated and again sent out with an announcement of a meeting to be held at the University of California on February 2, 1948. This meeting was attended by twelve persons. At that time recommendations were drawn up for presentation to the Association.

The committee was in agreement that there are two separate needs for common names. First, is the need for group names which will set off similar groups of mosquitoes for convenience in public relations work, through personal contacts and newspaper and radio publicity. Second, is the need for individual common names for use in reference to species of great importance. There was considerable divergence of opinion within the committee as to the necessity of such names. However, such a list was compiled for possible presentation to the committee on common names of the American Association of Economic Entomologists. This list was reduced to the minimum by eliminating all species considered unimportant, or more important elsewhere, and all of those on which a general agreement could not be reached.

It is felt by the committee that general acceptance and use of these group and individual names by mosquito control workers will help to avoid confusion in the future for the general public about kinds of mosquitoes. Standardization is particularly important in areas where a single newspaper is the principal one read in several different mosquito districts, each one of which is putting out publicity on mosquitoes.

Particular attention is called to the term "irrigated-field aedes." This name is recommended in the hope that it will be a means of calling attention to the fact that the major mosquito problem in California is not stagnant water, as is still popularly believed, but is actually irrigation water.

Recommendations of the Entomology Committee in regard to the common names of California mosquitoes:

A. Group Names:
  1. Aedes
    a. Salt-marsh Aedes
    b. irrigated-field Aedes
    c. tree-hole Aedes
  2. Culex
    a. dark-legged Culex
    b. banded Culex
  3. Anopheles
    a. malaria mosquito

B. Individual Names:

Scientific Name	*Common Name*
Aedes nigromaculis (Ludlow)	black & white field mosquito
Aedes dorsalis (Meigen)	field & salt-marsh mosquito
Aedes squamiger (Coquillett)	Calif. salt-marsh mosquito
Culex tarsalis (Coquillett)	common encephalitis mosquito
Culex stigmatosoma (Dyar)	banded foulwater mosquito
Culex erythrothorax (Dyar)	tule mosquito
Anopheles freeborni (Aitken)	western malaria mosquito
Anopheles franciscanus (McCracken)	false malaria mosquito

Section II. Sub-Committees.

The entomology committee discussed at some length the numerous and varied problems of a technical nature which might properly be taken up by such a committee, and decided that most of them could be included in one of three categories and might best be handled by sub-committees until worked into shape for consideration by the committee of the whole.

The three categories are as follows:

1. Insecticidal Testing and Formulation.

To work out recommended specifications of insecticidal formulations for varied use in mosquito control, and to standardize procedures for testing the effectiveness of the various insecticides on mosquitoes.

2. Mosquito Survey Methods.

To evaluate present methods of collecting, determining and recording mosquito densities; to determine the relative value of light traps, resting stations, biting collections, etc., and to evaluate current progress in plotting mosquito sources (section survey mapping).

3. Public Relations and Education.

To review the type of entomological information which it is desirable to "put across" to the general public, and the means by which such information can be disseminated; to devise units of general information which would be of value to any mosquito district, and make such units available to all districts.

The committee wishes to emphasize that any and all meetings of the committee of the whole or of the working sub-committees wil be open to all persons interested in mosquito control. These meetings will be announced in the "Mosquito Buzz" or by mail in the hope that those located near the meeting place and those particularly interested in the subject to be discussed will make an effort to be present. Those sub-committees are as follows: Sub-Committee 1 — Insecticidal Testing and Formulation, Gordon Smith of Bakersfield is Chairman; the other members, Ed Washburn, Norman Ehmann, Ted Raley, and Dr. L. L. Isenhour as technical advisor. Sub-Committee 2 — Mosquito Survey Methods, Ted Aarons is Chairman and other members, Jack Walker, Herbert Herms, Harvey Magy and Bernard Brookman. Sub-Committee 3 on Public Relations and Education — Dick Peters is chairman; other members, Don Murray, Vernon Walker, Wesley Dickinson and Chester Robinson. I hope that tomorrow, before the meeting breaks up, an announcement will be made about the first meeting of each of these sub-committees. In fact, if it is not too late when we break up tonight, those on that list can get together for just a minute; we might be able to name the date of the first meeting of each of those sub-committees so that the rest of you who are interested can arrange to be present.

Mr. Geib: Thanks, Ed. Are there any questions?

I believe, after reading to you the State of the Union here, there are a few unanswered things that we may be able to complete right now — for one thing, the Districts Investigation Act affecting mosquito abatement districts. That was taken up with the Legislature in order to find out whether we could write off the mosquito abatement act coming under the provisions of the Districts Investigation Act. Was that accomplished or not?

Mr. Peters: That was extended for two years. In the Operations Manual when you receive them on Saturday (we hope), you will find an excerpt from the Mosquito Abatement District Chapters of the Health and Safety Code, containing the amendments, including the one you refer to.

Mr. Geib: The Executive Committee was disappointed that it wasn't possible to have the Operations Manual here tonight for distribution. I wonder if many of them know very much about the contents of that. Could you elucidate a little bit on that, Dick? Tell us what the manual is, what it looks like.

Mr. Peters: The Operations Manual is a product of the California Mosquito Control Association, so named because we want it to be something that will go down through the ages of growth of the Association. It includes the progress of the Association. It is a blue canvas binder — a three ring binder with yellow printing on the outside; for those of you who come from universities other than California, it may not be so appealing. But, nevertheless, it is a rather attractive thing, we think, and we believe you will be proud to have it to use and to keep on your shelf. You won't be able to leave it there, but will have to take it down once a month or so to enter new inserts in it. The policy will be to transmit the inserts or technical and administrative memoranda through the Bureau of Vector Control. It is broken down into five categories. The first is Administration, which will include various information such as how to conduct a Board of Trustees meeting, a paper that Harold

Gray gave at the last Conference, and those interested in getting the most out of their Board of Trustees ought to read it before approaching the Board on a financial request. Next is the proposed Charter and By-Laws, which have been tentatively accepted. Another will be the excerpt from the Health and Safety Code previously mentioned. In the next category, yet to have an entry, is Engineering, which will be one as soon as you submit to the Association what you feel ought to be included in that; in other words, the manual is your publication and what appears in it, you are responsible for. You will profit from it, so there's another place to express yourself and to get something worth while in front of the Association. The third category is Entomology and it will include information concerning mosquitoes. Fourth is Operations, a grouping of data on this fundamental subject. Lastly, Miscellaneous, which is the catch-all for those subjects of less specific nature, including bibliographies, overlapping subjects, etc. Those are the five parts of the Operations Manual.

Mr. Geib: Thank you, Dick. I'm sure we will all derive much good from our manuals.

Now we are ready for the report of the Nominating Committee. Chet, you are Chairman.

REPORT OF NOMINATING COMMITTEE

By E. C. Robinson

Mr. Robinson: Our nominations of Raley for President, Sperbeck for Vice President, Washburn for Secretary-Treasurer, with Herms, Geib, and Kimball to complete the Executive Committee, have been submitted to the Association. Has the present Secretary-Treasurer received any other nominations?

Mr. Peters: None.

Mr. Geib: I presume a secret ballot is indicated.

Mr. Russell: It is only necassary to indicate that the selections of the nominating Committee be accepted and the Secretary instructed to cast the ballot.

Mr. Geib: Would you like to make a motion to that effect?

Mr. Russell: I so move.

Mr. Geib: Any seconds to it?

Prof. Herms: Second.

Mr. Geib: You have heard the motion to instruct the Secretary to cast the ballot for these men. The motion has been made and seconded. All those in favor. Any opposed? It is carried.

As I retire I would like to say that, even though it has been a lot of work, I have enjoyed it considerably. So, Ted, I hereby turn the chair over to you and ask you to close the meeting and, if you care to, to say a few words.

Mr. Raley: My first act as President of the California Mosquito Control Association will be first to inform Art that his work isn't over, and then to entertain a motion that we adjourn.

Mr. Henderson: I so move.

Mr. Robinson: I second the motion.

Mr. Raley: Meeting is adjourned.

FRIDAY MORNING, FEBRUARY 13, 1948

Mr. Raley: First we are to have a report from the American Mosquito Control Association, by Robert Vannote from the Passaic Valley Mosquito Control Conference, Morris Plains, New Jersey.

REPORT FROM AMERICAN MOSQUITO CONTROL ASSOCIATION

By R. L. Vannote

I have a report from the Secretary-Treasurer of the American Mosquito Control Association* and I shall skip through it, as it is rather lengthy. The American Mosquito Control Association has had its inception because of interest relating to conservation. I presume you had the same arguments here as we had in the East, and at that time it seemed wise that those interested in mosquito control bind themselves together in an Association larger than those defined by State boundaries for the purpose of protecting the interests of mosquito control. We organized an Eastern Association of Mosquito Control Workers, and the function of that Association was to hold annual meetings, field trips and generally represent mosquito control so far as federal projects and operations were concerned. It was very soon apparent that an organization with so small a scope could not adequately serve the problem, and the American Mosquito Control Association was the outgrowth of this Eastern Association. I think at the outset it would have been stronger today if we had recognized that fact, and established the American Association at the outset. Our Association today has one prime function, and that is to publish "Mosquito News," which is a means of spreading mosquito control information to all members throughout the country and now throughout the world, and we are particularly happy to see Mr. Harold Gray as our first Vice-President, and sincerely hope that, at our annual meeting in Florida at the end of March, he will be advanced to President. I think that that will give the California and West Coast workers a real opportunity to take hold of this Association and mold it more on a national pattern and to give it new life.

We had a meeting last fall in Asheville for the purpose of preparing a brochure on the use of aircraft for dispersing DDT for mosquito control. That conference was rather unique insofar as we had mosquito control experts from all over the country meeting at that one place and to discuss that one particular problem. We had some fifty members in attendance and it was amazing to see how those fellows got together, broke down in committees and whipped that brochure together. The manuscript, along with some fifty illustrations showing every type of aircraft, the piping details, the spray rig details, blueprints and drawings, is now in the hands of the printer and we hope to have that brochure available for distribution to our membership by the end of March. Our program for the meeting to be held at Ft. Pierce, Florida, this spring has another subject as its objective. That subject is the use of ground equipment for the dispersion of insecticides for mosquito control. It takes in a larger field and will probably find a wider interest among its readers. There again we propose to follow the same pattern. We have, how-

*See end of R. L. Vannote's presentation.

ever, selected certain chapter chairmen and provided them with associates, and prior to the meeting they will have their chapters outlined, so when we do meet at Ft. Pierce we will be able to break down into committees and to again whip this brochure into shape and get it into the hands of those who need that information just as soon as possible. Our Association has been growing and the outlook is for its continuing to better serve American Mosquito Control workers.

A REPORT FROM THE AMERICAN MOSQUITO CONTROL ASSOCIATION

By THOMAS D. MULHERN
Secretary-Treasurer, A.M.C.A.

On behalf of the A.M.C.A. may I extend greetings to the California Mosquito Control Association on the occasion of this Sixteenth Annual Conference.

In the sixteen years since it was founded, you have made great progress in your association, and your reports are looked forward to by mosquito workers all over the country. So, too, with the mosquito control work in California. According to your reports, its expansion has been phenomenal.

The American Mosquito Control Association is happy to number among its members many of you. Harold F. Gray is now first vice president, and Chester Robinson, Arthur Geib and others are contributing greatly to the progress of the national body by committee activity, etc. It appears as though the American Association, although it too has made great strides in the past several years through the help of the State and regional organizations and individual mosquito workers, is now only beginning to attain the position in which it can be of really substantial service to the cause of mosquito control.

Presently, the American Association is engaged in the publication of a brochure on "The Use of Aircraft in Mosquito Control." Probably no other organization would have been in a position to receive so generous a contribution of information from so many sources, nation-wide, as was presented at the Airspray Conference held in October at Asheville, N. C., and this is the data on which the airspray publication is based. But all of the outstanding authorities who took part could feel, and rightly so, that they were serving their own association and, through it, the nation's mosquito control. The costs of printing the book will be large, but your organization and the others have already begun to give great help in the pre-publication sale of the book, which will probably largely finance the printing. The book will be out about mid-March.

Now the 1948 Annual Meeting of the American Association is scheduled, with a program that will provide the information for a companion booklet on the subject of "Ground Spraying and Equipment for Mosquito Control." There is far more information on this broad subject, and the sub-committees will thus have a greater responsibility in compiling the information, for they must give adequate consideration to all of the material they can secure in building the various chapters of the final report, if it is to be of greatest value throughout the country. These committees will need your generous support in supplying data, either to be published, and in marketing the printed volumes. through your delegates, who will be at the Annual Meeting in Florida, or by bringing or mailing your contributions directly to the meeting, for presentation at the various sub-sections of the conference. Subsequently, your help will again be needed in selling advertising in the booklet

"Mosquito News" has had articles concerning work in California, but we are aware from the accounts in "Mosquito Buzz" and your reports that you are engaging in many activities that would be of immense interest to the readers of "Mosquito News" elsewhere in the country. You may be sure that the editor of "Mosquito News" would be happy to have articles describing the unique things you are doing, the equipment you are using and developing, and the results you are securing. And don't forget the personal notes, for the AMCA is not only interested in what you are doing, but also in who is doing it, and what.

Other worthy projects which have been suggested for accomplishment by the American Association are the compilation of a "Who's Who" of mosquito workers, the establishment of a research program in cooperation with industry and members, and the compilation of adequate directories of materials and supplies. All of these projects are desirable and they may perhaps be made self-supporting, but they all involve capital expenditures, principally for printing, which is now at an all-time high level of cost, so that some of these phases of Association activity must be deferred until the reserves of the Association may justify its engaging in these ambitious undertakings.

The expansion of the Association, and the improvement of "Mosquito News" has of course not been accomplished without a degree of the usual "growing pains," probably the greatest of which has had its source in the great distances involved and the virtual impossibility of securing adequate representation at meetings, wherever they may be held. As secretary of this association since its founding, it has been my privilege to see that this problem of due representation has been uppermost in the minds of the various official families which have been elected to carry on the business of the association. I can assure you that, although the personal representation from California has been necessarily small at meetings, the weight of opinion of the California group as expressed by letters and otherwise has influenced to no small degree the actions of the Executive Committee with reference to Association affairs. Even now a special committee, on which one of your members sits, is wrestling mightily with the problem, and attempting to devise a new constitution or charter which will provide the ideal of true democratic representation, mutual support and advancement of the various regional and the national associations, while still provide machinery which will allow the regular business of the Association to be conducted with dispatch in a businesslike manner.

For its continued progress in service to mosquito workers and mosquito control, the American Mosquito Control Association needs and welcomes the ideas of mosquito workers everywhere, their opinions as to the activities that are undertaken, and the same continued unselfish support and participation which your people and your Association as well as the others in the country have given it in the past.

In closing, may I invite each and every one to attend and to participate in the coming Annual Meeting, which will be held jointly with the Florida Association, at the New Fort Pierce Hotel, Fort Pierce, Florida, on March 28, 29, 30, and 31.

Mr. Raley: The next paper for the morning is to be by Perry Ruth, who is President of the Virginia Mosquito Control Association. Mr. Ruth is not able to attend, and Ed Washburn, Manager of the Turlock Mosquito Abatement District, will give that paper for Mr. Ruth.

Mr. Washburn: Mr. Chairman, and gentlemen. I would like to speak a word for Mr. Ruth. The paper is co-written by Perry W. Ruth, President of the Virginia Mosquito Control Association, and R. E. Dorer, Secretary of that Association. I am sorry these two men are not able to attend here. I had the good fortune of meeting both of them last spring in New Jersey, and I know we would have benefited by their attendance here.

MOSQUITO CONTROL IN VIRGINIA

PERRY W. RUTH, *President,* and R. E. DORER, *Secretary*
Virginia Mosquito Control Association

Mosquitoes are very closely associated with early Virginia history. It has been stated that the first English settlement in America at Jamestown in 1608 was doomed to failure because of malaria. Through the years, until the more recent times, malaria has taken its toll in the Old Dominion. As late as 1923 there were 3,611 cases and forty-five deaths from this disease reported, and probably there were many more which did not get into the health record. In 1855 one-third of the population of Norfolk died in an epidemic of yellow fever. However, all has not been bad, for the 'Old Mother State' contributed to the knowledge of the mosquitoes by giving the world such illustrious sons as Dr. Walter Reed and Dr. H. R. Carter. Now with organized mosquito control, the danger of a return of yellow fever or malaria has practically been eliminated.

Before the first world war some work was done on malaria control in Virginia, but it mostly consisted of making surveys. During the first world war, as a war measure, a great deal of mosquito control work was done in and about the Army and Navy cantonments. The Hampton Roads area received most of this work. The results were very good, and those who have been residents long enough will tell of the great relief experienced during that period.

Unfortunately, after the armistice the mosquito work stopped. In a few years conditions were as bad as they had been before. During the interim between the first war and the New Deal Relief program only a limited amount of mosquito work was accomplished in Virginia, and this was concerned almost entirely with subduing malaria.

With the advent of the Civil Works Administration in 1933 a new era for mosquito control in Virginia was started. The U. S. Public Health Service with the Virginia State Health Department sponsored projects for malaria control and salt marsh mosquito control. Later the U. S. Public Health Service declined to sponsor pest mosquito projects, but the State Health Department continued its interest. Within a few weeks more than 3,000 men were at work. However, almost as soon as the C. W. A. started it was over. Then followed the E. R. A. This program provided work for men in need of relief based on their needs. For example, if a man had ten children he might get five days a week, while a man with one child might get only one. It was very difficult to operate mosquito control under this system and do efficient work because it called for reorganization each day.

Following came the W. P. A., which was a work program and an improvement over its predecessor. Still Federal rules which sometimes appeared to be unreasonable when applied to local conditions were nevertheless enforced.

It can be said that in Virginia great progress was made under the relief agencies. and they did serve to demonstrate the good that could be accomplished. However, too often where work was done, it depended upon the people in need of relief and not on where mosquito control was most needed.

With the gathering war clouds in 1940, the Eastern section of Virginia became the center of Army and Navy activities and war industries. The U. S. Public Health Service created the Malaria Control in War Areas (M.C.-W.A.) program, which continued throughout the war years. Under this program work was carried on within a one-mile radius around forty-eight war establishments in Virginia. The work was designed to control *A. quadrimaculatus,* but in so doing many other species were also controlled. This was a gigantic effort, and the results were excellent. Local transmission of malaria was almost completely eliminated. Of course, with the end of the war came the end of the M.C.W.A.

Now Federal participation is only involved around the permanent military establishments. Thus we have brought you through two world wars to the present as far as Federal aid is concerned.

It has always been felt that mosquito control is a local problem. The people who receive the benefits should pay the bill. With this principle always in mind, the Federal funds available have been used to stimulate local appropriations.

Under the relief programs local contributions were always promoted. Norfolk City was the first community to realize the benefits derived from mosquito control. They gradually took over more and more of the activity until by 1938 they were carrying the entire cost with an annual appropriation of approximately $50,000.00. Thus Norfolk City has served as a model for other communities in the state.

In 1940 a law providing for the creation of mosquito control districts was passed by the State Legislature. Under this act the communities in Southeastern Virginia were allowed to establish themselves as mosquito districts and levy a tax. The State Health Commissioner, who is ex-officio chairman of each Commission, is empowered to contribute 25% of the funds collected locally, not to exceed $5,000.00.

In 1940 Virginia Beach and vicinity created a mosquito control district. No doubt more would have been created at that time but for the coming war. The good work done by the Malaria Control in War Areas program was continually kept before the local people, and with the momentum thus gained an effort was made after the war to get mosquito districts established. The Virginia authorities were determined that work would not stop at the end of World War II as had happened after World War I.

Since the end of the war six more mosquito control districts have been created which pretty much cover the more populated areas of Southeastern Virginia. Approximately $175,000.00 of local funds are being spent annually. No doubt the coming years will see more mosquito control districts created in Virginia.

In February, 1947, the Virginia Mosquito Control Association was organized. Its purpose is to promote mosquito control in Virginia wherever same is feasible; to maintain public interest in areas where mosquitoes are now being controlled; to keep up with latest developments in control methods; to disseminate information concerning mosquitoes to the membership and the general public through publications and meetings; and to unite and coordinate common interests and efforts.

Membership is open to any one interested in mosquitoes and their control. There are now 151 members. A periodical called the *Skeeter* is published each month.

The Association held its first annual meeting in the Monticello Hotel at Norfolk, Virginia, January 16, 1948, which was attended by over 150 members and guests. The program included such distinguished speakers as Virginia's Lieutenant Governor, Lewis Preston Collins; Rear Admiral J. C. Adams, Medical Officer, Fifth Naval District; Geo. L. Hutton, Entomologist, Tactical Air Command, U. S. Army; J. E. Borches, U. S. Public Health Service; Dr. L. J. Roper, Virginia State Health Commissioner; Mrs. Jesse A. White, President of the Federation of Garden Clubs; Robert L. Vannote and Harry H. Stage, Past Presidents of The American Mosquito Control Association; W. S. Harney, Manager, Norfolk Association of Commerce and Honorable Mayors; Richard D. Cooke of Norfolk; and V. D. McManus of Williamsburg. The morning session was devoted to matters of general interest, while the afternoon session dealt with new methods and technical phases of mosquito control work.

The interest manifested at the meeting indicates, as well as anything could, the extent of the development of organized and positive mosquito control in Virginia.

Mr. Raley: Does anyone have any questions on Virginia that they would like to refer to Mr. Vannote? Virginia sems to be well taken care of.

Question: I would like to ask where the Virginia headquarters are.

Mr. Vannote: The office is in with the Virginia Department of Heath at Norfolk. There is one problem in Virginia that is a litle troublesome and might be of interest here. There is a large national park area near Virginia Beach that breeds large numbers of *Mansonia.* The Virginia authorities have not been able to trespass on that national property. Neither will the Department of the Interior exercise any control, so the section of Virginia Beach is a place where they are severely annoyed with flights from the national park area. That might be improved, and it might be that some action should be taken to overcome such a situation.

Mr. Gray: You might ask Mr. Knipling as to what can be done.

Mr. Raley: Bob, I might ask where would we get the proper contact so that we might get on the Virginia mailing list. I am sure a great many of you will be interested in getting on that mailing list so that you will be informed on Virginia's activities. Dick, will you see that each one gets that address?

Mr. Peters: Mr. Dorer has already put the Association on his mailing list. I receive it monthly and occasionally I even quote from it in the *Mosquito Buzz.*

Mr. Raley: At this time I would like to pass on a message from Arve Dahl. Mr. Dahl, Acting Chief of the Bureau of Vector Control, is ill. He wasn't able to be here, and feels very bad both figuratively and literally. He had looked forward to this meeting for several months, but he got caught up with the flu bug — we don't know whether it is virus X or virus A, but he does send his regrets.

We have a pile of forms here which I am sure a good many of you will be interested in. This was prepared by a committee of entomologists of the Association, of which Mr. Edgar A. Smith is Chairman.

Mr. Smith: Copies are available for anyone who is interested and wants the daily operational report form that has been recommended by the Association, and also the list of the common names for mosquitoes as prepared by the Entomology Committee. They will be here on the desk and if anyone wishes them, just help yourselves.

Mr. Raley: I will excuse myself if I may, and turn the meeting over to Dick Peters.

Mr. Peters: When Mr. Vannote was contacted, I am sure he didn't reckon with all the punishment he was going to be submitted to. He is a resident of New Jersey, and I am sure he will talk long and loud about New Jersey, but today he finds himself in possession, not only of a paper that he prepared himself, but also with a paper that was prepared by the Secretary of the New Jersey Association — Mr. Mulhern, who is also the Secretary of the American Mosquito Control Association. Now as to how he has worked out this little matter— whether he is going to combine them, or whether he is going to lean upon Tom Mulhern heavily, is Bob Vannote's problem.

MOSQUITO CONTROL IN NEW JERSEY

BY ROBERT L. VANNOTE

Secretary, Passaic Valley Mosquito Control Conference Morris Plains, N. J.

AND BAILEY B. PEPPER

Head, Dept. of Entomology, N. J. Agricultural Experiment Station, New Brunswick, N. J.

Mosquito Control in New Jersey dates back to 1901, when Spencer Miller and a group of residents in South Orange undertook a program for the control of the house mosquito, *Culex pipiens.* Informaion supporting this program was secured from Dr. John B. Smith, then Head of the Department of Entomology of the N. J. Agricultural Experiment Station, and Dr. L. O. Howard of the U. S. Department of Agriculture.

From 1901 to 1905 Dr. Smith received special appropriations from the State Legislature to examine and study the mosquito biology in New Jersey and to establish methods of open salt marsh mosquito control. From this research, the basis of pest mosquito control was established.

From 1902 to 1912 a number of municipal mosquito control programs were initiated under the supervision of the local Boards of Health, in some cases, taking advantage of state funds appropriated for salt marsh irrigation under the control of the N. J. Agricultural Experiment Station.

During this period it was apparent that local control was not the answer to the pest mosquito problem; as flight species often offset completely the effectiveness of the local work. To meet this situation various Leagues and Associations were formed to stimulate regional cooperation. The outgrowth of this activity was the preparation and passage of the Legislative Act in 1912 establishing County Mosquito Extermination Commissions under the budget control of the Director of the N. J. Agricultural Experiment Station.

Since 1912 Mosquito Control in New Jersey has expanded and fully demonstrated its value to the health and welfare of our residents and to the economic improvement of our State. The basis of this succes has been the wise and capable leadership of the Agricultural Experiment Station, coupled with the non-salaried Commissioners appointed without political consideration. Today nineteen of our twenty-one counties enjoy the benefits of mosquito control at costs below the quarter mill per dollar valuation provided by the Act.

Another important factor in the success of the undertaking has been the wise selection of county superintendents on the basis of demonstrated ability to serve all the technical functions such as entomology, engineering, administration and public relations, coupled with long training in field practice. The "Associated Executives," consisting of all the county superintendents, meets monthly and forms a strong basis for inter-county cooperation.

New Jersey is a small seashore state of 8,224 square miles, having diverse physical characteristics, including salt marshes, coastal plains, rolling farm and residential areas, low mountain ranges, and flat valleys. It has an annual average rainfall of 45.58 inches. The northeastern section is characterized by extensive industrial and manufacturing centers with a heavy concentration of population; the northwestern part consists of low mountain ranges, spotted with lakes and small industrial areas, and its principal income is derived from dairy farming, mining, and resort trade; the coastal strip is typical of the Atlantic coast, having extensive beaches with wide bays separating them from the mainland, and here fishing and the resort trade supply the main income; central and south Jersey is a coastal plain with agriculture and poultry raising the chief industries, and the western strip along the Delaware River is industrial. The active mosquito season extends from May to October with all general species being found with the exception of the *Aedes aegypti.*

Our methods of control on the open salt marshes involve the use of parallel systems of ten-inch ditches, approximately twenty inches deep, that permit the irrigation of the marshes with the tides and provide avenues for the small fish to reach all extremes of wet areas. Of a total of 296,000 acres of salt marsh, 70 per cent is now under this type of control.

The former salt marshes in northeast Jersey are now diked to screen out the pollution. Control of the water table is maintained by tide gates and pumps, with the result that large tracts are now fresh. This necessitates fresh-water methods of control.

Fresh-water control is based on inspection, drainage, and spraying. The two problems are local and flight mosquito control. Local work in and around the centers of population is positive, insofar as every known breeding place is located and placed under a rigid control. No known breeding is permitted to emerge. Street catch basins and yard breeding is also tied to fixed schedules. The result is that little emergence can take place under normal conditions.

Mosquito flights from extensive flood or salt marsh areas sometimes offset the effectiveness of the local work. This cannot be avoided, as mosquito control must be designed like any other public project having a reasonable cost determining the extent of its scope. Where practical, large-scale drainage or flood control projects are undertaken as a control of the flight mosquitoes, and tests are underway to determine the effectiveness of airplane applications of larvicides where brood emergences might cause local hardship. Prior to 1934 no practical method existed to control flights of mosquitoes when unusual weather conditions overtaxed our controls. The development of the N. J. Mosquito or Pyrethrum Larvicide at that time gave good control in stadiums, yards, or small areas; however, its effects were of short duration. The post-war developments such as the Todd and Beskill Fog Generators, the Hession Microsol, the Buffalo Turbine, and the Bean Dust-Mist Blowers, and similar equipment have provided us with new tools in our mosquito control kit for the removal of adult mosquitoes from community areas. The airplane has been found to be essential to cut off brood migrations in the rural areas; however, its use in New Jersey is limited due to State and Federal regulations.

From this, it appears that the mosquitoes in New Jersey are under reasonable control, as is evident from popular public support for many years. The problem of adult control when rainfall or adverse tides overtax our systems is solved in theory; however, much additional work must be completed to adjust existing equipment and insecticide formulations to make such methods practical and safe.

Mr. Raley: Since I have been attending the conferences here I have been made to realize that there are not only males in this world. There is another side that is quite able and quite willing to enter into activities of all types, and it is my pleasure to introduce Dorothy McCullough Lee, Commissioner of Public Utilities, Portland, Oregon, and she will report from Portland and elsewhere in Oregon.

Mrs. Lee: Mr. Raley and gentlemen, perhaps it is apropos that you should have one lady at least on your program, considering that we are discussing mosquito control, because if I remember, as far as the mosquitoes are concerned, the female of the species is the deadliest. I dislike papers. I usually like to just get up and talk. Of course I know that's dangerous. You know if you get a woman started talking sometimes they don't know when to quit; but Mr. Peters scared me to death. He said, "You've got to have a paper and leave it with us," so, since I always mind Mr. Peters, I do have a paper. There's a thing or two, however, I'd like to tell you just ad lib, because this is probably a new audience from the former meetings of the California Mosquito Control Association. By the way, this is my third meeting, and I know of no meetings and no group associations as beneficial to me in the problems that were in my lap as the meetings of the California Mosquito Control Association. You probably are wondering why the Commissioner of Public Utilities of Portland has anything to do with mosquitoes, and that is a very good question. I am not an expert at all on mosquitoes, and I am always deeply impressed and awed by this assembly of true experts in this field. I feel very small indeed, but I do feel that our story in Portland is interesting to you. I approach it as a layman; I give it to you as a layman. But how did I happen to get into mosquito control? How do bugs get mixed up in my business? Well, we have a commission form of government in Portland — a mayor and four commissioners, and each commissioner has a principal assignment. I happen to be the Commissioner of Public Utilities, and in that field I won't say I am an expert, but at least I think I have my feet partially on the ground because I had the privilege of graduating from Boalt Hall here at the University of California many years ago — I won't tell you how many — so I am a lawyer and I have some experience in the utility field, BUT — we have a few miscellaneous bureaus in our department. Every commissioner does; and I happened to get Insect Control in 1945, and that involves among other things, mosquitoes. Because of the situations that prevailed at that time, I found that I would personally have to find out something about mosquitoes, so that is how I got into the bug business.

One word about the history of mosquito control in Oregon. I was most interested in the history of it in Virginia. I won't take much time to tell you about it because the agenda this morning doesn't permit, but I do want to say this. You probably realize that Portland is situated at the confluence of the Willamette and the Columbia Rivers, and there is quite a rise in those rivers, and there has always been a mosquito control problem, I presume, in that vicinity. The history of early Oregon tells us they had malaria in that part of the country and I presume it must have been from mosquitoes. During the depression in the thirties, the WPA and the other Federal agencies, which may use strange numerals and aphabets occasionally, but you know what I mean, the series of Federal work projects, came in there and did a fine mosquito control program, not only for Portland and Multnomah County, but also for the Washington counties across the river just as they did for us; and for our neighboring Oregon counties on these great rivers. They must have spent over a million dollars in that region and it paid out in results, and we had pretty good control until about 1938 or 1939, before I was Commissioner and I wasn't paying any attention to mosquitoes. Then it went back to local government, and local government, because of the cost involved, just didn't bother with it at all on either side of the river — on the Washington side or the Oregon side. In Portland, the city and county together appropriated ten thousand dollars with a mental note — please don't use all the ten thousand because we really need it for other purposes. And that was about the nature of the program. The brush all grew back that the Federal government had cleared at such expense; the personnel, so far as knowledge on the part of the men carrying it out, was no longer there; they had the benefit of the Federal men in those days, but they were almost invited to stay home by the local authorities, who didn't want experts but just didn't do very much about mosquito control. Well, in 1945, they found they really had a situation on their hands and it became very bad. This was just at the time the Bureau was shifted to me. I don't know just how that happened, but that's where I came in and that's when I began to learn about mosquitoes. I have our mosquito control experts here today for the first time. Arthur Woody, our Supervisor, and Virgil McKay, our Field Director, are here. They are modest souls and they are sitting up here in these cheaper seats somewhere. The thought occurs to me that some of you might be interested in our technical field problems, and these are the men who have had charge of it and not myself. I'm the girl that runs interference to try to get them the stuff they've got to have to do the job. Where are you, Art and Virgil? Will you stand up? There they are! If you want to ask some questions, go ahead. However, I did not have them with me in '45. You just give me credit for having the good judgment to pick out good men to do a job.

Now down to this paper which I say Mr. Peters scared me into writing. We'll get down to that because I want to obey the rules. So here we go.

REPORT FROM PORTLAND AND ELSEWHERE IN OREGON

By Dorothy McCullough Lee
City Commissioner, Portland, Oregon

It's always a pleasure to make a report when you can "report progress." And that is what we can do in the field of mosquito control in the City of Portland and County of Multnomah, where Portland is situated, in the State of Oregon. Last summer our citizens were able to enjoy their gardens and porches without having to endure the onslaught of mosquitoes. In our rural areas, dairy herds were no longer pestered by these noxious insects, and field workers could carry on their work in comfort. These favorable conditions, enjoyed because of relative freedom from mosquitoes, had not been maintained in our district, however, prior to last season. I am confident that the change was brought about by revolutionizing our control methods, and the sincerity and interest of the men in charge of the field activities.

Portland is situated almost at the confluence of the Willamette and the Columbia Rivers. The mosquito breeding areas in and around Portland are thickly wooded and brushy lowlands. When the spring freshets come, frequently 35,000 acres of these lowlands are flooded. These rivers occasionally rise 14 feet above their normal levels. Not only is the area in our County flooded at such periods, but similar lowlands of the Oregon County northwest of us, and of three Washington Counties to the north and across the Columbia River, are likewise flooded. Mosquitoes bred in these neighboring Counties are blown in on us by prevailing winds. Our salvation apparently lies in controlling the mosquito while it is still in the larva stage. During flood periods, we have an immense amount of territory to cover in a very short period of time. After the lowlands are once flooded by the rising rivers, the mosquito eggs can hatch and be on the wing in from five to ten days, depending on the temperature. To control thousands of acres of breeding ground in such a short period was our problem. In previous seasons we resorted to brush cutting in the winter season and spraying a film of diesel oil or diesel oil and DDT from ground equipment during the hatching season. We carried on the program with three power pumps mounted on trucks and also by men with knapsack pumps in areas where motorized equipment would not be taken. But there were lots of breeding grounds which we could not reach by either method. Many mosquitoes "got away from us." Then, too, we couldn't recruit an army of men fast enough to cover the necessary territory, even if the budget would have permitted such a payroll, which, incidentally, it did not. And although these methods afforded us some degree of control within our own County, our neighboring Counties had no control programs whatsoever, with the result that their mosquitoes were carried our way by prevailing winds and soon became ours.

Conditions became so unbearable that some improved control program was imperative. During June of 1946, when the mosquitoes were at their worst, through the cooperation of the U. S. Army Air Force, a B-25 Bomber was placed at the City's disposal. This plane, stationed at Portland, was fitted with spray equipment, the bomb bay tank was used as an insecticide tank and gravity-fed spray booms were placed below the bay doors. This plane released a DDT spray over not only our County, but also over the surrounding ones. The results obtained from this operation were so satisfactory that we decided to use airplane control methods during the 1947 season.

We have found our answer, I believe, in controlling our flood water mosquitoes by airplane. In January of 1947, we purchased two Stearman P. T. 17 airplanes. These planes are equipped with 220 H. P. Continental engines and are the type used by the Army and Navy as trainer planes. We have found them to be very stable and capable of carrying heavy loads and standing the stresses of spraying work with a minimum of maintenance.

One of the planes was equipped with wind booms and the other with an exhaust aerosol generator. As our season progressed, we found that the exhaust aerosol generator was the most efficient unit for this territory. The DDT solution and its finely atomized state, as dispersed by the exhaust aerosol, penetrated more readily into the dense growth and left a very excellent residual deposit on the foliage. The larvicidal action of both units on more open terrain was very good.

The spraying of the insecticide was done in early morning, as we found air conditions to be the best both for flying and spraying at that time. Walkie Talkie radios, purchased from W. A. A., were used as a means of communication between aircraft and ground scout crews. The very dense cover in the breeding areas made the use of smoke signals, flags and other visible communication practically useless. The insecticide dispersed by both aircraft was identical, consisting of Xylene, Japonica Oil, Diesel Oil and DDT. The rate of dispersal was two quarts per acre, 110 foot swaths at eighty mph.

A careful check of results was made at various intervals after treatment by our field scouts. We found that larvae in 1st and 2nd instar responded most readily to treatment with the DDT solutions. The aircraft method of dispersal commends itself because of the rapidity with which large areas can be treated. The aerosol generator has also proved itself to be very effective in the control of adult mosquitoes because of residual toxicity.

The cost of control from aircraft proved to be approximately 10% less than the other methods used previously, in spite of the fact that it was the initial year of the new program. Also, the results obtained were far superior, regardless of expenditure.

Continuous checks were made throughout the control season, with the help of the Oregon Fish and Game Commission and the Federal Bureau of Entomology and Plant Quarantine to determine the effects of our spray solutions on wildlife. No ill effects on wildlife or fish were found with the solution strength at 5%, and extreme care was exercised to keep the solution strength at 5%.

The people of Portland, as well as the property owners engaged in farming and similar enterprises in the rural sections of Multnomah County, have shown themselves to be highly pleased with the results of this year's airplane control program.

Much of our success resulted from the fact that we did not stop with just controlling our own hatching grounds. We also went into the neighboring counties and carried on a control program there. DDT solutions were spread over areas in Clackamas and Columbia Counties in Oregon, and Clark and Skamania Counties in Washington. In all, we covered about 95,000 acres of hatching ground. I have definitely come to the conclusion that mosquito control is a regional problem. It does little good to control mosquitoes in one county if they are permitted to breed in the surrounding ones, because prevailing winds apparently blow mosquitoes as far as 35 or 40 miles. Through extensive testing of DDT chemicals, we have perfected an insecticide formula that appears to get good results.

We had much annoyance from the culex and anopheles mosquitoes during 1946, most of which were bred in gardens and vacant lots. To meet this problem we are now conducting an educational campaign in our schools and community clubs. We show moving pictures depicting control work and places where mosquitoes breed, and answer questions from the audience. We have given over 235 showings since he program started. This is proving very helpful and is serving to keep public interest alive in the program.

By our educational program, we hope that eventually householders and farmers will voluntarily eliminate the mosquito breeding places around their own premises. During the latter part of May, our Boy Scouts distribute an informative pamphlet on mosquito control to every home. They also inspect all yards and gardens and point out breeding places. We have conducted such a campaign for the past two seasons and it has proved very helpful.

In conclusion I should like to again thank all the various officials of Mosquito Control Districts in California who have been so patient in answering my questions concerning control problems. The information you have given me has been invaluable to us in solving our local situation in and around Portland. I am afraid that if it had not been for your assistance and encouragement, we might have despaired of ever finding solutions to fit a condition that, at times, seemed almost staggering in its proportions. I hope that the day will come when we may be able to reciprocate in some way for your many courtesies.

Mr. Raley: Gentlemen, as I warned you, you'll have to look to your laurels. When Mrs. Lee entered the picture she really entered the picture. She wanted the law changed and she took care of that. When she wanted equipment, she took care of that. Sometimes we get a little narrow in our view, and that is a very worthy paper and very refreshing, and should be a stimulation to us.

Mr. Gray: May I make a couple of announcements? I have here a series of application blanks for membership in the American Mosquito Control Association, signed by myself and Harry Stage or Tom McGowan, and will be very glad to have those of you who are not members of the Association join. We would sure like to have a lot more members out here on the Pacific Coast.

The other announcement I would like to make is that the Alameda County Mosquito Abatement District has put in some of its equipment, including a power sprayer and a jeep with a "plumber's nightmare," a weasel with sprayer and also a truck with a Hessian aerosol machine on it. They are all parked in the back of Agriculture Hall, and you can take a look at them at noon.

Mr. Raley: With our late start, I think it might be wise to disrupt our program a wee bit, hoping that we can pick up as we go on through the day and get our time balanced back. Therefore, with the permission of Mr. Mondala, I will at this time call a recess. It might be worthwhile for you to walk around in back and see some of that equipment.

Mr. Gray: We will reserve that equipment until after lunch, so try to get back early after you have had your lunch. At that time we will show the equipment. So take a very short recess now so that we can go ahead with the program.

RECESS

Mr. Raley: I hope you all enjoyed the recess. Being President gives me a little authority, as I learned from Art last year, along in our Executive Committee group. We have a Vice-President. This year I am very happy to introduce Mr. Sperbeck of the Sutter-Yuba District as Vice-President of the California Mosquito Control Association for 1948 and to ask him to carry on from this point.

Mr. Sperbeck: Thanks, Ted. I thought when I got the job as Vice-President, it would be only to relieve the President in his absence; yet he's right on hand — I hope this isn't a precedent he is starting here, and that he won't pass the buck too often.

We are behind with our schedule this morning and there are going to be some changes made in the program. The next to the last two papers will be changed and worked into the afternoon session. So I will now introduce Mr. Mitchell Mondala of the State Health Department, Seattle, Washington.

REPORT FROM STATE OF WASHINGTON

M. Mondala

Advisory Sanitarian, State Health Department
Seattle, Washington

Mr. Mondala: To be sure that no one misses my talk, will you check the hall, because this is going to be like a Joe Louis fight and if they are not here the first minute they are going to miss my whole presentation.

Mosquito control in the state of Washington is rather in its infancy. Our oldest district is just starting its third year. Most of the mosquito control work in the state of Washington was started when there was pressure put on by various civic groups. The thinners in the apple orchards refused to work because of the mosquito population. When the growers had to come forth with extra premiums in salaries in order to get apple thinners into the orchards, immediately the problem of doing a good job of mosquito control reared its ugly head and the health department was asked to give some advice — actually very little advice, but mostly to furnish the various districts with a lot of money. But then, when it was pointed out that we had no money, that we are in the peasant class, that out Director was not appointed by the right Governor, that is, didn't belong to the same party as the Legislature, we got less money. The interest in mosquito control in the state of Washington varies with the influx of the various mosquitoes. When the Columbia River is up, and mosquitoes are heavy, all the interest is in mosquito control work. Then, when the river goes down and the problem of coming forth with some money is brought up, it seems like the mosquitoes disappear also. The best method of control in Washington, from my viewpoint, is to stay out of the area until at least October or November and then go steaming in there stating that you want to do something about mosquitoes, because then no one is interested, and I can go out and do my other work in sanitation. In 1939 and 40, there is an example of this particular type of interest in mosquito control work in Washington. We had an outbreak of encephalitis, and naturally the thing to do then was to get all the public health people involved, and the usual wire to the Hooper Foundation to come up and help us. Since then, outside of what information Bill Reeves and Dr. Hammon got out of the Yakima Valley, nothing has ever been done about the mosquitoes. Apparently, encephalitis-bearing mosquitoes did not justify such a program, since the mosquitoes were not of a malaria vector species but of the usual pest type of mosquito.

Mr. Sperbeck: Next we will travel to Utah with a detour to Japan, which takes in a lot of territory. So I will introduce Prof. Don M. Rees, Professor of Entomology, University of Utah.

REPORT FROM UTAH (WITH A DETOUR TO JAPAN)

Don M. Rees

Professor of Entomology,
University of Utah, Salt Lake City, Utah

Mr. Chairman, members of the Association, and guests. I think that Dr. Stewart very aptly spoke yesterday of a form of punishment which permits drops of water to drop on the victim's head until they can endure it no longer. These speeches are somewhat like that. Here are a few more drops.

I might say first that I would like to congratulate the members of this Association on the excellent work you are doing. I have been attending these meetings for some time and I have heard today and yesterday the remarks that now this has become big business. I would also like to state that these meetings have grown correspondingly and have become bigger and better. California always does things bigger and better than anyone else and I am a close enough neighbor to agree with it, I think, and mean it.

My paper today, on mosquito abatement in Utah, and then a detour by way of Japan, I will try to make brief in the interest of time. I have a few slides of mosquito conditions as they exist in Japan and Okinawa, but I think it is better to dispense with them and just present the paper.

MOSQUITO ABATEMENT IN UTAH DURING 1947

During the year 1947 the Centennial Celebration, commemorating the settlement of Utah, was held in Salt Lake City. As part of the Centennial program open air gatherings were held in some part of the city practically every day and evening throughout the summer months. The Board of Trustees, Supervisor of the District, and other employees made a special effort to control mosquitoes during 1947 and thus contribute to the enjoyment and comfort of the residents of the city and visitors attending the Centennial Celebration. This required careful planning in advance, and continuous diligent effort throughout the mosquito season. As a result, mosquito abatement work was very effective and satisfactory. The Board of Trustees, Supervisor and employees were commended by the Governor of the State, Mayor of the City, Centennial Committee and the Press for the excellent results accomplished by this organization.

In addition to mosquito control measures and equipment that had previously been used effectively in the district, fogging attachments were placed on several mosquito abatement trucks. This fogging equipment was used with good results on mosquito breeding grounds but was most effective as a means of eliminating adult mosquitoes from the area where outdoor gatherings were held. The fog, containing pyrethrum, DDT, thanite or mixtures of these chemicals, was released just prior to the outdoor gatherings, where and when any mosquito annoyance seemed probable. This new weapon worked very well as an additional safeguard in protecting the public from mosquitoes, and contributed materially to the effectiveness of mosquito control work in Salt Lake City during the mosquito season.

The Board of Trustees of the Salt Lake City Mosquito Abatement District raised the tax levy for 1948 from .2 to .3 of a mill. This levy will provide an income of about $45,000. The raise was necessary to provide for the increase in wages, materials and other increased costs of operation. The maximum levy set by law is one mill.

The Box Elder County Mosquito Abatement District, which has been operating since 1945, reported a very successful year in Box Elder County.

The Magna Mosquito Control District completed in 1947 their first season of operation. An efficient drainage system of 34 miles was installed. About 26 miles were constructed through the use of ditching dynamite, in which approximately three carloads of powder was used. The Magna District has also employed two men under the G. I. Training Program. This is the first time this program has been used in mosquito control work in Utah.

Weber County Mosquito Abatement District was officially organized in 1947 as the fourth abatement district in Utah. A Board of Trustees was organized and Dr. O. Whitney Young, of the Biology Department of Weber College, was appointed to supervise the work. Mosquito Control was started, and progress was reported as very satisfactory.

At present residents of Logan, Cache County, are attempting to organize an abatement district, and the organization of districts is under consideration in Davis, Utah and Sevier Counties.

MOSQUITO PROBLEMS IN JAPAN AND OKINAWA DURING 1947

By Don M. Rees, Ph. D.*
University of Utah
Salt Lake City, Utah

This report is an attempt to present some of the important mosquito problems of Japan and Okinawa as they existed during the summer of 1947, as observed and interpreted by the author. I would like it understood that this is not an official report from any governmental agency, nor does it necessarily reflect the opinion of other members of the commission of which I was a member.

JAPAN

Harold Gray, as a result of his trip to Japan in 1946, has presented an excellent article in the March, 1947, number of the "Mosquito News," entitled "Mosquito Control Problems in Japan." The article I am presenting today is prepared as a follow-up report with emphasis on developments within the past year.

A number of mosquito studies are in progress in Japan at the present time. Among the Japanese Dr. Manabu Sasa of the Government Institute for Infectious Diseases, in conjunction with Dr. Masami Kitaoka, Director of the Division of Virus and Rickettsial Diseases of the National Institute of Health, and their associates, are making the most extensive studies. Their work is based on the role of mosquitoes as vectors of disease, but also includes: taxonomy, distribution, life history, and feeding habits of all species encountered. However, the most extensive study of mosquitoes in Japan is being conducted by the 207th Malaria Survey Detachment, stationed in Kyoto, under Capt. Walter J. LaCassee, Sanitary Corps, U. S. A. Intensive collecting of larvae of all species of mosquitoes in Japan was started by this Survey Unit in the spring of 1946. A report of this study was released on May 1, 1947. During 1947 about twelve men were engaged in collecting mosquito material and extensive data from all parts of Japan. Several Japanese artists were also engaged in preparing drawings of adults and larvae to be used in the final report. This should be an excellent contribution when completed.

The services of Drs. Sasa, Asanuma, Miura and others were obtained to assist the Virus Commission during the summer in the Arthropod collections and studies. Capt. LaCasse also assisted the Commission in every way possible.

Mosquito collections were obtained by the Commission for virus studies from various parts of Japan. Samples were taken primarily of living adults but larvae were also included as a necessary part of the investigation. Adults were taken by sucking tubes and light trap to which a large collecting bag was attached in place of a killing jar. Mosquitoes collected by sucking tubes were taken from houses and public buildings, animal shelters, natural shelters and while feeding on man and animals. All adults were taken in these collections as they appeared, with no attempt at selection of species. The light trap, of the New Jersey type but larger in size, was operated in Japan only in Tokyo. It was set up in various parts of the city in the

*Member of the Virus and Rickettsial Disease Commission, Army Epidemeological Board, Office of Surgeon General in Japan and Orient during the summer of 1947.

vicinity of mosquito producing water. As a result of all collections, eleven species were taken in Japan and seven of these were in sufficient numbers to be used in virus studies. Adult Collections were as follows:

	Numbers	Percent
Culex tritaeniorhynchus	5060	44.34%
Culex pipiens pallens	3823	33.51%
Anopheles hyrcanus sinensis	2119	18.57%
Aedes albopictus	150	1.31%
Armigeres subalbatus	142	1.24%
Aedes vexans japonicus	83	.72%
Aedes togoi	31	.27%
	11,408	100%

The kinds and relative numbers of the mosquitoes taken in the collection are indicative of the mosquito population in Tokyo and vicinity, for the months of July and August. The same relationship exists in general throughout the major islands of Japan.

Mosquito abatement work in Japan is being carried on, after a fashion, on an extensive scale. Each Prefecture has its own organization, which is subdivided into Ku's and these into smaller units. The program tries to provide a six-man team for every 10,000 population. In Tokyo area there were 360 field teams and 6 training teams, a total of 2196 men on mosquito and fly control. In one Prefecture there were 6,600 men engaged in this work. The control work consisted almost entirely in the use of 5% DDT as a residual spray. The material, equipment, and general supervision is provided by the U. S. Military Government. In addition, the Military Government is carrying on an educational program among the Japanese with films and demonstrations by trained teams.

No systematic inspections for larvae, use of larvicides or other generally accepted mosquito control practices other than residual spraying and dusting were included in the program last summer. However, small minnows, similar to Gambusia, were very abundant in some rice paddies and when present mosquito breeding was effectively controlled. It was reported these fish were being planted in certain localities by mosquito control workers. As a result of the elimination of many of the artificial mosquito producing containers in 1946, and the use of DDT, as a residual insecticide in 1947, the Mosquito and fly situation was reported as greatly improved. From my own observations, mosquitoes were not very numerous in central Tokyo. However, they were quite annoying in certain suburban sections, and as many as 2,000 mosquitoes were taken in our light trap in one night.

OKINAWA

One of the most interesting parts of the trip occurred during the second week in August when I spent eight days in Okinawa. According to reports, mosquito control work on this island was very effective soon after it was taken over by our military forces.

At the time of our arrival it was apparent that the Okinawans were starting to flood rice paddies that had not been used since the beginning of the war, thus greatly increasing the mosquito control problem. Mosquito control work at the time was directly in charge of a group of Philippine Scouts. The control program consisted of weekly inspections at a few designated stations, but no consideration was given to the paddies that had been flooded since the stations were selected. Actual control work was limited almost entirely to the spraying of native dwellings with DDT for residual effect. This had little if any effect on *Culex tritaenoirhynchus* and other rice paddy breeders.

The first night the light trap was operated at the 37th Station Hospital where we were billeted, 1700 mosquitoes were collected. During the week, from the light trap and sucking tubes, the following collections were made and prepared for virus studies:

	Number	Percent
Culex tritaenoirhynchus	2986	65%
Anopheles hyrcanus sinensis	831	18%
Culex quinquefasciatus	742	16%
Mansonia uniformis	51	1%
	4610	100%

This is representative of the mosquito population on Okinawa at this time of the year. Although additional mosquitoes of the above species were taken, they were in about the same relative numbers and were not retained. A few of the more rare species were also taken but not in sufficient numbers to be included.

It was obvious from observations and the collections taken that mosquito abatement was not even approaching maximum efficiency. As a result of the increase in Anopheles mosquitoes a serious outbreak of malaria was taking place among our military forces while we were there. This outbreak of malaria did not reach its peak until several weeks later. To think that this situation occurred among our own military forces in 1947, after such recent and disastrous experiences with malaria in World War II and in the face of the information we now have on the subject, seems incredible. It was nothing more than the result of a false sense of security, and a plain case of neglect of the most important phase of an anti-malaria program, "Mosquito Control."

Mr. Sperbeck: Thank you, Dr. Rees, for your interesting presentation. Arthur Lindquist will now introduce his co-worker to present our next paper.

ACTIVITIES OF UNITED STATES DEPARTMENT OF AGRICULTURE LABORATORY

Mr. Lindquist: Mr. Chairman, ladies and gentlemen: The Oregon-Washington feud over the flight of mosquitoes has been going in for a number of years. It has become so serious that we have considered tagging a number of these mosquitoes in order to determine how many of the Washington mosquitoes get over to the Oregon side and how many of the Oregon mosquitoes get over to the Washington side. But I don't think that we are going to have to do that now. I believe that in a very short time the Washington people will be out controlling mosquitoes as the Oregon people are doing, and then we will not have any mosquitoes. Presumably the feud will end. I would like now to present Mr. W. W. Yates of our Corvallis, Oregon, office, who will present a paper on "A Comparison of the Toxicity of DDT, TDE, and the Methoxy Analog of DDT to Several Species of Mosquitoes."

Mr. Yates: I would like to make just one remark about this control work around Portland and Vancouver. It has its disadvantages. We go out every year and bring in big tubs of dirt to get larvae of *Aedes* mosquitoes to work with during the winter. But it has gotten so that we can't go over in the Portland area any more and get that. We have to go now and make a trip about eight or nine miles down the Columbia on the Vancouver side. If they control farther down, I don't know where I'm going to get my dirt. I think we'll have to reserve a certain area there so I still can get the larvae that I want to work with.

My paper has to do with the technical feature of control. We are doing lots of testing in the laboratory of different new insecticides on the different species of mosquitoes, and have found some rather interesting results. This paper has to do with one phase of it — that of comparing results secured by testing DDT, TDE, and the analogs against larvae of several species, also against adults.

A COMPARISON OF THE TOXICITY OF DDT, TDE AND THE METHOXY ANALOG OF DDT TO SEVERAL SPECIES OF MOSQUITOES

By W. W. Yates
U.S.D.A., Agr. Res. Adm.,
Bureau of Entomology and Plant Quarantine

The value of DDT as a larvicide to control mosquito larvae and adults is well established. The literature shows that some attention has been given to other organic chemicals that are closely related to DDT. Prill *et al.* (1946) described 32 compounds related to DDT and compared their toxicity against mosquito larvae and houseflies, and among the compounds that showed the most promise were TDE and the methoxy analog. Deonier (1946) found that TDE was as toxic to *Anopheles quadrimaculatus* larvae as DDT and that the methoxy analog was slightly less toxic.

During the past season investigations at the Corvallis, Oregon, laboratory of the Bureau of Entomology and Plant Quarantine have included larvicide testing on several common species of mosquitoes. Among the chemicals tested and compared with DDT were TDE and the methoxy analog. The effect of residual deposits on adult mosquitoes has also been determined.

Tests against larvae: In the routine laboratory testing different chemicals dissolved in acetone were applied as suspensions. The three chemicals were also used in the form of emulsions, and on *Culex tarsalis* DDT was used as a suspension made from a wettable powder. The emulsions of DDT and TDE were commercially prepared 25 per cent concentrates. The emulsion of the methoxy analog of DDT was prepared in the laboratory and contained 10 per cent of active ingredient, plus 85 per cent of xylene and 5 per cent of Triton B-1956 (a phthalic glyceryl alkyd resin) as the emulsifier. Tests were made in beakers containing 600 ml. of water, and 25 fourth-instar larvae were used in each beaker. Each test was replicated three to five times. All tests were made at 75° F., except for mountain *Aedes,* which was tested at 50°-60°. A sample of TDE was received too late to be tested against *Aedes* larvae.

The results of these tests are given in Table I. All three chemicals proved to be good larvicides. The outstanding finding was the wide range in susceptibility of different species. DDT at a concentration of 1 part to 5 million parts of water killed only 55 per cent of the *Aedes varipalpus* larvae in 48 hours, and *Culiseta incidens* required 1 part to 70 million for a 72 per cent kill in 48 hours, whereas at the other extreme 85 per cent of the mountain *Aedes* were killed with a concentration of 1 to 600 million within 48 hours. The three chemicals exhibited considerable selectivity in their toxicity, the methoxy analog causing 59 per cent mortality of mountain *Aedes* in 48 hours at a dilution of 1 to 600 million, as compared with 85 per cent for DDT at the same dilution. On floodwater *Aedes* DDT at a dilution of 1 to 300 million gave 89 per cent mortality in 48 hours and the methoxy analog at the same dilution 77 per cent. DDT was also superior to the methoxy analog and TDE when tested against *Culiseta incidens.* Against the two *Culex* species DDT at a dilution of 1 to 400 million gave better kills than the methoxy analog, but TDE proved as good as DDT. With *Anopheles* larvae there was little difference between the chemicals. Emulsions of DDT and TDE gave better kills than did the acetone suspensions but the reverse was true for the methoxy analog, which was a much quicker breaking emulsion than the others. The suspension of wettable DDT was considerably less toxic than either the acetone suspension or the emulsion of this chemical.

A few tests with goldfish were made. One part of DDT to 10 million parts of water killed the fish. TDE at this concentration was nontoxic, and the methoxy analog affected the fish but they recovered. TDE at 1 to 5 million affected fish but did not kill them. Several hundred larvae killed with DDT and TDE were fed to hungry fish for a 2-day period. The fish fed the DDT-killed larvae ate greedily with no ill effect. Those fed the TDE-killed larvae ate sparingly, and finally one died in this lot.

Tests against Adults: The adults of several species of mosquitoes were exposed to residual deposits of the three chemicals to determine knock-down time. Two-quart jars were coated on the inside with 10 mg. of chemical to 1 square foot of surface by dissolving the material in acetone and rotating the jars until the solvent evaporated. From 15 to 20 mosquitoes, usually 24 to 48 hours old, were used in each jar, and three or more replicates were made.

Table II gives the time required for complete knock-down. The time for males and females is reported separately, as invariably the males were knocked down in less time than the females. It is apparent that the chemicals exhibit a selectivity in speed of knock-down and that considerable differences in susceptibility of species occurs. *Culiseta insidens* females were knocked down by DDT in about one-fourth the time required by females of the *Culex* species and in one-third the time required by *Anopheles punctipennis.* Against *C. incidens* DDT was twice as effective as its methoxy analog and three times as effective as TDE. Against *A. punctipennis* there was little difference between the chemicals.

Culex tarsalis adults were used to test the toxicity with limited exposure. In these tests jars were coated with 1 mg. of poison per square foot, and mosquitoes were exposed for 1 minute and then removed to clean cages. After 24 hours 94 per cent of the females and 100 per cent of the males were dead after being exposed to DDT and the methoxy analog. With TDE the mortality was 86 per cent for females and 94 per cent for males.

TABLE I.—Toxicity of DDT, TDE, and methoxy analog of DDT to several species of mosquitoes. Material applied as an acetone suspension unless otherwise indicated.

Species	1 part of toxicant to indicated million parts of water	Percentage mortality of mosquitoes after indicated intervals: DDT 24 Hrs.	DDT 48 Hrs.	Methoxy analog 24 Hrs.	Methoxy analog 48 Hrs.	TDE 24 Hrs.	TDE 48 Hrs.
Culiseta incidens (Thomson)	50	57	85	34	65	67	79
	70	68	72	20	41	32	48
Aedes varipalpus (Coq.)	5	28	55	77	85		
	10	5	18	30	48		
Mountain *Aedes*[1]	400	72	100	84	100		
	500	57	89	49	89		
	600	38	85	31	59		
Floodwater *Aedes*[2]	250	68	87	78	85		
	300	54	89	53	77		
	350	37	87				
Culex tarsalis (Coq.)	300	87	88	81	87	91	97
	400	77	87	57	81	73	91
	600[3]	57	81	39	51	49	74
	400[4]	97	99	29	49	96	98
	600[4]	82	88	20	22	77	85
Culex pipiens (Linnaeus)	300	81	96	83	95	88	97
	350	84	95	81	95	75	89
	400	75	89	63	80	63	86
Anopheles punctipennis (Say)	300	76	96	63	97	55	88
	400	65	89	57	87	53	81
	600	51	76	44	78	43	79

1. 93 per cent *A. communis* (DeGeer), 6 per cent *A. hexodontus* (Dyar), 1 per cent *Aedes* sp.
2. 68 per cent *A. vexans* (Meigen) and 32 per cent *A. lateralis* (Meigen).
3. Wettable DDT killed 36 per cent in 24 hours and 45 per cent in 48 hours.
4. Compounds in emulsion.

TABLE II.—Minutes required to knock down mosquitoes exposed continuously to residual deposits of DDT, TDE, and the methoxy analog of DDT in jars coated with 10 mg. of toxicant per square foot.

Chemical	*Culiseta incidens* Female	*Culiseta incidens* Male	*Culex tarsalis* Female	*Culex tarsalis* Male	*Culex pipiens* Female	*Culex pipiens* Male	*Anopheles punctipennis* Female	*Anopheles punctipennis* Male
DDT	10	9.3	39	32	38	31	27	22
Methoxy analog	24	16	37	28	57	24	32	26
TDE	37	22	57	37	44	31	26	21

Summary: A study was made to determine the effectiveness of various insecticides—DDT, TDE, and the methoxy analog of DDT—applied as larvicides and as residual sprays against adults of several species of mosquitoes. These chemicals exhibited considerable selectivity in their toxicity to these insects. Larvae of different species varied greatly in their susceptibility to these poisons. In general DDT and TDE were about equal as larvicides against all the species tested, and the methoxy analog was slightly less toxic. DDT was more toxic to goldfish than either of the other chemicals. When used as a residual deposit against adults, DDT gave much faster knock-down of *Culiseta incidens* than did TDE and the methoxy analog, but with *Anopheles punctipennis* the three chemicals were nearly equal. In most of the tests the methoxy analog was superior to TDE as a knock-down agent, but not quite so good as DDT.

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Mr. Sperbeck: The remainder of the papers will be worked into the afternoon session and we are all very sorry that Stan Freeborn, Assistant Dean of the College of Agriculture at the University of California, was unable to be here today to give his paper. I know that we will miss his presentation. We have always enjoyed them very much. But the other two papers will be worked in later this afternoon.

If there are no announcements at this time, we will adjourn and all be back here a little before 1:30 so that we can get started on time.

Mr. Raley: In order to speed this thing up and to give these people in the afternoon session due time, I wonder if we can't get back about one o'clock to observe the various pieces of equipment out in back. The formal meeting will take up at 1:30.

Mr. Gray: All employees of the Alameda County Mosquito Abatement District will please be back at one o'clock.

FRIDAY AFTERNOON, FEBRUARY 13, 1948

Mr. Raley: We will keep rolling along. I want to thank you for your ready response in getting back from lunch for the equipment demonstration. If I may at this time, I am going to take the liberty of doing something that I very much want to do. You have heard one comment already on the "plumber's nightmare," and many of you are familiar with it. I have gotten a lot of glory from that. But, as I told you last year, any glory that I get is merely reflected glory from work that was done by another man. I just happened to be boss. There was one man that spent many hours and burned his fingers and fought mosquitoes and did everything unpleasant to develop that piece of equipment. I would like to introduce that man now, and I do hope that you will keep this straight in your mind — that the "plumber's nightmare" is usually referred to as my pet, but someone else actually did the work. I am going to ask Bill Miller from Sutter-Yuba to stand up. Bill spent many hours on the "plumber's nightmare."

To get right along, we'll pick up on the program where we left off before lunch.

I want now to introduce the man who to me is the father of mosquito control in California, and at this time Professor Emeritus, University of California, Berkeley, California, who will give us a paper on public relations in mosquito control work — Prof. Herms.

Prof. Herms: Mr. Chairman, and friends of the Mosquito Control Association: Usually, my papers are of the technical or semi-technical nature. I was a bit interested and a bit concerned when I was asked to give a paper that seemed to be rather completely out of my line. I began wondering just why that was done. Discovery is the thing that keeps us alive and on our toes, and even at my age I am making discoveries from day to day, so I made a discovery earier this week. I gave a paper at a meeting, on Monday I think it was, and after I had competed the paper the gentleman who was presiding remarked that my paper was on the moralizing side. I began to wonder why I had reached that particular state in life where I would begin to moralize. I did learn then that there are two periods in one's life when you moralize. The first period is in one's youth when he is yet inexperienced, and again in his old age, when he ought to know better. So then I began wondering, don't you see, about those two periods in life — one towards the beginning of one's life and the other towards the latter end, what all occurred between. Are we unmoral or are we demoralized during that period of time? Well, I got some evidence on that just this morning that helped me considerably. In ;'Time," I think it was, that just came to hand, there is this item: It helped me tremendously because it shows what happens between the two extremes. In Cambridge, Massachusetts, a housewife explained why she kept her husband drunk. Sober, he made thirty dollars a week. In jail, he made her eligible for sixty dollars a week. So there's your demoralizing influence.

PUBLIC RELATIONS IN MOSQUITO CONTROL OPERATIONS

By WILLIAM B. HERMS, SC. D.

Professor of Parasitology, Emeritus, University of California, and Consultant, California State Department of Public Health

When asked to present a paper dealing with public relations at this meeting, I was inclined to refuse the invitation, primarily because of my ignorance of the subject. However, on second thought it occurred to me that this might be an interesting assignment and an opportunity to learn something about this much discussed subject.

On consulting two or three well-informed public relations men, I found that there are college courses in public relations, mostly post-graduate courses in the field of business administration, and that among the auditors are men with legal training; also some engineers. For me to present a paper on such a high powered subject seems presumptuous; however, I do recall that I was a college professor for some forty years without having had prior formal training in pedagogy, so why not undertake a thirty-minute discussion of public relations without benefit of prior academic tutelage? I know full well that someone in this audience is saying to himself (and I say it out loud) that I would probably have been a better teacher had I received some formal instruction in pedagogy — education, I believe, is the proper label. It is conceivable that I might have been a poorer teacher at that. Be that as it may, you and I are daily, and have been for years privately, in the midst of public relations, good or bad, so far as we are concerned individually. Our concern today is with public opinion or public reaction to what we do and what we say in our capacity as members of mosquito control units. How does our conduct as individuals affect the attitude of the public toward the organization with which we are connected?

In our control work the public often consists of one individual, i. e., one person at a time. To illustrate what I mean by this man to man public relations, I recall sitting some 35 years ago with a farmer beside an anopheline-infested irrigation ditch in the northern Sacramento Valley (that has happened many times since), attempting to explain to him that these insects are involved in his ill health, chills and fever. Above the ditch on the road there was an automobile that bore the label, State of California, Board of Health, and I had introduced myself as being connected both with the University of California and the State Board of Health. I don't know which of us suffered the severest handicap, but you will agree with me that I was up to my ears in public relations. Such incidents were repeated many, many times during our statewide survey of malaria-mosquito conditions in California. This survey covering 20,000 miles by automobile was conducted during the summer months of 1915 to 1919 inclusive, with a year out for World War I. I don't know how much a prior course in public relations would have helped me to gain the confidence of those individual farmers and others in what I was proposing. This I do know — you had better know well the scientific field in which you are functioning. I am equally certain that high pressure salesmanship, based on a smidgeon of truth, as is commonly the case in such procedures, is downright poor public relations. We should not forget that in the practice of mosquito control we are actually engaged in an educational program, and education is a slow process, requiring much patience. Even the badge of your office, if authorized to wear a badge, should be used sparingly except as a means of identification. There are rare instances when you may need a badge of authority as a recognized procedure in gaining good public relations. Ordinarily the forceful use of authority to speed up a program only results in poor public relations.

Good public relations on a man to man basis is still good practice but there are so many more of us engaged in mosquito control; the several units (mosquito abatement districts and other similar units) often consist of a dozen or more individuals, including office personnel and laborers. This behooves all of us to observe good internal relations. It has been well said that good public relations is good private relations turned inside out. It is highly important that all members of a given unit (district) work in harmony and understanding. It doesn't sound like a harmonious situation when the engineer or manager of a district assigns the entomologist to some particular duty just to get him out of his, the manager's, hair. Having dealt with entomologists for many years in many connections, I am confident that these men, if properly qualified, are capable of contributing very greatly to the success of mosquito control operations. These operations, to be successful, must be fundamentally governed by a technical knowledge of mosquitoes, which you must recognize as insects whose biology, particularly ecology, is outside the usual ken of the engineer and business administrator. This being the case, it is easy to see how the entomologist who has had a radically different training can easily get into the hair of his superior officer. I use the word superior also because, too often, the relationship is exactly that, whereas the internal attitude should be one of cooperation, working together in the interests of the public. Don't be alarmed when your entomologist uses his imagination to develop new ideas and approaches. As a teacher who has helped to train many of these individuals, I would feel that I was being let down if it were otherwise. On the other hand, I would caution our entomologists to always bear in mind our objectives in this work. I want them to keep their feet on the ground even though their heads are at times in the clouds. You look down to see what you are doing, but your ideas may come from the clouds. If the entomologist is an experimentalist, let his experiments have a definite bearing on a better knowledge of mosquitoes, their behavior, ecology and control. If the entomologist is particularly interested in taxonomy, let him bear in mind that we must have accurate identification of mosquitoes in order to effect successful control but that mosquito taxonomy in this instance is a means to an end and not an end in itself. If each of us will try very hard to understand the viewpoint of the other and all work together in harmony, our several units will do a top job in public relations.

Obviously, I feel deeply about our relations to the public, having had some responsibtility in mosquito control operations over a long period of years. Health is a precious commodity and mosquito control has such implications. We want the public to have the full truth about this commodity, in which California citizens have a very large investment. I refer to public health in its various applications, such as mosquito control or the overall program of vector control as a commodity, because the public gets just about what it pays for. Let us deliver an honest bill of goods: We don't want a lot of high pressure salesmen overcharged with half-baked knowledge peddling it under the guise of scientific authority. The service which you render for the most part has placed your work in the spotlight of favorable opinion. The public will continue to be favorable and your favor will be expanded as long as it, the public, understands the methods and purposes of your program. Use every legitimate means to foster this understanding, but do not confuse the term "public relations" with the word "publicity," as I shall point out later.

Naturally, I have spent some time during the past few weeks reading dissertations on public relations but I find practically all off these are concerned with commercial enterprises. Many of the ideas, however, presented in the material which I have consulted may be useful to us. Definitions that fit our work apparently do not exist. The Director of Public Relations of the General Motors Corporation has this to say, "Public Relations is a fundamental attitude of mind, a philosophy of management which deliberately and with enlightened selfishness places the broad interests of the customer first in decisions affecting the operations of the business itself." Undoubtedly this definition was, and is, an answer by big business to the unfortunate impression gained by the public long since from the famous, or infamous, statement made by a well-known financier whose name I need not mention, during an interview with a reporter, at which time the reporter mentioned the public criticism of that financier's policies, to which the latter replied, "The public be damned." That probably marked the beginning of a new field in business, namely, "public relations." I might inject a nasty note at this point by remarking that there are still some bureaucrats that spend the people's money with a public be damned attitude. I trust we have none of these among us.

I have found nothing in my reading of pertinent literature that seriously disagrees with what I have said in my introductory remarks. Truth stands out as a fundamental requisite to good public relations. From what I have learned, I prefer to think of public relations as a philosophy applicable to all organizations — business, professional, fraternal, civic, and public, and to individuals as well. A public relations friend of mine advised me that the basic law governing public relations was laid down by the Apostle Matthew, when he said: "Therefore, all things whatsoever ye would that men should do unto you, do ye even so to them." In other words, deal with your public in matters concerning mosquito control as you would wish to be treated were the situation reversed.

It is possible to test or gauge any organization's public relations by the support it engenders from the public and by the organization s total effect upon the life of the community. That manifestly takes time, for education is a slow process. It may be some time before the public will welcome you with open arms every time you show up with your aerosol equipment.

A well-known public relations authority poses the question: "Is the community better off with the organization than it would be without it?"—and the collective answer of the community given to that question determines the quality of the public relations job which the organization has accomplished.

At this point I wish to urge the most friendly cooperation with Farm Advisors, County Agents, Agricultural Commissioners, County Health Officers and other official representatives of agencies in your area who should be interested in your work.

Many different views have been expressed as to what actually is embraced within the work of the public relations department of any organization or institution. Many have confused the work of press agents and publicity men with that of a true public relations counsel. It has been said that a publicity representative is a press agent when he puts on a necktie, and if he wears a coat and has some semblance of dignity, he becomes a public relations counsel.

Actually, a press agent is the weaver of yarns and stories designed to get the name of the person or organization he represents into print. To the press agent, it matters not whether this public notice be by way of notoriety or as the result of constructive news. His work is colorful and interesting, but definitely not public relations. Thus, the press agent glamorizes his client, such as an actress who is selected as the "Pin-up Girl of the Year." I don't know how you would go about glamorizing a female mosquito. I recall participating in the distribution of a pamphlet dealing with malaria prevention. On the cover of this pamphlet there appeared a grotesque picture of a mosquito with the title "This is 'Ann'; she's dying to meet you." I always felt like apologizing when handing out this document to medical officers and others who were to use it.

On the other hand, the publicity man usually scorns imagination and confines himself to the facts. If he is hired by the manufacturer of cheese, for example, he learns all he can about his client's product and reports it to the trade magazines and newspapers. Just look at the magazine "ads" and listen to the radio, and you won't want to be without cheese. That sort of thing you can do—the truth of the matter is that prosaic mosquito control can be superbly sold as something the public won't want to be without. Think about it!

Rarely, if ever, is either a press agent or a publicity man consulted on policy matters, and therein lies the great difference between them and the person charged with the responsibility for the public relations program of any organization.

The public relations approach to publicity is limited and defined by the organization's policy and its program, which are first determined in the light of the organization's problems, personalities, limitations, aspirations, competitive position—if any—and social responsibility. The selection of material and timing of releases are two of the most desirable elements in any program designed to obtain public favor or support. More than anything else, perhaps, time and selection involve good judgment. And good judgment is, indeed, a rare quality. It should be a prime quality of a public relations man. Good judgment should characterize your dealings with the public.

Another rare and valuable gift is the ability to write a story for exactly what it will be worth to the editor of a publication, rather than to the person who is preparing the story. Experience in newspaper writing could be an asset in your public relations work.

The quality of public relations is determined wholly by public opinion. This is particularly true in a free country. Public opinion is a great force in America and it is the force by which all responsible men and organizations seek to have mirrored a warm and friendly attitude or, if that is not possible, at least a respected reflection of themselves and their activities in the public mind. To be accepted by the public, to be recognized as a leader in community thought and action, is a very great privilege, but one which carries with it an equally great responsibility. An organization, even like an individual, cannot be all things to all men. He who seeks to please everyone soon finds that he is pleasing no one.

No public relations program is "worth a hoot" unless it does mold public opinion. As Abraham Lincoln once remarked, "Public sentiment is everything; with public sentiment, nothing can fail—without it, nothing can succeed. Consequently, he who molds public opinion goes deeper than he who enacts statutes or pronounces decisions."

The extent of public opinion on any given subject is the extent of the education of the public on that subject. You have an educational function. Everyone's views are based on information and impressions. But public opinion can only be a force for good when truth is unfettered and men's tongues and minds and hands are not shackled to the will of a totalitarian government. Whether you are employed by the State Board of Health, Mosquito Abatement District or any other agency, remember your dignity as free agents in a free country, but also remember well your responsibility.

Today the need for men to know the truth is perhaps greater than at any other time in our history—greater because of the great conflict in ideologies which the world is now experiencing. We cannot and we must not be afraid to expose our point of view to public consideration. Just as competition in business develops the greatest advantage to the buyer of merchandise, so too does competition in opinion create balances which benefit the public. And so it is that free and open discussions have always helped to clarify issues and create better basic understandings.

All too often we fail to think of the real significance of the words we use, even on those occasions when we are trying to influence others to our way of thinking. And that is unfortunate. The power of words to move us, mold us, and to activate us is sometimes so mysteriously subconscious that to most people it seems something apart. Unless we devote considerable thought to the subject, we are apt to overlook the all-pervasive influence of the language we use. As a consequence, care must be exercised to avoid public misunderstandings. Be sure your listeners or your readers know what you mean. Do everything within your power to make certain everyone understands the thought you are trying to convey. The selection of the proper words at the right time is most important.

The real public relations of any organization, its real standing in public opinion and esteem, are determined: first, by what the organization stands for and *does* in its daily contacts with the public; second, by the manner in which it serves its public; and, finally, what it tells the public about itself, its work, its services, and — *how* it tells its story.

There is no substitute for truth and sincerity. One should never build up fictitious or imaginary issues. Treat those that do exist with the best understanding you can develop, and always with sincerity and truth.

No discussion of public relations would be complete without discussing the media through which all persons and organizations must tell their story to the public.

The first of these media I would list are newspapers. There are nearly two thousand daily newspapers and more than ten thousand weekly papers published in the United States. They are still the backbone of the nation's news distributing system.

Newspapers are not interested in sheer propaganda — they are interested in *news*. Each paper has its own editorial staff and its own editorial policy.

Few, indeed — if any — there are among the publishers and editors who do not place public interest above all else in establishing their editorial policies.

The second I would list is the radio. While radio is largely an instrument of entertainment, it has steadily grown as a power for molding and influencing public opinion. The type and kind of job to be done in public relations for your organization can be done better through public service programs and specialized programs than through the so-called "feature shows."

Third, magazines. There are all kinds of magazines from house organs to national magazines. And a real worthwhile story of what you are doing, your program, its progress or accomplishments, can well be told in magazine articles.

Fourth, newsreels. Newsreels are limited mainly to the dramatic, exciting, pictorial events of the day, and while public relations experts claim that they do not customarily afford opportunity for publicizing the work of public health officials, I feel that I cannot agree. Do you?

Fifth, pamphlets. Pamphlets are regarded as the very first written media for influencing public opinion.

Sixth, personal public appearances. Public appearances by officials and others before civic groups, service clubs, public gatherings, et cetera, are among the most potent means of influencing public opinion. Ability in the art of public speaking is an asset of great value, and care in your personal appearance is much desired.

And, finally, it must always be remembered that while the public relations policy of any organization is the responsibility of top-level management, *every* employee from the highest to the lowest is constantly engaged in public relations activities. And the finest and most enlightened program of public service can be destroyed through the careless or discourteous conduct of employees.

Bad impressions cannot help but lead to unfavorable public opinion. And there are some things which I have found over the years most aggravating to the public and which, if allowed to continue, will certainly damage the individual responsible and his organization. Without attempting to list them in the order of their importance, they are:

(1) An impatient or impudent telephone operator;

(2) A driver of a company car or truck who "hogs" the road, or otherwise violates traffic laws or disregards the common courtesies of the road;

(3) Referring customers or clients from one person to another;

(4) Hard-to-see officials — those who keep callers waiting an undue length of time, or fail to keep appointments promptly;

(5) Failure or unwillingness to tackle a complaint or problem, lying within the scope of the activities of the organization.

These are the things with which the public has but little patience and understandingly so — yet they are the things we must all guard against in the conduct of our offices, for they can develop almost overnight, and oftentimes with the guilty employee justifying such conduct in his own mind.

In conclusion, I should like to give you the ten general principles of any public relations program as laid down by authorities in this field. They are:

1. The program must be justified in terms of expenditures and results.
2. Keep those who pay the bills informed about the use of their money.
3. Keep the program on the offensive — not on the defensive.
4. Get the cooperation of all employees from top to bottom.
5. Base the program on actual facts. Do not build up straw dummies to knock down for effect.
6. The program should be continuous in nature.
7. Satisfied customers are the best measure of the program's effectiveness — or, put another way — public response is the best measure of "how well" you are doing.
8. Impersonal attitude. Do not allow personal jealousies or likes and dislikes to sway your judgment.
9. Proper timing.
10. Do not become a community pest — have good taste.

I might appropriately conclude my remarks with this tenth principle, in which the word "pest" occurs, common ground to avoid for both the public relations man and the mosquito control operator.

In closing I wish to gratefully acknowledge the generous assistance given me by Mr. Edwin B. Moore, Public Relations Council for the California State Automobile Association.

Mr. Raley: Thank you, Prof. I am now reminded of the Keystone comedies, where the head man of the town had several hats and coats, and he would change for the appropriate operation that he was performing at that time. So, to continue with the program, I will change coats and present my paper.

In connection with this, there was a reference yesterday by Dr. Stewart on the drops of water. Today there was another reference by Dr. Rees on drops of water, and I am going to at this time continue that and give you a perfect example of a drip.

PUBLIC RELATIONS IN ACTION

By Theodore G. Raley
Manager, Consolidated Mosquito Abatement District, Selma, California

At the regular meeting of the Board of Trustees in August, 1947, a resolution, based on provisions of the Health and Safety Code, was read into the minutes of the Consolidated Mosquito Abatement District, fixing responsibility for correcting a known source of mosquitoes on the person owning the land upon which the known source occurred. This was probably the most important step in a series aimed toward a goal, efficient mosquito control. This goal has been and will continue to be the objective of the district's "Public Relations."

The decision to fix responsibility on the person or persons maintaining a mosquito source was reached after careful consideration of all facts available. A detailed survey of the 640 odd square miles within the district revealed that a majority of the people were suffering from the indifference and neglect of a minority. To correct this very apparent injustice, and to prepare a firm foundation for the future, the Board decided wisely, that the district could not accept permanently the burden of taking care of an individual's abuse of propriety.

The practical result of this policy has been demonstrated several times within the past few months. One outstanding example had to do with a Mr. X, owner and operator of a trailer camp.

Mr. X, through a desire to squeeze the utmost from the rentals under his control, was operating on the principle that waste water from the various dwellings was indeed waste water, and any effort to dispose of it in a proper manner was waste added to waste. After several routine calls by the operator in that area, Mr. X was politely informed that measures must be taken to correct the condition as it existed. The operator was just as politely informed that Mr. X was glad to have him come round and do any work necessary, but, as far as he was concerned, nô changes would be made. This exchange was carried on for some time between both the operator and Mr. X, and the district foreman and Mr. X. The district was quite content to continue persuasive tactics, but was suddenly confronted with the fact that Mr. X. was laughing at our efforts, as well as spreading the word around the area that the district was just a farce. Amazingly, this talk was having definite results on other land owners. Operators in that zone were repeatedly confronted with the discouraging information that the residents just didn't think they would bother to correct mosquito sources when these were called to their attention. The outgrowth of this was a very frantic call for help from the men in that zone. After investigating, a notice was prepared instructing Mr. X. to abate the nuisance in a specified period of time. Serving this notice took the better part of three weeks, but after successfully cornering the "vacationer," the notice was read to him and, at his request, an additional 24 hours was granted.

The results were very gratifying, and may serve as a guide for all districts. Mr. X. installed a very practical and adequate disposal system. The renters within the trailer court were happy, with a dry, more sanitary front yard. Five, by actual count, new household waste disposal systems were installed within a radius of one quarter of a mile of the tralier court. The operators were able to lift their heads and walk like men again, and the prestige of the district was enhanced.

Other examples could be cited, but each would only stress the very definite results gained by taking positive action when that course is just and expedient. It is remarkable how quickly gossip spreads. Atomic chain reaction must have been first demonstrated when humans started living in close proximity to one another.

Many more steps have been taken, all aimed at one objective. No effort will be made to present these in the order of their importance, but rather, they will be outlined in respect to the time and efforts devoted to them.

Accepting the fact that the best public relations are achieved by keeping the mosquitoes from annoying the taxpayers, more stress is placed on personnel training than all other activities combined. Starting with the theory that the public is very prone to judge the district's activities on its failures, the lowest-paid employee represents the norm for a district's public relations. Consolidated is using every means at its command to train each employee to the limit of his capabilities. Strong emphasis has been placed on the idea that there are no "bosses." Each man is assigned a particular task, with the full understanding that the more highly trained men are there only to help. No effort is made to drive the men, but each is made responsible for the results within his own area. To date this approach has worked to very good advantage, and each employee is a credit to mosquito control.

Service calls, complaints, or what have you, are closely tied to personnel relations but distinct enough to be set apart. Experience has taught that nothing incurs the enmity of a person more fully than to be ignored by a public agency. Every service request is followed up immediately. Careful consideration is given to each one, primarily with the thought of selecting the best qualified person to service the request. This is done for two reasons: first, to give the problem the best answer possible; second, not to step on the toes of one of our own employees. When a man is doing the best he can, with the tools he has to work with, he gets a little griped when someone not fully informed butts into a situation that often has little merit to begin with. It is very easy to foul up a simple complaint with a few ill chosen words.

In the realm of public speaking, Consolidated really hit the jack pot. At best, the average talk on mosquito control is very dry to the layman. Generally, speaking engagements are a fill-in, promoted either by some frantic program chairman or by a sense of duty on the part of one side or the other. Early this summer the district realized that it had something both interesting and instructive to offer to the public. Equally interesting to schools, service clubs, farm groups, or mixed audiences, this program has made more people conscious of the mosquito district than the high tax rate. Instead of being squeezed into programs at the convenience of others, the office has been besieged by requests for speaking dates from both inside and outside the district. This very welcome addition to the district's public relations is Wesley Dickinson, district entomologist, and his collection of snakes. On the surface, snakes and mosquitoes have very little in common, but after critical observation I sincerely recommend some similar step to all districts. Mr. Dickinson's very instructive discourse on the reptiles of the world, and the confidence he displays when handling his pets, gives the audience a truer conception of the part snakes play in our scheme of living. He very adroitly brings out the fact that most people would take very positive action if they found a snake in their bedroom, but these same people exhibit only casual interest over a little mosquito on the bedroom wall. Then he points out that these little mosquitoes are actually responsible for more of the world's ills than the much maligned snakes.

The printed word can be disappointing. In newspaper articles I hold with the school that feels satisfied if the name is spelled correctly. "Canned" releases are usually like some other canned goods, corny. Even these don't always appear in print in the same form in which they were submitted. In an effort to improve this situation, each zone foreman is making an effort to enlist the support of their respective newspapers in publishing news on mosquito control activities of local interest. Each foreman keeps his local paper fully informed on the work being done in that particular area. District policy and activities are blended into this local note whenever it can be done to advantage. Other mediums of reaching the public through the printed word are used, notably the pamphlet. We have had the pleasure this past year of "hatching" our first issue.

This booklet, made of 24 pages of pictures and a miscellany of written material, originated with the idea of informing the public on what they were buying. Confronted with the appalling fact that comparatively few people were taking advantage of the service available to them, we felt that something should be done to shake them out of their indifference and, if possible, correct the mass of misinformation on mosquito control and mosquitoes. Our effort is now being distributed to each home within the district, and copies have been sent to others interested in pest abatement. May I say here that I am somewhat in the position of a father? It's alright for me to call my offspring a brat, but woe-be-tide the outsider who makes disparaging remarks about my "baby." Honest circiticism is welcome, however, with the thought in mind that in the very near future the association may be financially able to print a handbook for lay distribution. The difficulties and mistakes experienced in our release may benefit any future publication, for either local or state wide distribution. A large share of the cost of producing this booklet was borne by friendly commercial agencies.

Other steps in our march toward efficient mosquito control are: emphasis on good appearance, both physically and in everyday conduct; a close contact with other similar groups; a nearly hopeless race to keep up with new developments; proper consideration of all merchants within the district in regards to purchasing; full cooperation with all civic groups; and rather detailed entomological operations and pictorial records to better chart the future.

A very welcome aid to our public relations has been the apparent decrease in the area's fly population. Actually a by-product of present-day mosquito control, this decline of a very obnoxious pest has brought forth more appreciative comment than all other activities combined. Mosquito control is taken for granted. They're paying for it and expect us to do a good job. This agreeable situation is being fostered by expanding fly control measures, but always under the cloak of mosquito control. The small additional cost to the district will return big dividends in happy taxpayers. This side-stepping direct responsibility is not because we lack courage — rather, it is another deliberate step aimed toward good public relations.

Our next paper will be "How California Compares in Mosquito Control with Other Regions," by H. F. Gray, Engineer, Alameda County Mosquito Abatement District, Oakland.

HOW CALIFORNIA COMPARES IN MOSQUITO CONTROL WITH OTHER REGIONS

By H. F. GRAY, *Engineer*
Alameda County Mosquito Abatement District
Oakland, California

Mr. Gray: The topic presented to me for discussion, "How California compares in mosquito control with other areas," is couched in the form of a question such as no one but a jackass would ask, and no one but a damn fool would attempt to answer.

That, Professor Herms, was recorded.

But before I enter upon this asinine discussion I have the pleasure of calling attention to the fact that Commander Rock and Mr. Sunderland from the Twelfth Naval District are up stairs there, very quietly in the corner. We have had very excellent relations with the Navy in past years, and we sincerely hope that it continues.

I will allow this to be recorded for a while, while I am speaking in terms of glittering generalities, but after I get down to specific comparisons I am going to shut the recorder off. I don't want to get shot when I go to Florida, or up to Portland, or back to New Jersey, or possibly Virginia. If you are going to make comparisons as to mosquito control problems and mosquito control work in various places in the world, you have to remember that there are variations in conditions which modify what you will do and what results you may be able to get. The type of terrain varies very greatly in different parts of the world and, above all, climatic conditions vary so widely that it is extremely difficult to evaluate any particular area in relation to another unless you have a good acquaintance with the variations.

Just as an example, within our own state of California we have very decided differences in climatic conditions between the coastal counties and the interior valleys. We have a relatively cool climate on the coast and a moderate humidity, probably averaging in the vicinity of 50 or 60 percent relative humidity. We have cool breezes at night, and the nights are usually cool even in the hottest days of summer. But if you go into our interior valleys — the Sacramento and San Joaquin Valleys — you have during a number of months of the year temperatures that are running up above 100° F., and sometimes up to 120° in the shade. The development of mosquitoes is extremely rapid under those conditions. The central valleys also have a much lower humidity than we have along the coast. In some cases it gets to such a low state of humidity that I doubt if a mosquito dares spit during any time of its existence, because she couldn't afford to lose that much fluid. Now, if you try to make any comparisons between California and other areas, you have to take into consideration that we have variations of our own in climatic conditions and terrain, and so on, and these other areas have very decided differences compared with us.

For one thing, in California there are several mosquito species which breed throughout the year. But if you go into Illinois in January, for example, all breeding ceases from perhaps about the first of November to say in April. They have winter conditions which make outdoor work difficult to impracticable. We can work on maintenance, for example, all through the winter as a general rule. Back East they cannot for a number of months do very much outdoor work. Bob Vannote will correct me in that, if I am wrong. I consider this to be quite a serious handicap to outdoor maintenance, the maintenance of drainage systems and other structures, for example.

California is essentially rainless from about the first of May until about the early part of October, and therefore it should be a mosquito man's paradise, for the reason that he does not have new rainfall providing additional and perhaps unexpected breeding places. If you go into the southern states of the United States, the eastern seaboard and the middle west, summer rainfall is quite common. Sometimes it is exceedingly heavy, and they have the constant creation of new mosquito breeding places. You might say, "Well, that makes it pretty tough." I can assure you, gentlemen, that it does make it pretty tough to exercise effective control measures. On the other hand, we are not entirely fortunate here in California, because we substitute for that summer rainfall the application of water by irrigation systems. Any of you who have ever worked in the Sacramento or San Joaquin valleys, where there is a good deal of irrigation, are quite well aware of the fact that some idiot farmer can almost always apply more water than his land can take, run it off down the roads and into unexpected places, and then you have some new breeding places that you didn't know existed until perhaps you stumbled upon them when the neighbors started complaining and you had to go out and hunt for them. So I don't know that the disadvantage of the eastern states in regard to natural rainfall is a disadvantage that is very greatly in excess of the problems of irrigation that we have under our more arid summer conditions.

On the other hand, we do not face some of the things and situations that they have in the East, along the seaboard particularly, and one of the things that you will meet in tropical areas. That is — some of the summer storms may approach hurricane, typhoon and tornado proportions and, when that happens, you will have extensive damage to the structures that you have built, and sometimes you may have a lot of your work torn out by an exceedingly bad storm, and then you are in a pickle of trouble right there. Another thing that can happen, and this is very apt to happen in the Florida area, is that when one of those big hurricanes comes along, it may pile up the tides along the shores and the shore marshes for weeks on end, and the water can't get out in spite of the drainage system, and you just have a devil of a time with mosquito breeding, particularly *Aedes taeniorhyncus*. Control difficulties are tremendously enhanced in the Florida area by some of these tropical storm situations in relation to the piling up of tides. Fortunately, we don't have that particular difficulty here in California. We do not have summer storms, and the winter storms are usually not bad enough to bother us to any particular extent.

Areas of flat terrain are harder to drain than areas which are hilly. In California we have on the average a more varied terrain and more hilly country, except in the central valley, than in many of the areas in the eastern part of the United States, particularly the north central states, New Jersey and Florida. Their relief is lower than ours, and their problems of hydraulics and drainage are therefore more difficult to take care of. In that particular respect California does have a certain amount of advantage.

Our relatively low humidity in California is an advantage because all mosquito species seem to be more active, live longer and are perhaps more penetrating in their hide-piercing effect with a high relative humidity than they are where it is particularly dry. I don't know whether that is only an impression, but it does seem to me that they can bite a little bit better under humid conditions than they do under arid conditions. About the only exception that I might make to that, however, is our *Aedes flavescens*, which we have up in the Shasta-Modoc area, which is a large mosquito that lives in a dry country, and can she drill! She really takes a piece of meat out of you when she bites.

There is perhaps some difference in the background of why mosquito agencies have been created in California and in some other areas. In California, in spite of the fact that many of our districts were organized originally with the impetus coming from the real estate and commercial agencies, there has always been a strong public health influence, and we have never been able, nor have we attempted, to get too far away from the disease prevention aspect or from close cooperation of the State Health Department. In a good many other areas in the United States the emphasis has been primarily on strictly a nuisance aspect and economic considerations. That is not true in the southern states of the United States, but there you have almost no development of the independent mosquito abatement district. Much southern mosquito abatement is done directly under the health department, is purely a public health function, and the health departments are unlikely to concern themselves very much with species which are not disease-vectors; in other words, they will stick pretty close to *Anopheles* malaria problems, and dengue. We are more apt out here to take the whole field; to take both vector mosquitoes and pest mosquitoes more or less as they come.

I will probably be criticized for even these general remarks, but now what about specific instances? Here's where I shut this thing off!

(Remainder of discussion not recorded.)

Mr. Raley: I will now present Dr. W. C. Reeves.

Dr. Reeves: At the time the topics were selected for this particular report, I was a little bit dubious about what tie-in we might have with other topics that are on this program. However, developments of the last day and a half have shown, first, that we will have some potential ammunition, a continuation of the fight up north as to how far mosquitoes will fly and in which direction — and of course we all love a good fight. Our information is on the wrong species of mosquitoes, but the representatives from Washington and Oregon are very welcome to it if they want to use it. Secondly, yesterday we had considerable information given us on detrimental potential effects of mosquito control on wildlife, and I believe we can have an optimistic note in the second half of this paper on the possible beneficial effects of mosquito control on wildlife. This paper, as was Dr. Hammon's paper yesterday, is not my paper but it is a paper from the Neurotropic Virus Unit of the Hooper Foundation, the Kern Mosquito Abatement District and the Disease Laboratory of the Bureau of Game Conservation of the California Division of Fish and Game — and for this reason we feel that is the only fair way in which to present it, as there are many people in this room who contributed to this work, as well as those who are not here.

A FINAL SUMMARY OF FLIGHT RANGE STUDIES ON *CULEX TARSALIS* AND NOTES ON WILD BIRD MALARIA IN KERN COUNTY

By the Staffs of

The Neurotropic Virus Unit of the George Williams Hooper Foundation, University of California, and the Disease Laboratory of the Bureau of Game Conservation, California Division of Fish and Game

At last year's conference we reported the first studies on the flight range of *Culex* mosquitoes in California: that in Kern County *Culex quinquefasciatus* may frequently travel a mile, and may fly as far as two and a half miles; that *Culex tarsalis* may travel at least half a mile; and that *Culex stigmatosoma* were recovered as far as one mile from their release point.

During the summer of 1947 these studies were continued in cooperation with the Kern Mosquito Abatement District. As in the previous year, mosquitoes were marked with the fluorescent dye, Rhodamine B, and were released in the center of an experimental area. Daily collections of adult mosquitoes were made at collecting stations varying in distance from 0.2 to 2.5 miles in every direction from the release point.

In 1947 particular emphasis was placed on a study of the flight range of *Culex tarsalis*, although a small number of *Anopheles franciscanus* and *Culiseta incidens* were released at the same time.

Of over 20,000 marked *Culex tarsalis* released, 18 females and 10 males were recovered. The majority of the recoveries (22 out of 28) were made upwind from the release point, and the maximum range of recovery was 2.5 miles for females and 1.1 miles for males. The majority of recoveries were made within one mile. Marked specimens of *Anopheles franciscanus*, both male and female, were recovered at a maximum distance of 0.9 miles; and *Culiseta incidens* males were recaptured at 0.6 miles.

The present studies were designed to determine the "effective" flight range of the species, rather than the maximum range of flight. We would consider the "effective" range to be the maximum distance which a species normally would be able to fly from a breeding place in numbers sufficient to transmit disease or to become a nuisance.

In the case of our studies it was not possible, with the personnel and time available, to collect extensively beyond the two-mile zone. Only six stations at that distance were visited regularly. Also relatively few stations were utilized between 1.5 and 2 miles. It is obvious that the relatively enormous area involved beyond the one and one half mile boundary into which released mosquitoes could disperse (provided food and shelter were available) was scarcely touched. However, the fact that even one female of *Culex tarsalis* or one of *C. quinquefasçiatus* was recovered at 2.5 miles from the release point leads us to believe that, given an extensive breeding ground of either or both of these species, large enough numbers of these could disperse beyond one mile to become a problem. Thus we feel that we are justified in recommending that control measures be carried out in a zone not less han one and one half miles beyond the human or animal hosts to be protected from these *Culex* mosquitoes. It could very well be that, under different conditions of temperature, humidity, wind or topography these mosquitoes would have a longer or shorter life and an inclination to travel longer or shorter distances. However, this does not detract from the fact that, for the first time experimental proof has been obtained in answer to an important practical problem of mosquito control workers.

As is indicated by the title of this paper. the following section will be devoted to some notes on wild bird malaria. During the past several years we have been asked an increasing number of questions by mosquito abatement workers and by laymen concerning the relationship of bird malaria to human malaria; what effect malaria has on birds, and which mosquitoes are carrying it. Popular articles and references in the newspapers on the use of bird malaria for testing possible anti-malarial drugs have undoubtedly stimulated this interest, and at times these studies have led to misunderstanding. Many of the recent advances in drug treatment of malaria have been due to the fact that possible therapeutic agents could be tested first against malaria of canaries and, if effective in such cases, then tested against human malaria.

In 1885, only five years after the discovery of malaria in the blood of man, a similar type of parasite was found in bird blood. It now is known that at least 4 species of *Plasmodium* may infect man, and that in North America at least 9 species of *Plasmodium* are found in birds. The malaria parasites of man will not infect birds; those of birds do not infect man.

As yet very little is known of the prevalence of infection among birds over wide areas or of the detrimental effects of malaria in birds. Although death or prolonged illness from malaria frequently occurs in man, a similar condition is not recognized in wild birds. Of course, if such were the case, it might not be recognized, since sick birds will hide or else are quickly disposed of by predators. However, there are indications that malaria may be one of the important factors in the mortality of nestling birds.

The method of transmission of malaria was first demonstrated 50 years ago by Ronald Ross, who worked with a *Culex* mosquito and avian malaria. His observations were later confirmed in the case of human malaria and *Anopheles* mosquitoes.

Since the time of Ross, a number of blood-smear surveys have been made to determine the frequency of malaria infection in birds and the species of *Plasmodium* with which they were infected. Surprisingly, there is no record in the literature of field studies to determine which mosquitoes serve as the vectors in nature, although many laboratory tests have been made on the ability of mosquitoes to transmit the parasites.

In 1946 we began a study in Kern County to determine the frequency of malaria infection in birds, the species of *Plasmodium* responsible for such infection and the mosquitoes which served as vectors. These studies were a part of our investigations on encephalitis, and it was hoped that information about the frequency with which birds and mosquitoes were infected with avian malaria would give us an idea of the frequency with which mosquitoes were feeding on wild birds, and demonstrate the species of mosquito which frequently fed on wild birds, facts most difficult to measure by other means.

Briefly, the results of this two-year study are as follows: A series of over 5,000 blood smears were made on more than 25 species of wild birds of all ages. Although examination of these slides is not complete, it has been found that malaria infection is common in most species of wild birds in Kern County. Thus in the case of two species of birds most abundant there, the house finch and the English sparrow, it was found that 3 to 4 months old birds of the first species were 97 per cent infected in 1946 and 76 per cent infected in 1947; a similar sample of English sparrows revealed that they were 76 per cent infected in 1946 and 25 per cent infected in 1947.

Six species of *Plasmodium* have been recognized from Kern County.

In order to determine the species of mosquito responsible for the transmission of these infections, over 2,000 specimens were dissected during the two-year period. The following infection rates were demonstrated:

Culex tarsalis 11.4 per cent
C. stigmatosoma 15.9 per cent.
C. quinquefasciatus 1.9 per cent.
Anopheles sp. .01 per cent
Aedes sp. 0.0 per cent

It might be pointed out here that the infection rates determined for wild-caught *Culex tarsalis* and *C. stigmatosoma,* as noted above, are somewhat comparable to those found in the most efficient human malaria vectors in highly endemic malarious regions of the world.

It might be pointed out here that the infection rates determined for wild-caught *Culex tarsalis* and *C. stigmatosoma,* as noted above, are somewhat comparable to those found in the most efficient human malaria vectors in highly endemic malarious regions of the world.

Laboratory experiments designed to test the comparative efficiency of various species of mosquitoes for transmitting malaria demonstrated that *Culex tarsalis* and *C. stigmatosoma* were the best hosts and vectors for the malaria parasites under study.

On the basis of these studies it appears that *Culex tarsalis* and *C. stigmatosoma* are largely responsible for the demonstrated high malaria infection rates in wild birds in Kern County, while *Anopheles* and *Aedes* probably are in no way involved.

In summary, it may be stated that bird malaria infections are common in any part of California surveyed, little is known of the effect of the parasite on the birds, and several of our common species of *Culex* are acting as vectors. Also, it should be emphasized that there is no relationship between malaria infection of man and that of birds. The blame for human malaria still must be placed on the *Anopheles* mosquitoes.

Mr. Raley: I will ask Mr. Peters to present the next paper.

Mr. Peters: You will note from the program that two papers are scheduled from the State of Washington at this meeting. You had a report this morning from Mitchell Mondala; however, with all regards to our friend Mitch., he is unpredictable. However, Dr. Frederick F. Ferguson of the University of Washington has prepared a paper, and expressed his regrets that he couldn't personally attend this Conference. He has reasons why he could not attend this meeting. They were paternal reasons, which I have recently experienced, so I feel that I am a particularly appropriate person to express his laments. He asked, as his choice of a person to read this paper, for Arve Dahl. He and Arve have close understanding between each other, being fellow Washingtonians at one time; in fact, they had discussed the paper. So, Arve Dahl isn't here either and, since I have to pinch-hit otherwise for Arve, I have another reason for introducing this paper. Without thought of in any way cutting Dr. Ferguson short, since this is a technical paper and, since Mitch Mondala has covered the Washington aspects of popular interest to this group as a whole, I suggest that this paper be deferred for inclusion in the proceedings, and those of you who are interested in the subject matter can then read it.

SOME PHYSICAL FACTORS IN THE DEPOSITION OF DDT MISTS AS MOSQUITO LARVICIDES

By Frederick F. Ferguson
(Dept. of Zoology, University of Washington),

S. W. Simmons and William M. Upholt
(Technical Development Laboratory, U. S. P. H. S., Savannah, Ga.).

Introduction

Beyond the fact that we see DDT mist larvicides deposited on mosquito breeding surfaces and are certain of the high degree of efficiency of the larviciding method, we know very little of the physical nature of these depositions or their ultimate fate. Preliminary studies at the U. S. Public Health Service Savannah laboratory showed that ethanolic suspensions of DDT contained numerous microscopic crystals (1.25% DDT, 0.5% *Intracol* in 95% ethyl alcohol). These stable suspensions in both laboratory and field tests showed above average initial larval kills with no improvement in the residual character of the treatment. In an attempt to explain the lack of a residuum in the use of DDT as a mist larvicide in dosages compatible with aquatic wildlife (near 0.05 lb. per acre) Upholt (1945) has recently advanced the theory of DDT absorption upon the organic constituents of the pond bottom complex. This theory has been very substantially supported by laboratory findings. Another factor for consideration has been the perplexing differences in the toxicity of DDT in various solvents. Author's data (mostly unpublished) indicate striking kills with *highly volatile* solvents and those with *low volatility,* while satisfactory kills accrue with the use of solvents of *medium volatility.* It must be noted that considerable toxicity is inherent in some of the solvents studied. During the past year we have attempted to give preliminary answers to the following questions pertinent to DDT suspensions and solutions:

1. What are the physical properties of the dispersed liquids with DDT in 1 gallon volumes at 0.05 lb. DDT per gallon plus small amounts of appropriate spreaders and dispersers?

2. What happens to these liquids dispersed in relatively *uniform droplets,* as for example, an average of 100u mass median diameter produced by a particular test nozzle, Marley Co. No. 1H41 using 30-50 psi?

3. What happens to drops of either the DDT suspensions or solutions (listed below) of 0.05 cc volume placed on *distilled* water, *natural pond* water and *tap* water?

4. Does the *crystalline morphology* of DDT differ between identical larvicides deposited on *water* and on *dry* surfaces, i. e., glass?

5. What is the relative *longevity* of DDT mist deposits on a water surface?

Observations

The following test samples were taken for this study from identical batches of materials on which adequate unpublished field data are available. In these batches DDT was either suspended or dissolved at the rate of 0.05 lb. per gallon of fluid and applied in the field tests at the rate of 1 gallon per acre.

Solvent list:

- Acetone
- *APS — 202* (Velsicol Corp?)
- Benzene
- Carbon-tetrachloride
- Chlorobenzene
- Ethanol
- Fuel oil (no. 2)
- Hexane
- Tetralin
- Toluene
  - *Velsicol* NR-70
  - *Velsicol* AR-30
  - *Velsicol* AR-60
  - Xylene
  - Xylene as a 35% wall spray emulsion concentrate

The closely related DDD, and the newly developed benzene hexachloride and *"3956"* (Hercules Co.) were also studied in fuel oil.

1. Filter Paper Smears

In order to gain some idea of the expected morphology of crystal developed by these compounds in these solvents, our initial effort was to take ¼ inch strips of filter paper soaked in each of the above larvicides and to smear the surface of crystal dishes. These preparations (set up in duplicate) were observed with stereoscopic dissecting and compound microscopes using both ordinary and polarized light at intervals of 10 minutes, 30 minutes, 1 week, 2 weeks, 3 weeks, 1 month and 7 months. Summarizing this phase, it may be noted that hexane-DDT is decidedly superior to the others, producing very numerous, tiny, uniform liquid lenses which begin the formation of *crystalloids* within 30 minutes of the drying of the substrate. Within 1 week rather evenly dispersed burrs consisting of uniform rods are seen. These burrs persist at 7 months and measure an average of 142 u. The other fluids which dried to produce crystals were acetone, benzene and xylene. Of these, benzene is the most striking. Chlorobenzene gave only a few tiny crystalloids during the 7 months. Some solvents, expected to dry out, remained persistently damp, with little crystal formation. Such was ethanol. Carbon-tetrachloride likewise refused to dry and produced only a few crystalline foci. Ether petroleum showed delicate barb-wire clusters *only* after 7 months. Tetralin and toluene were drying at the end of the study, with few crystalloids. Of the oily solvents, *APS-202* is the one of choice from the viewpoint of having produced an abundance of tiny evenly dispersed crystalloids within 1 month. Fuel oil very gradually produces the same sort of crystalloid as does *APS-202. Velsicol NR-70* and *AR-60* are especially resistant to drying under these conditions and *AR-30* develops numerous, small, evenly dispersed crystalloids.

DDD, benzene hexachloride and *"3956"* in fuel oil were seen to be dry or drying compounds producing very few crystalloids in either case at the end of the study. (Note author's use of *crystalloid* to denote small, amorphic forms either as foci in drying liquid lenses or in dried out smears. *Crystal* is used where apt, i. e., when morphology and response to crossed Nicolls dictate it.)

Conclusions: The less volatile compounds delay crystal formation by resistance to drying, while the reverse is generally true of the other more volatile mixtures. True crystals are all positive with crossed Nicolls when the larvicide is sufficiently dried out, or are large enough.

2. Microslide Smears

In order to improve microscopic examination of crystal formation, single drops of the above compounds were placed between two microslides and smeared much as in a blood film technique for subsequent observation on both slides of a pair. Again hexane-DDT quickly produced crystals (within 10 minutes), likewise the xylene concentrate (35% DDT). Within 24 hours carbon-tetrachloride, ether-petroleum and the xylene suspension gave up crystals. DDD and *"3956"* also crystallized during this period. By 1 week's time acetone, *APS-202,* fuel oil, tetralin and toluene showed definite crystallizations. Chloro-benzene and ethanol persisted for 2 weeks in a liquid state but within 3 weeks these compounds, plus the 3 *Velsicol* preparations, were showing a positive response to crossed Nicolls. At the 7 month check, all compounds listed still showed positively polarizing crystallizations, although of a somewhat amorphic nature.

Conclusions: There is general agreement between results from this technique and the paper smear method noted above.

3. Single Drop Deposits

Having gained some general idea as to the expected morphology of crystal produced on dry surfaces from these compounds, the next step was to allow single drops of 0.05 cc volume to fall on the surface of freshly distilled water from a height of 2 inches. These tests, established in duplicate, were run in new Petri dishes maintained at normal room temperatures and ventilation and exposed to no more agitation than necessary for observations. Surface and bottom checks were made at 10 minutes, 1 hour, 24 hours, 1 week, 1 month and at 1 year following the treatments. As expected, these compounds behave quite differently from one another, depending on a number of factors, among which are probably viscosity, spreading pressure, volatility, boiling point and relative purity.

Within 10 minutes *APS-202,* carbon-tetrachloride, fuel oil, tetralin and the three *Velsicols* formed more or less perfect surface lenses. Fuel oil, the Velsicols and carbon-tetrachloride produced a single large lense, although the latter one was decidedly pock marked. The others formed very numerous tiny globules at the surface which in some cases (acetone, benzene, ether-petroleum, hexane and toluene) appeared as nebulous streaks under lower magnifications (X36). There was no appreciable change in any deposit within one hour following treatment. Within 24 hours all of the test compounds except *Velsicol NR-70, 3956* in fuel oil, DDD in fuel oil, ether-petroleum, carbon-tetrachloride, benzene and acetone had produced crystals. It must be emphasized that there were striking differences in the morphology and genesis of these various crystallizations too numerous to mention here. It may be noted that fuel-oil produced *relatively few* but *large crystals* under these conditions. Within 1 week, concerning those remaining without crystals (acetone, benzene, carbon-tetrachloride, DDD, *"666"* and *"395 "* in fuel oil, and *Velsicol NR-70*) only ether-petroleum failed to produce them. Even at the 1 month check, ether-petroleum still showed only the droplet nebulae mentioned above, but within 7 months had developed a striking set of barbed crystal clusters.

The observation at the end of 1 year revealed the following: DDT in *Velsicol AR-60,* DDD in fuel oil and *"3956"* in fuel oil did not show crystals. Of the remaining larvicides hexane, *Velsicol AR-30* and *NR-70* toluene, xylene, and carbon-tetrachloride displayed crystals on the dish bottoms but not on the water surface. In most cases crystals showed as tiny evenly dispersed spicules as bottom deposits. Ethanol and hexane maintained their cluster formations intact. Crystals of benzene hexachloride in fuel oil evidenced disintegration of cluster crystals at the surface. In general those cluster crystals at the surface were maintained in their morphology at deposition while those that sank to the bottom seemed to diminish in size and to effect cluster separation.

Conclusions — DDT crystals show evidence of striking longevity when in contact with water. When undisturbed many types remain at the surface for as long as 1 year.

4. DDT mist dispersion

Because of their more or less practical significance, three of the formulations listed for the above tests (acetone, fuel oil and *Velsicol NR-70*) were selected for laboratory tests designated to simulate field dispersion techniques of DDT as a mist larvicide. These three compounds were dispersed under pressure of 40 psi through a Marley Co. nozzle (1H41) which delivers droplets of an average of 100 microns. Under conditions of a gentle breeze (circa 1 mph) these mists were deposited on new Petri dishes containing either tap, distilled or pond water. Tests were duplicated once and were maintained at room temperature. Observations were made with both the dissecting stereoscope and the compound polarizing microscope at 10 minutes, 1 hour, 24 hours, 1 week, 1 month, and 2 months following treatment. Under such conditions of dispersion normal surface lenses were in evidence for all three compounds at the 10 minute, 1 hour and 24- hour check; however the fuel oil lenses were showing evidence of loss of surface tension, gradually becoming streaked. At the end of 1 week the *Velsicol NR-70* showed large flat lenses plus nebulous droplet formations but no crystals; acetone had lost the lense form and displayed numerous globules just under the surface without crystals; while fuel oil showed as streaked and pock-marked, with no evidence of crystals. The presence of a bacterial surface glea does not seem to alter the course of events in any of the test formulations. At the end of 1 month the *Velsicol NR-70* deposits were still non-crystalline while acetone on all three types of water displayed the rail fence tabular type of surface crystallization. Fuel-oil had become globulated but non-crystalline in both tap and distilled water but showed a few clusters of long spike crystals on the scummy surface of the pond water. A check made 5 days beyond this time showed no further change in any of the tests. At the end of 2 months DDT in fuel oil had developed a few long spiculate surface crystals, *Velsicol NR-70* as a solvent did not show crystals, while DDT in acetone displayed numerous crystal clusters on the surface. There were no invertebrates alive in the *Velsicol* pond water preparation, while they seemed unharmed in the other two tests.

Discussion

Is DDT or other modernly used mosquito larvicide more potent in solution and suspension or in crystalline form? This question seems to logically derive from these preliminary observations. It is very probable that the striking potency of these larvicides results from contact of the larvae with surface deposits in liquid form. Note that the commonly used DDT-fuel oil formulation of medium efficiency develops only a few extremely large crystals of microscopic nature. Larviciding solvents should certainly be selected on the basis of detailed information as to their physical properties in combination with those of the toxicant. These factors must be buttressed by biological data as to their efficiency in both field and laboratory tests.

Summary

1. An indication of the fate of DDT mist larvicides upon contact with water is given; the inference being that, as these solutions produce crystals, they are buffeted about by wave action and are eventually occluded in the pond bottom complex.

2. DDT crystals have a striking perseverance, being maintained either at the surface of water or sunk to the bottom for periods as long as 1 year under laboratory conditions.

3. There is general conformity in the morphology of DDT crystals produced on wet (water) surfaces and dry (glass) surfaces with the solvents listed.

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Mr. Washburn: We will now have a ten-minute recess, after which we will re-assemble for a symposium on the use of aircraft.

RECESS

Mr. Washburn: Now we are coming to the afternoon's program. This symposium on the use of aircraft was to have been introduced by Arve Dahl, but, as we all know, Arve is ill, so again this has been delegated to our friend Dick Peters. Dick, do you want to start the ball rolling on the thing?

INTRODUCTION TO SYMPOSIUM

USE OF AIRPLANE FOR MOSQUITO CONTROL

Mr. Peters: It might be better had I become ill as well. Morris Stewart yesterday mentioned that he hadn't prepared anything. Well, I hadn't counted upon Arve becoming ill, and furthermore, I was on the Program Committee and thereby engineered or assisted in keeping my name off this program, but once again find myself pinch-hitting for Arve.

I would like to just mention a little bit on this matter of airplanes and start off by going into the history of the subject. I can remmeber from my experiences in mosquito control in California in 1940-41, when an airplane, if it had been used for mosquito control, would have caused people to wonder who that crack-pot stunt pilot was. I had the dubious distinction of serving in the United States Army for almost four years, and there I saw the airplane come into its own. I saw it come into its own in flight formation in which as many as six C-47's more or less cast a shadow as they covered a definite cantonment area, leaving a trail of DDT behind them, flying at elevations of 500 feet — higher if they wanted to, lower if they wanted to. Some of them were technically controlled; others just passes. I saw some very effective results from such operations in the control of flies and in the control of mosquitoes. Prior to the war I can recall that the airplane was used in California in limited amounts. Pete Pangburn sprayed Diesel oil on salt marshes before the war. Am I right, Pete? And I believe an airplane was used by the Monterey County Health Department in the late '30's and early '40's to control certain ponds that were inaccessible by ground equipment.

But in starting to introduce this symposium, I do want to keynote it by suggesting that whether it be airplane or not, the same fundamentals of mosquito control apply. There is no magic attached to airplane operations. I have encountered in my various trips throughout California a general attitude among the public that mosquito control is no longer a matter of getting down and doing backbreaking work, but that all you have to do is charter an airplane and distribute DDT. It is the general attitude, however strange. It is, on the other hand, when airplane operations are used, a very desirable public relations gesture. I don't differentiate now between good or bad airplane operations, but recognize that there is this gullibility that wants satisfaction, and the use of airplanes can do an awful lot of good in just giving satisfaction to those people who expect it. However, I think that the tenor of this symposium to be given following my remarks, will point out that the matter of access, which I mentioned a bit ago, has a lot to do with this matter of the use of the airplane. I think they will discuss the matter of economics. I think they will go into the matter of the ecology of the mosquito in question, the variables to be encountered. I think they will discuss aerosol approaches and spray approaches. They might even touch upon dusts. I hope they will establish some very solid outlining of the need for inspection as a prerequisite to airplane operations, for, in my opinion, without inspections before and after, airplane operations are just a public relations gesture. They will get results, but they are costly. Now this matter of the symposium itself. I think my remarks are superfluous because I have nothing specific to contribute.

In the preliminary program of this meeting which you received, there were indications that we would have speakers representing the Orlando Laboratory. Dr. Deonier was invited to lead this symposium. He was short-circuited and unable to make it. It was a matter of funds. Dr. Hess was invited from TVA, but he couldn't make it either because funds were dwindling in TVA, he said. We were hopeful that a representative, Dr. Yuill, of Forest Insects on the Atlantic Coast would be present to give his side of the field. In fact we were hopeful that we could have a miniature air spraying discussion like that which occurred in North Carolina, I believe it was — attended by Art Geib during last year. Well, with the disappointments which we suffered, we also suffered some pleasures, because when we glanced down our program and noted the banquet speaker who is to hold sway tonight, we saw Dr. Knipling there and it recalled memories that Dr. Knipling had been in Orlando, Florida — in fact, during the war I believe he was in charge of U.S.D.A. activities around Orlando, Florida. Consequently, when unwary Dr. Knipling arrived, he was confronted with the reality that he was to become the leader of this next symposium, and I am about to allow him to take over. Now, in addition to Dr. Knipling, I don't mean to minimize our own participants from California, because from the best of my understanding of the literature, in airplane operations we are doing pioneering work in California. We have something to offer the east coast, the southern part of the United States, and elsewhere throughout the world, and I feel that as a result of this symposium today those members who will participate, from Dr. Knipling through Bill Porter, who will represent a private concern, through Harvey Magy, who will represent ou Bureau of Vector Control and its activities, through Art Geib, who is doing a lot of work in Bekersfield, and last but not least, Ed Smith, who has been doing a whirlwind job in Merced County, I feel that this symposium will be an outstanding contribution to this Conference. So with this buildup, I will now turn this meeting over to Dr. Knipling and suggest that he assemble his group together.

Dr. Knipling: I can assure you I was not prepared to take over this symposium, but this morning when I was cornered I agreed that I would do the best I could.

At Orlando, Florida, I was actively participating in the various aspects of aerial dispersion of insecticides, but during the last few years I have just been reading reports of what is being done in that field. The members of the symposium, however, have been actively engaged in the aerial application of insecticides, so I will promptly begin this symposium by introducing the first speaker, A. F. Geib.

EXPERIENCES IN THE USE OF AIRPLANES IN THE KERN MOSQUITO ABATEMENT DISTRICT

By Arthur F. Geib

Manager, Kern Mosquito Abatement District, Bakersfield, California

During World War II and the post-war years there have been extensive and varied developments in the use of aircraft for distributing DDT to control mosquitoes. Reports of these newer techniques are widely scattered through the literature and not readily accessible to the average individual. In addition, much useful information has not yet been published.

It was because of these conditions that the American Mosquito Control Association held meetings in Ashville, North Carolina, in October, 1947, to prepare a brochure presenting practical information about when, where, and how aircraft may be used to distribute DDT to control mosquitoes, and appropriate methods for appraising results.

I was fortunate in being able to attend and participate, and would like to report that as a result of these meetings much information of value to individuals interested or engaged in mosquito control activities will soon be available in this publication.

The latest information I have is that it will be ready for distribution in time for the joint American Mosquito Control Association and Florida Anti-Mosquito Association meeting to be held next month, March 28-31, at Fort Pierce, Florida. It will contain information of a general nature, covering the following subjects:

1. Historical Background of the Use of Aircraft for Disbursing Insecticides.
2. Types of Aircraft and Dispersal Equipment.
3. Operational Procedures.
4. Insecticidal Formulations.
5. Situations in Which Aircraft is Useful.
6. Appraisal or Evaluation.
7. Precautions in the Use of DDT Insecticides.
8. Public Relations, Liability and Insurance, Legislation.

I am sure that those of us having any interest in airplane mosquito control activities wll find this a very valuable pamphlet.

Anyone who wishes to obtain copies of this publication and has not already made arrangements to do so can contact either myself or Dick Peters during the Conference.

Use of Airplanes in California

In California DDT application by airplane has been used in 1945, 1946, and 1947 with varying degrees of success for the control of mosquitoes. Airplanes equipped with dusting hoppers, spray apparatus, and aerosol exhaust generators have been used.

With the exception of a few rivers and the salt marsh mosquito problem in the San Francisco Bay Region the use of planes has been primarily for the control of *Anopheles* and *Aedes* mosquitoes in the Central Valley of the State, where the mosquito breeding potential is in almost direct proportion to land area used for agricultural purposes. In the Sacramento and Northern San Joaquin Valleys the thousands of acres involved in the rice growing industry provide an Anopheline habitat that can only be economically controlled by airplane spraying. The *Aedes* species have adapted themselves perfectly to the irrigation of crops where the water will remain sufficiently long following irrigation to produce adults. From March into October the irrigation practices and climate in the Central Valley are ideally suited to the development of these mosquitoes in abundance. The control problem of this species not only involves the repeated flooding of large areas for agriculural purposes, but also the rapidity with which the species of this group pass through their aquatic cycle in hot climates. These factors favor the production of mosquitoes in tremendous numbers and make it almost impossible to economically control *Aedes* except by the application of larvicides by airplane.

Use of Airplanes in Kern District

The first use of planes in the Kern District for mosquito control with DDT was undertaken in the fall of 1945, using crop dusting equipment and techniques. These applications were made for control of *Aedes* developing in flooded duck ponds, using a PT-17 Stearman, operated by a commercial firm. At that time we knew very little about DDT as a mosquito larvicide and started by using a 5 to 15% DDT dust in diatomaceous earth at estimated rate of 1 to 2½ lbs. of DDT per acre. These rates, as we now know, were extremely high, and I believe it is of interest to note that no ill effects were subsequently encountered either to wild fowl or to the cattle pasturing in and about the ponds. Satisfactory control of the mosquito breeding was obtained by these applications, but no accurate checking and records were made to determine the exact results.

In the spring of 1946 the Kern District made arrangements with a local crop dusting firm to continue DDT dusting for control of *Aedes* mosquito breeding in irrigated pastures and along the Kern River bottom within the District. Stearman planes with a 3 to 7% DDT dust were used, varying the rates of DDT applied from .1 to .6 of a pound per acre. These applications were very helpful in our control operations but did not prove to be entirely satisfactory. In many instances we found it necessary to fly the same areas twice to obtain a satisfactory control, and quite often to follow up the plane application with ground equipment to spray areas missed or where a satisfactory larval kill was not obtained. The cost of these flights was quite expensive with the operator charging $1.00 per acre for the application and the material varying from 25 cents to $1.00 per acre.

Airplane Spray Operations

While this early 1946 dusting was being undertaken we were trying to convince the contractor to provide a plane with spray equipment or find someone else available to do spray work, rather than dusting. We felt that liquid DDT would prove more satisfactory as a larvicide and also be less expensive to apply.

In May of 1946 we located a commercial operator with spray boom equipment on a Stearman PT-17 and with this ship we completed the mosquito season of 1946. During the period we made use of this ship, May to November, only liquid applications of DDT were used. These were made with spray boom and engine exhaust venturies that we induced the operator to install on his plane.

Nearly all spray applications during 1946 were made with 5% DDT Diesel oil solutions at rates varying from .05 to .85 lbs. of DDT per acre and the volume of spray material from 1 pint to 2 gallons per acre. Flights were made at heights from 15 to 100 ft. above ground, the height being regulated according to the need for clearing obstacles such as trees, power lines, etc. Swath widths varied from 50 to 100 ft., but we eventually found that at widths greater than 60 ft. the percentage of flights resulting in untatisfactory control was quite high.

Cost for liquid application proved to be considerably less than dusting, ranging from approximately 17c to $1.53 per acre, with the contractor being paid at the rate of $40.00 per flight hour. Factors influencing the wide range in cost per acre were: Ferrying time, size of area flown, shape of area and amount of material sprayed.

Results of spray applications were more satisfactory than dusting but were not as we had hoped for. We frequently obtained what we considered complete larval kills, but results from flight to flight varied considerably. Occasionally failures resulted with applications of material that had previously, under similar conditions, given us what we considered a complete larval kill. Failures were not too frequent, but we did find that all too often we had to refly an area or return later with ground equipment to complete the larviciding where only a 50 to 75% control resulted from the initial airplane application.

For one period during the season's spraying with the 5% DDT Diesel oil, accurate checking revealed that of 57 flights,

50.8% resulted in complete control;
31.6% resulted in 95-100% control;
3.6% resulted in 75-90% control;
10.5% resulted in 25-75% control.
3.6% resulted in 0-25% control.

Grouping these percentages, we find that in 86.1% of the57 flights we obtained a 75 to 100% larval kill and a 0 to 75% control in the remaining 13.9% of flights.

Without going further into a lengthy detailed discussion of the season's spray operations with the 5% DDT Diesel oil solution, I will briefly summarize and point out a few additional statements regarding our findings for 1946.

1. Diesel oil DDT solutions did not prove entirely satisfactory for control of *Aedes* larvae in flooded pastures and river bottoms when applied at rates varying from .05 to .86 lbs. of DDT per acre.

2. The 1st, 2nd and 3rd larval instars of *Aedes* larvae were much more susceptible to the DDT than the 4th and pupae stages.

3. The addition of B-1956, a spreading agent, to the DDT Diesel oil solutions at the rate of 1 pint to 40 gallons generally increased the effectiveness of the larviciding applications.

Airplane Aerosol Spraying

I previously mentioned that we induced the plane operator to install an aerosol exhaust generator on his ship, similar to that developed and used by the TVA. We ran larviciding trials with this equipment, using different concentrations of DDT and different solvents. During 1946 and again in 1947 we obtained some promising but very erratic results with this equipment but to date we have not found this method of application satisfactory for control of *Aedes* larvae, but we do find it quite effective in controlling adults of all species. In many cases, particularly over wooded areas, we prefer to use aerosol sprayers for adulticiding in preference to direct spraying applications. In situations of this type aerosols provide better penetration of vegetation and will lay down wider effective swaths than by spray boom. In addition, smaller amounts of material can usually be applied with satisfactory results.

I will not attempt to carry the discussion about airplane aerosol sprayers any further at this time. Mr. Harvey Magy, of the California State Department of Public Health, Bureau of Vector Control, is participating in this symposium. As a State representative on their experimental program during 1947 he spent the entire season in the Kern District and the Sutter-Yuba District at Marysville studying aerial spray and aerosol applications. I believe that he will shortly tell us in some detail the results of the aerosol applications at Bakersfield and Marysville against the larval forms of *Aedes, Anopheles* and perhaps *Culex* species.

Aerial Spray Equipment

The *Aedes* control problem confronting the Kern district and the results of our 1945 and 46 use of airplanes for larviciding indicated a definite need for continuing control activity by airplanes. The District purchased 3 Stearman PT-17 Bi-planes and equipped two of them for operations in time for the 1947 season's activity.

One plane was prepared with spraying apparatus consisting of a 110 gallon aluminum tank mounted in the front cockpit, a small wind driven gear pump mounted on the front edge of the lower wing, and a 30-ft. spray boom of 5/8 inch I. D. steel tube with forty Chicago Spray Systems Whirljet spray nozzles mounted below the lower wing. The pump contains a built-in by-pass and develops a maximum of 60 lbs. pressure, pumping a volume of 10 gallons per minute, at a normal plane speed of 90 miles per hour.

In the other ship we mounted a tank and pump system similar to that just described, but the spray liquid was discharged through an engine exhaust aerosol apparatus similar to the type developed and used by the TVA. This consisted of a 14-ft. length of 4 inch I. D. steel tubing mounted along the fuselage of the ship. It is connected at one end to the exhaust of the plane's engine and on the other end is mounted a venturi with a 7½ inch long recovery section. The liquid spray material is pumped from the tank to the throat of the venturi, where it is discharged into the stream of exhaust gases through two Chicago Spray Systems Fan nozzles. The venturi is so arranged that various size nozzle and throat diameters can be substituted.

The 3rd ship purchased by the district has been used for inspection and survey purposes. We have found it extremely valuable in taking up inspectors for weekly flights. By so doing, we find we can do a more effective control job and save many miles of travel and hours of inspection time.

Spray Applications

Spray applications are conducted with the district ships and apparatus as is now commonly done in mosquito control with airplanes of this class.

Flight Pattern

Height of flight	10 to 100 feet
Swath width	50 to 100 feet

Flights made any time of the day.

Most flights into and with the wind, but also frequently cross wind.

Larvicide

You will recall that the spray material used during 1946 was a DDT Diesel oil solution. I did not mention previously, however, that we made several spray applications of an aqueous emulsion of DDT in 1946. These proved to be so satisfactory that we started out the 1947 season with this material and ended up using it in preference to oil solutions. The emulsion used was the military Xylene formula containing 25% of DDT. This was applied by spray boom as 2½ to 10% solutions at rates from .1 to .7 lbs. of DDT per acre.

Accurate records of all flights were kept through 1947 covering a total of approximately 25,000 acres for the season, most of which were flown with swath widths of 50 feet. Liquid discharge rates during the season varied from 1 qt. to gallons per acre but in normal operations accomplishing desired results the amount was about 3 qt. to 1 gallon per acre at approximately 40 lbs. nozzle pressure.

For comparative purposes applications of DDT oil solutions were also made during the year. The following are the detailed results of 2 groups of flights made with DDT aqueous emulsion and DDT oil solutions respectively. All flights were made for control of Aedes larvae, 1st to 4th stages, in irrigated pastures, alfalfa fields and riverbottom.

In 28 flights using a 5% aquaeous emulsion applied at rates from .23 to .57 lbs. of DDT per acre, we obtained a 94% kill.

In 5 flights using a 5% DDT oil solution applied at rates of .58 to .68 lbs. of DDT per acre, we obtained a 60% kill.

It can be seen from the foregoing comparison of larvicides used that the aqueous emulsion proved superior to the oil solution. There were times, however, when even the emulsion failed to obtain the desired results and complete failures resulted. Instances when this happened were quite rare, however, and the emulsion proved to be the most satisfactory larvicide used in all cases. Reasons for complete and partial failures using either the oil solution or emulsion are still unknown.

Costs of Airplane Operations

Before giving you detailed information concerning our airplane larviciding costs for 1947, I want to tell you that I don't believe these figures should be used as a guide to reflect airplane larviciding cost in the normal operations of a mosquito abatement district. This is primarily because all during the 1947 season we have been conducting a joint program with the State Department of Public Health, Bureau of Vector Control, in an experimental study in the use of airplanes for mosquito control purposes. Our 1947 cost figures include all flights, many of which would not have been made under normal conditions. In addition, we frequently fly areas as small as 2 acres, which is not normally an economic practice. We anticipate that this year the per acre cost will be considerably less than for 1947.

The costs of operating planes owned and operated by the district for 1947 include the salary of a pilot hired on an annual basis, spray material, as well as the time of a swamper and his equipment used for loading the planes.

On an hourly basis the total season's cost for airplane larviciding, including inspection and survey time, amounted to $28.64 per hour. The cost on a per acre basis amounted to 66c. This latter figure can be misleading, as the acreage cost will vary tremendously on each flight or application. For example, on a monthly basis the cost per acre to the district varied from 41c per acre in September to 97c per acre in July. Primary factors affecting the cost of flights are:

- Ferrying time to and from area of application.
- Width of swath.
- Size of area to be flown.
- Shape of area flown.
- Payload of ship.
- Cost of larviciding material.

There are many additional factors affecting costs per acre, but time will not permit their enumeration. I believe it will be of interest to call to your attention, however, the example of how just the shape of the area to be flown can increase the cost per acre by one third. Take an arbitrary area of 100 acres. When such an area is long and narrow, a minimum amount of total time will be used in turning to fly swaths in adequately covering the area; if on the other hand, the area is square, almost half the total flight time may be consumed in turning operations.

Summary

1. Airplanes have been used in California for mosquito conrol since 1945.

2. Airplanes are used in California for control of *Anopheles* and *Aedes* species in rivers, rice fields, irrigated pastures and fields and salt marsh areas, primarily in the Central Valley and the San Francisco Bay area.

3. Dusting apparatus, spray booms and aerosol sprayers have been used in applying DDT larvicides and adulticides for mosquito control.

4. First applications using DDT dusts were expensive and not entirely satisfactory.

5. Aerosol spraying of DDT by plane has not proven satisfactory in controlling *Aedes* larvae.

6. 1st, 2nd and 3rd instars of *Aedes* larvae are susceptible to DDT applied by spray apparatus at rates of approximately .3 to .4 lbs. of DDT per acre; however, larger quantities are occasionally needed to kill 4th instar.

7. Control of *Aedes* larvae in the Kern district was not satisfactory using a 5% DDT oil solution at rates up to .85 lb. of DDT per acre in ½ to 2 gal. of spray material.

8. Spraying 3 to 4 qt. of a 5% aqueous emulsion of DDT at rates of .3 to .4 lbs of DDT per acre proved satis-

factory for control of *Aedes* larvae in pastures and river-bottom in the Kern District.

9. Using Stearman PT-17 bi-planes owned and operated by the Kern District, the annual operating cost amounted to $28.64 per hour flight time, or 66c per acre during the 1947 season, on the average.

M. Knipling: Thank you, Mr. Geib. The next paper of this symposium will be by Edgar A. Smith, Entomologist, Merced County Mosquito Abatement District, Los Banos, California.

AERIAL SPRAY OPERATIONS IN MERCED COUNTY, CALIFORNIA

By Edgar A. Smith
District Entomologist
Merced County Mosquito Abatement District
Merced, California

The Mosquito Problem in Merced County in Relation to the Need for Aerial Spraying

The Merced County Mosquito Abatement District includes nearly two thousand square miles of land. Approximately three fourths of this area presents a mosquito control problem. Although nineteen different kinds of mosquitoes are to be found in the district, most of the complaints about mosquitoes may be traced to only two species, namely *Aedes dorsalis* and *Aedes nigromaculis*. This is due not only to their extreme abundance, but also to their habits, for they are the most vicious biting mosquitoes in the valley, have the longest flight range, and bite day or night. Because of their preferred ecological habitat, probably 90% of the necessary aerial spraying in the district is for control of these two mosquitoes. Both species have adapted themselves perfectly to the irrigation system of the San Joaquin Valley. Virtually every irrigated crop in the valley produces its share of *Aedes* mosquitoes on every irrigation from April to October. By far the greatest producer of all is permanent pasture — land which is seeded with pasture grasses and irrigated regularly every 7 to 21 days all season. Unimproved land whch is flooded and used as pasture also contributes a large share of the county's *Aedes* population. Ladino clover, alfalfa, barley, cotton, corn, beans, etc., all produce *Aedes* mosquitoes in varying degrees.

According to the 1946 Agriculture Report, Merced County has 850,000 acres of pasture, a large part of it flooded one to four times a year, 37,600 acres of permanent pasture flooded every seven to ten days, 85,500 acres of alfalfa, and 73,000 acres of barley. Obviously even if only a small part of this land was producing mosquitoes at any one time it would present a problem of such magnitude that it could only be handled by aerial spraying. Actually, so much of this land is continuously producing mosquitoes that it would be financially impossible to operate enough spray planes to keep the mosquitoes under control over the entire area throughout the season. However, it is possible to substantially reduce the mosquito population in the more populated areas for the greater part of the season by carefully selecting the areas to be sprayed and keeping abreast of current developments with a thorough system of inspection.

Airplanes and Equipment Used by the Merced County Mosquito Abatement District for Aerial Spraying

The District has used two airplanes in its spray program, an Aeronca Champion owned by the District and a Stearman biplane under contract.

(The Stearman spray plane was developed in the late summer of 1946 by the Inland Aviation Company of Los Banos, California. It is a PT-17 with a Pratt & Whitney 450 H.P. engine, and was modified for liquid spray work by Lloyd Stearman, the designer of the original Stearman airplanes.

The modified plane is known as an Inland Boeing 75-A. It is equipped wih a 130 gallon tank, a spray boom and an exhaust aerosol apparatus. The spray boom is actually four separate booms equipped with a nozzle on each end. Each boom may be operated separately or in combination with one or more of the other three. This makes it possible to vary the output from 7 to 28 gallons per minute. In actual practice on mosquito work this makes possible dosages of from one-half gallon to ten gallons of liquid per acre.

The exhaust aerosol apparatus was constructed in accordance with the recommendations of the U.S.P.H.S. and T.V.A. in Public Health Report Volume 61, Number 32, August 9, 1946. It is capable of putting out from 1 to 14 gallons per minute or from 1 pint to 1 gallon per acre. The changeover from spray boom to exhaust aerosol can be made in the air or both can be operated together.)

The Aeronca Champion was equipped with a metal propeller, and the 65 H.P. engine was altered to increase the horse power to 75. The spray apparatus was designed by Lloyd Stearman and built by Inland Aviation Company. It consists of a spray boom with 10 nozzles, Spray system "whirljet" spray nozzle 1/8B5, and a 35 gallon tank. Liquid is supplied under pressure to the nozzles by an Oberdorfer pump #4, Type A, Form Y, 10 gallon per minute output. The pump is driven by a four blade aluminum alloy adjustable pitch propeller. Tank, boom, and all piping is aluminum alloy. Output is varied from one-half to one gallon per acre by means off a pressure regulating valve.

Rates and Methods of Aerial Application of Insecticides for Mosquito Control in Merced County

The only insecticide used for aerial spraying has been DDT in its several different forms. Most of the work has been done with technical grade DDT in Diesel oil and xylene as an auxiliary solvent. In some cases the 25% emulsible has been mixed with Diesel oil and in a few cases the 25% emulsible has been mixed with water. Five, ten and fifteen per cent solutions have been used, but in all cases the application rate of actual DDT was approximately the same. The first season a five per cent solution of DDT was used in the Stearman plane with the spray boom. It was applied at the rate of one gallon to the acre, giving approximately .4 lb. to the acre. The second season a 10% solution was applied at the rate of ½ gallon to the acre, giving the same dosage of DDT. A fifteen per cent solution was used in the exhaust aerosol and applied at the rate of one quart to the acre, giving approximately .3 lb. to the acre of actual DDT.

The use of the aerosol was extremely dependent on the weather, and was restricted to the early morning hours.

It was possible to use the aerosol from daybreak until the beginning of the thermal upcurrents which, during the summer months, usually meant from daybreak at about five A.M. until eight A.M., or only two to three hours a day.

The spray boom was more versatile and could be used until a strong wind came up or until it became quite warm. This meant about five or six hours of flying a day, as it was usually possible to work until nearly noon with either plane. It was also possible to use the spray boom for an additional two to three hours in the evening, and this was done regularly with the Aeronca. On one occasion the Stearman plane continued spraying from 6:00 a.m. until 4:00 in the afternoon, but such perfect weather conditions were rare.

Ordinarily spraying is continued until it becomes so warm that the spray no longer reaches the ground or until the wind becomes so strong or gusty that it is impossible to obtain an even distribution of the spray particles. That decision was normally left up to the man on the ground. The spray operations ordinarily required two men on the ground. One drove the truck with the spray material and operated the pump for loading the plane; the other man, usually the Division Foreman or Inspector, worked with the plane. In some cases it was necessary to measure off the swath width and signal the plane for each flight line. This was true in rice fields, duck clubs. etc., or any other large areas where there were no roads, fences, or other markers for lining up the flight lines. Signaling was accomplished in the smaller fields simply by pacing off each swath and standing or waving a white flag at the end of the field. Where it was possible, a jeep or truck was driven ahead and parked for each swath. For long flight lines of one to two miles, it proved quite satisfactory for the jeep to shoot out a puff of the aerosol smoke as the plane approached each flight line. The smoke could be seen several miles away. Even when it was not necessary to signal the plane for swath width, the ground man stayed right with the plane in order to insure that an effective job was being done and to obtain a record of the area covered.

The Place of Aerial Spraying in the Overall Program of Mosquito Control

Aerial spraying is only used when it has a definite advantage over ground spraying. Some areas are inaccessible from the ground, but may be reached easily from the air. In some situations where time is a factor, the mosquitoes might hatch out before they could be treated from the ground, but could be taken care of from the air. Spraying of large areas can be done cheaper from the air than from the ground. With the Stearman plane it is not economical to spray individual fields smaller than 100 acres, as so much time is lost in the turns that it raises the cost to more than it would be for ground treatment. With the Aeronca, it is not economical to spray fields smaller than 10 acres. With either plane, spraying of large areas brings the unit cost down to a point where it is equal to or less than the cost of ground spraying.

Most of the aerial spraying in Merced County has been in the large areas of pasture land for control of both larvae and adults of *Aedes* mosquitoes, principally *dorsalis* and *nigromaculis*. No attempt was made to spray only that part of a pasture under water. When a pasture was partially flooded and developing mosquitoes, the entire field was sprayed. In a single large field or a series of smaller adjoining fields, a single spray job would be an adulticiding treatment at the end first flooded, a larviciding treatment of the actual water area, and a pre-hatching treatment of the end not yet flooded. Hence, it was necessary to arrive at a dosage which would effectively accomplish all three purposes. After much experimentation, a dosage of .4 lb. per acre was decided upon. This dosage gave 100% kill of the larvae and the pre-hatching treatment and 95% plus kill of the adults. In individual cases, this treatment has been effective through as many as three or four irrigations, or a period of three to six weeks.

In addition to the spraying of pasture land, the airplane has been used to advantage in otherwise inaccessible places such as: tule ponds, clogged drain ditches, sloughs, river-bottoms and gold dredger-pits. Entire cities have been sprayed as well as certain urban areas for fairs, celebrations, etc. Extensive rice fields which could be controlled in no other way were treated by aerial spraying.

Some of the pastures and duck clubs which remained flooded for long periods of time were sprayed for control of *Culex tarsalis* larvae. Several farms were sprayed for *Culex quinquefasciatus* and *Culex pipiens*. Ditches and sloughs were sprayed for *Anopheles freeborni, Culex stigmatosoma* and *Culex tarsalis*. The rice fields were sprayed for *Anopheles freeborni* and *Culex tarsalis*. The gold dredger-pit area along the Merced River produces all 19 kinds of mosquitoes found in the County, so was sprayed in an attempt to kill larvae and adults of as many kinds as possible. In some cases, the spray boom and aerosol were used together in order to get penetration through the trees and to get a high initial kill and a lasting effect.

The Relation of the Mosquito Aerial Spray Program to the Wildlife of Merced County

Although no serious problem has yet arisen, there is always the possibility of deleterious effects of DDT on fish, birds and beneficial insects.

The dosage used, .4 lb. per acre, is sufficient to kill small fish in confined water areas such as shallow puddles left after flooding a field or ditches in which the water has been turned off. However, in these situations the fish would probably die anyway. It is doubtful that this dosage would be enough to kill any fish in the deep flowing canals, ditches, sloughs and rivers. Since most of the spraying is done on pasture and swamp land, the danger to fish does not present a very serious problem. A note of caution might be added in regard to the spraying of lakes, reservoirs or even slowly moving rivers. In one case in the upper Merced River area, a number of bass were killed. The local fishermen blamed it on the mosquito spraying. Although the dosage applied would hardly be sufficient to kill such fish, in slowly moving water it is quite possible in this area that the pilot became confused and repeated the same swath several times. Such a heavy dosage would certainly be enough to kill fairly large fish.

There have been no ill effects on the bird population so far as is known. However, with nearly 300 Duck Clubs covering 70 square miles, the possibility makes it essential that every precaution be taken. It seems very unlikely that there would be any direct effects of the DDT on the ducks, but since many of them eat a certain number of aquatic insects which are readily killed by DDT, it is possible that the ducks might be affected. The only place where this has come up is on the California State Game Refuge at Los Banos, California. The manager of the game refuge was hesitant about allowing the district to spray his ponds.

Instead of larviciding the ponds, the district waited until the mosquitoes had hatched and then adulticided the area with the exhaust aerosol.

Several thousand acres of duck clubs have been aerial sprayed with the same dosage used on pastures and swamps without a single complaint from the owners or the hunters.

The problem of killing beneficial insects has come up several times in regard to bees. Several complaints have come in to the effect that the aerial spraying was killing off bees in certain hives. Every case so far has eventually been traced to other spray materials, principally arsenicals. Although the pilots take every precaution to avoid spraying directly on bee hives, in one or two cases it has been done. In one case a truckload of beehives was in a back yard in town and was covered with the DDT spray. The owner observed the hives closely and reported no ill effects whatsoever.

There is also the possibility of materially reducing the populations of pollinating insects and insects in general. As yet so little research work has been done on such problems that it is difficult to determine how important the problem actually is. During the normal spray program, the only other insect which was obviously consistently killed off was the housefly. This was definitely an advantage, as it resulted in much good will towards the district.

Just what the result of repeated sprayings in the same field will be is hard to predict. However, one incident involving the application of a higher dosage than normal showed some interesting results.

In one particular field, 100 acres of permanent pasture, a dosage of .8 lb. to the acre was applied by mistake through faulty adjustment of the pressure relief valve. In this field no mosquito larvae were found for nearly sixty days. However, at the time of the spraying many other insects in the area were also killed. Within ten or fifteen minutes the surface of the water was blackened with the bodies of insects such as bugs (Notonectids and Corixids), beetles (Hydrophilids and Dytiscids, etc.), dragonflies, mayflies, bees, wasps, etc. It almost seemed to be raining insects for a few minutes.

The danger of seriously upsetting the balance of nature is one which should be considered with due caution by those responsible for large scale aerial DDT spray programs.

APPENDIX

Comparative Tables

Aerial Spraying	*Ground Spraying*
Cost: Comparable to or cheaper than ground spraying where large areas are sprayed.	*Cost:* Cheaper than aerial spraying for small areas.
Time: Much faster. Possible to spray from 100 to 400 acres per hour.	*Time:* One truck with a spray boom can spray from 5 to 20 acres an hour.
Accessibility: Plane can spray many places which are inaccessible from the ground such as large swamps, tule ponds, duck ponds, rice fields, etc.	*Accessibility:* Ground rig can sometimes get to spots with overhead obstructions which would prevent plane operation.

Comparative Tables

Small Plane (Aeronca Champion)	*Large Plane* (Inland Boeing 75A)
1. Can spray an average of 125 acres an hour.	1. Can spray an average of 270 acres an hour.
2. Economical for spraying areas of 10 acres or larger.	2. Economical for spraying areas of 100 acres or larger.
3. Can spray ½ gallon to 1 gallon per acre.	3. Can spray from 1 pint to 10 gallons per acre.
4. No aerosol.	4. Equipped with exhaust aerosol apparatus.

Comparative Tables

District-Owned Plane		*Rented Plane*	
Direct costs of operating the Aeronca Champion airplane from April 15, 1947, to Sept. 30, 1947, not including the cost of insecticide:		Rental of 450-h.p. Inland Boeing 75A biplane. May and June, 1947.	
Gasoline and oil	$697.81		
Repairs & overhaul	649.63		
Hangar rental	180.00		
Fire & Theft Ins.	126.00		
Liability Ins.	180.00		
Compensation Ins.	371.68		
Pilot Salary	2479.50	Plane rental	$2939.83
Total direct cost for 1947 season	$4684.62	Total	$2939.83
Total acres sprayed	71,290		14,692
Cost per acre	$0.07		$0.20
Total hours of flying	564		54
Cost per hour	$8.30		$55.00
Total gals of spray	32,996		7,646
Cost per gal sprayed	$0.14		$0.38
Gals per hour	58		141
Acres per hour	126		272

The above costs do not include the cost of 10% DDT larvicide in diesel oil at 50 cents per gallon or the capital cost of the Aeronca airplane and the spray equipment.

Aerial Aerosol Spraying

Plane rental	$1743.64
Total acres aerosoled	9222
Cost per acre	$0.17
Total gallons of aerosol	2383
Cost per gallon aerosol	$0.73
Gallons per hour	74
Acres per hour	288

COMPARATIVE TABLES

District-Owned Plane	*Rented Plane*
1. Capital investment: Aeronca plane $2777.65; Spray equipment 881.50; Total $3659.15	1. Capital investment: None.
2. Unit operating cost: (Does not include capitalized cost of airplane and equipment.) $8.30 per hour; $0.07 per acre covered; $0.14 per gallon sprayed	2. Unit operating cost: $55.00 per hour; $0.20 per acre covered; $0.38 per gallon sprayed
3. Convenience — always ready for immediate operation on short notice.	3. Requires 24 hours' notice and even then not always available.
4. No problem.	4. Minimum guarantee of 1 hour's flying time if called out.
5. Pilot is district employee, trained in mosquito control methods and is familiar with the terrain.	5. Same pilot is not always assigned to the job, hence is not familiar with the work or the terrain.

CLASSIFICATION OF AREAS SPRAYED

	Acres	*Hours*
Pasture and Swamp	82,586	605:32
Ditches, Canals, and Sloughs	1,986	5:25
Ponds	300	1:10
Rice Fields	320	2:19
Urban	210	1:03
Sewer Farms	580	2:31
TOTAL	85,982	618:00

COMPARATIVE TABLES

Aerial Spray - Boom	*Aerial Aerosol*
1. Large droplet size. Mass median diameter of 150 microns.	1. Small droplet size. Mass median diameter of 50 to 75 microns.
2. Fair penetration through foliage.	2. Excellent penetration through trees, bushes, and tall grass.
3. Maximum kill in 26 hours.	3. Maximum kill in 3 to 6 hours.
4. One load of 130 gallons dispensed in 20 minutes at ½ gallon to the acre. 260 acres to the load. 10% solution of DDT used to give .4 lb. per acre.	4. One load of 130 gallons dispensed in one hour at 1⅓ qt. to the acre. 390 acres to the load. 15% solution of DDT used to give .4 lb. per acre.

Mr. Knipling: Thank you, Mr. Smith, for your valuable presentation. Next, Mr. H. I. Magy will give a paper on "A comparison of the use of the thermal exhaust aerosol plane and the spray plane in mosquito control in Kern County and the Sutter-Yuba Mosquito Abatement District."

A COMPARISON OF THE USE OF THE THERMAL EXHAUST AEROSOL PLANE AND THE SPRAY PLANE IN MOSQUITO LARVAE CONTROL IN KERN COUNTY AND THE SUTTER-YUBA MOSQUITO ABATEMENT DISTRICT

HARVEY I. MAGY

In collaboration with the Kern Mosquito Abatement District, the Bureau of Vector Control of the California State Department of Public Health conducted 150 studies closely evaluating the control of mosquitoes by using the airplane application of insecticides in Kern County during the spring and summer of 1947. The various meteriological, operational, entomological and biological factors that might have influenced the results were evaluated. For the purpose of this symposium, only the general concepts and results of these studies are reported herein. A complete report of these studies will be presented to the members of this Association in the near future.

Two airplanes were used, one equipped with a spray boom and the other with a thermal exhaust aerosol generator. The thermal exhaust aerosol plane would be the preferred method of application of insecticides because of the greater distance the ship could fly without reloading and the wider swaths that the insecticides are dispersed. Mr. Geib has already indicated that the sprayplane was more successfully used as a means of controlling *Aedes* larvae in pasture lands than the aerosol plane. A kill approaching 100% was imperative, due to the tremendous number of *Aedes* larvae occuring in freshly-irrigated pasture lands. This kill was consistently obtained with the use of a 5% War Assets DDT emulsion applied with the spray plane, at the rate of 0.3-0.4 lb./acre, and between ¾ and one gallon/acre at a swath width between 50 and 100 feet. However, very erratic results were obtained when the thermal aerosol plane was used.

Twelve different DDT solvents and mixtures were used in the thermal exhaust aerosol plane. These materials were applied at the rate of ¼ to 1/3 gallon/acre and between 0.3-0.4 lb. DDT/acre, at a swath width of 50 feet. The following materials were used:

No. *Studies*	*Material*	Approx. Percent *Kill Larvae*
6	21.4% Golden Bear Extract, 16 oz. B-1956	80
5	21.4% Velsicol NR-70, 16 oz. B-1956	80
8	21.4% Standard Base Oil WT	85
3	25% (Com.) Chemurgic Emulsible	90
	General Petroleum Distillate 544 C (PD 544C)	
	DDT	
10	10%	72
4	15%	49
3	20%	66
11	21.4%	40

This kill was considered inadequate for *Aedes* larvae control, since an 80% mortality wherein 50 larvae per dip were found would produce about 350,000 adults per acre.

At this point in the discussion if would be apropos to ask: Why did the emulsion-spray give more effective control than the aerosol plane applications, inview of the fact that the DDT dosage per acre was similar for both types of application? I would like to offer the theory, and I am sure Mr. Geib believes the same as I do, that the emulsion spray larvicides penetrated the water surface, whereas the aerosol larvicides remained on the surface. Since *Aedes* mosquitoes are principally bottom feeders, there would be a greater chance for the larvae to come into contact with a lethal quantity of DDT that was applied as an aqueous emulsion.

Since the aerosol plane could fly three times as far with one load of insecticide than the spray plane, it was thought that it might be a good idea to attempt to duplicate the same principle of control by incorporating a large amount of emulsifying agents in the aerosol larvicide with the hoped-for result of surface penetration and cheaper control. Two trials were run, using 3½% Igepol and 1½% B-1956 as the emulsifying agents, and 21.4% DDT in PD 544C. Both were applied for the control of first and second Instar *Aedes* larvae. The average mortality was 75%.

We next attempted diluting the same material at various proportions with water and Diesel oil and applying the materials with the aerosol plane.

No. Studies	*Material*	*Kill*
3	PD 544 C 1:1 Water	12%
1	PD 544 C 2:1 Water	0
1	PD 544 C 1:1 Diesel oil	0

Velsicol AR-60 was prepared in the same manner with 5% emulsifying agents and applied the same way:

No. Studies	*Material*	*Kill*
2	Velsicol AR-60 1:1 Water	83%
1	Velsicol AR-60 1:1 Diesel oil	26%

When emulsified with water and applied with the aerosol ship, the kill looked promising; however, it was not as good as the W. A. emulsion—and its price was prohibitive.

Of all the above materials mentioned as being used in the aerosol plane, Standard Base Oil W. T. and Chemurgic Emulsible appeared to be the most promising. Of the latter, only three studies were completed. These were conducted toward the end of the season. More studies with these materials should be made in the future.

Later on in the summer, this Bureau conducted similar studies in conjunction with the Sutter-Yuba Mosquito Abatement District for the control of anopheline larvae in rice fields. A thermal exhaust aerosol ship was used. The plane flew 100 ft, swaths and applied between one pint and 1/3 of a gallon per acre of insecticide. There were 11 studies in which a PD 544 C-DDT concentrate was used, in combination with Diesel oil at various ratios. These studies had an average mortality of better than 96%. In three of these studies, 0.026 lb. or less of DDT in about one pint was applied per acre with better than 95% mortality. Compare this with 0.4 lb. required to control *Aedes* mosquito larvae. In other words it required only 1/16 the amount of DDT necessary to effectively control Anopheline larvae than was required for *Aedes* larvae control. Probably, the fact that Anopheline larvae feed at the surface accounted for this difference in susceptibility. Obviously, the aerosol plane application of DDT has a place in the control of Anopheline mosquitoes in rice fields. The complete results of these rice field studies will appear as a miscellaneous item of the Operations Manual. It will be available within a few weeks.

On the basis of both the studies conducted in Kern County and in the Sutter-Yuba Mosquito Abatement District, one could safely say that a 5% DDT War Assets emulsion applied with a spray plane has given a consistently high mortality rate approaching 100%, for the control of *Aedes* in pasture lands. DDT solutions applied with a thermal exhaust aerosol ship have not given consistently satisfactory results for the same species. However, this method of application has been used for the successful control of Anopheline larvae in rice fields in the Sutter-Yuba Mosquito Abatement District. At present we can safely recommend the use of the thermol exhaust aerosol plane *only* for Anopheline larvae control in rice fields. More investigations of the use of this type of plane in mosquito control is warranted.

I might also add that we have always had satisfactory adult mosquito control with the aerosol plane.

An Analysis of Flight Data and the Costs Data in the Airplane Application of DDT

In computing the cost of treating the fields in our studies at Bakersfield, we were strongly impressed by the relationship of the total flight time and its component parts to the unit cost per acre treated. The component parts of the total flight time included the actual spray or treatment time, the turning time, and the ferrying time. Mr. Geib figured that it cost him $28.64 per hour of flight time. This included the pilot's salary; ground crew salary; maintenance and repairs, cost of airplane, and special equipment. Since the larger portion of the cost of treating a field is due to the total flight, this item of cost must be determined accurately.

There were many variables that tended to give a false flight time picture, and consequently a false cost picture.

The pilot was often obliged to fly great distances to a very small experimental plot. The cost per acre would obviously be exceedingly large, out of proportion to a similar field if it were close to the landing strip.

When the experimental field and other fields that were being treated under the district's routine control program were treated together during one flight, the cost for each routine control field and the experimental fields was at a minimum but when a special flight was necessary in order to fly only the experimental fields, the cost was much higher.

There wasn't a clear understanding of the relationship of turning time to the size of the acreage. Most of the flight time for small acreage would have been spent in the turning time between swaths. For example, there would be as much time spent on the turns for a ten-acre field as for an 80-acre field, if the width of the fields was the same, because the same number of swaths would have to be made. This relationship was not clearly indicated on the flight time data.

With these reasons in mind, it was decided that a more accurate method of analyzing the flight time data should be made. The folllowing graphs were made:

A. *Specific Reasons for this Analysis*

1. To determine the relationships between the various items of flight time and the cost of treating fields of given acreage.
2. To determine the difference in cost of treating similar acreage with planes that have different rates of discharge.

B. *Flight time analysis of Square fields*

(This is the hypothesis or presumption on which we

COST DATA FOR AIRPLANE OPERATION, APRIL, MAY, JUNE and JULY 1947

SPRAY BOOM

SWATH	ACRE	FLIGHT TIME	SPRAY TIME	MATERIAL	GAL/ACRE	DDT/ACRE	GAL.	GAL OF CON.	OPER COST	MATERIAL COST	TOTAL COST	COST/ACRE
50'	4726	58.0 Hrs.	8 Hr-43 M	5% Emul.	1.1	.46 lbs.	5245	1049.0	$1017.32	$2098.00	$3115.32	.65
50'	591	11.0 Hrs.	1 Hr- 3 M	2½% Emul.	1.15	.24 lbs.	679	67.9	192.94	135.80	328.74	.56
75'	2872	24.5 Hrs.	3 Hr-33 M	5% Emul.	.94	.39 lbs.	2705	541.0	429.73	1082.00	1511.73	.52
100'	2530	14.0 Hrs.	1 Hr-54 M	5% Emul.	.57	.24 lbs.	1448	289.6	245.56	579.20	825.16	.32

AEROSOL

SWATH	ACRE	FLIGHT TIME	SPRAY TIME	MATERIAL	GAL/ACRE	DDT/ACRE	GAL.	GAL OF CON.	OPER COST	MATERIAL COST	TOTAL COST	COST/ACRE
50'	4979	70.7 Hrs.	9 Hr- 7 M	Aver. 20% DDT	.29	.46 lbs.	1422.5		$1240.08	$1806.57	$3046.65	.61
75'	136	2.8 Hrs.	10 M	95% PD544C	.24	.38 lbs.	33.2		49.11	42.16	91.27	.66
100'	108	.9 Hrs.	6 M	3½% Igepol 1½% B1956	.18	.29 lbs.	19.0		15.78	24.13	39.91	.37

Gas & Oil	889.55
Repairs	92.53
Insurance	250.30
100 Hr. Check	100.00
Pilot	1,600.00
Helper	259.49
	$3,191.87

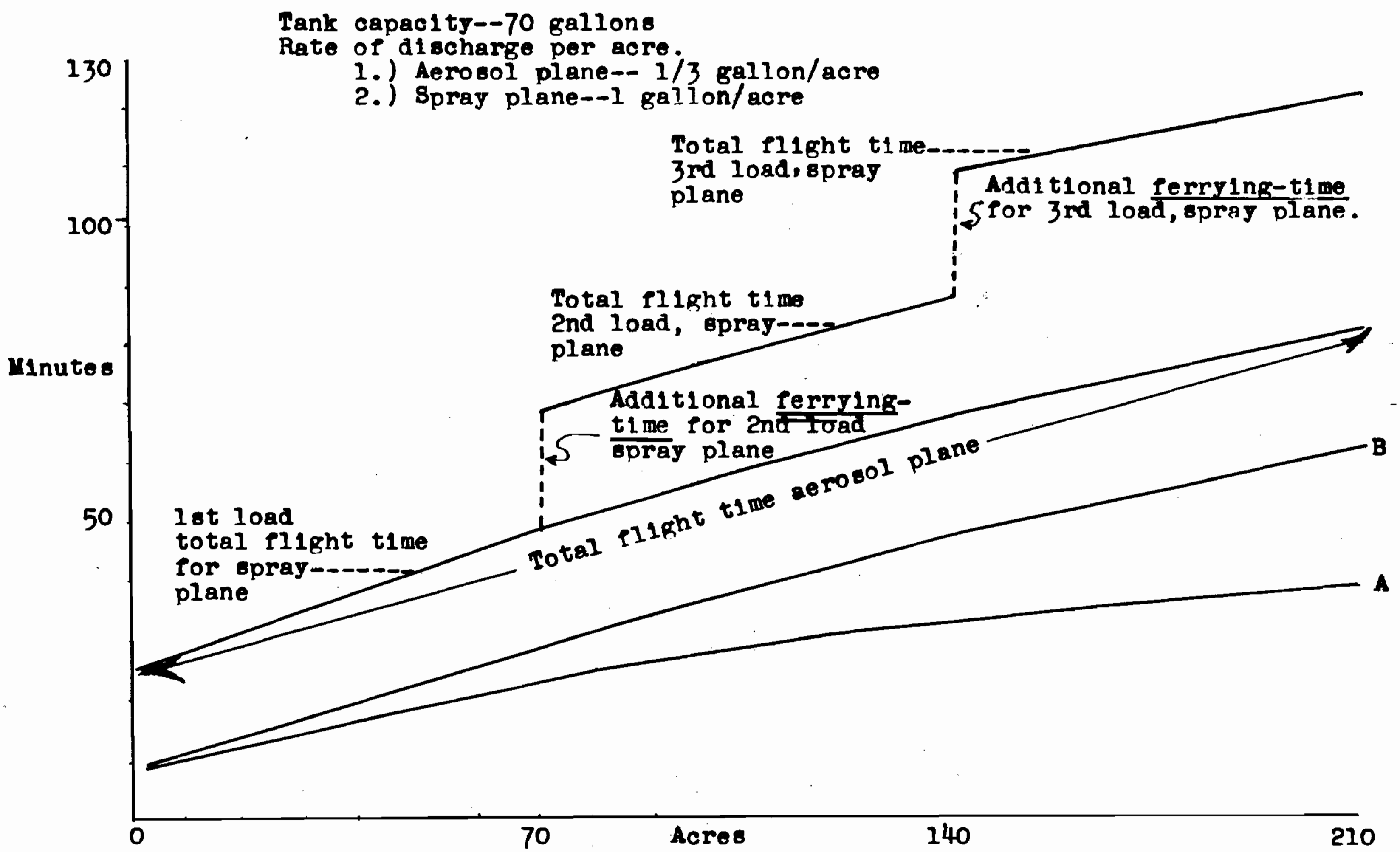
Operational cost/hr	$17.54
Cost Emulsible/Gal.	2.00
Cost Aerosol/Gal. straight	1.19
Cost Aerosol/Gal. with Emulsible	1.46

	Average Acreage	Spray Time	Flight Time	Operating Total Cost	Operating Cost/Acre	*Total Cost/Acre
5 - 25 Acres	14.9	1 Hr-39 M	.57 Hr.	$10.00	.67	1.07
30 - 60 Acres	45.6	5 Hr-00 M	.70 Hr.	12.28	.27	.67
75 - 120 Acres	94.0	10 Hr-20 M	.99 Hr.	17.36	.185	.585

SWATH WIDTH OF 50 FEET

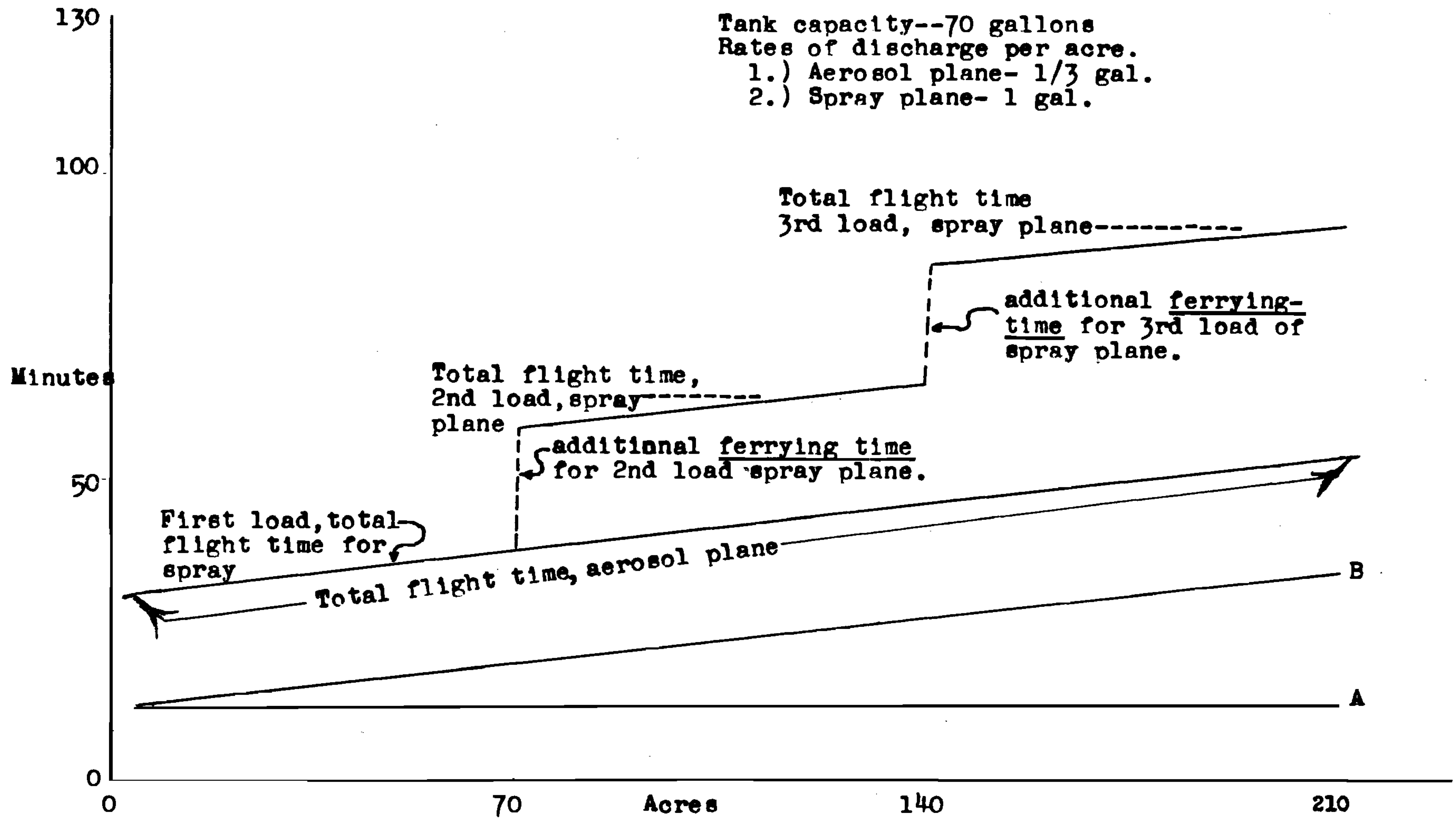
*Total cost based on a 5% Emulsible solution $.40/gal. at 1 Gal/acre.

Flight time analysis of square fields treated with thermal-exhaust aerosol and spray planes at 90 MPH.



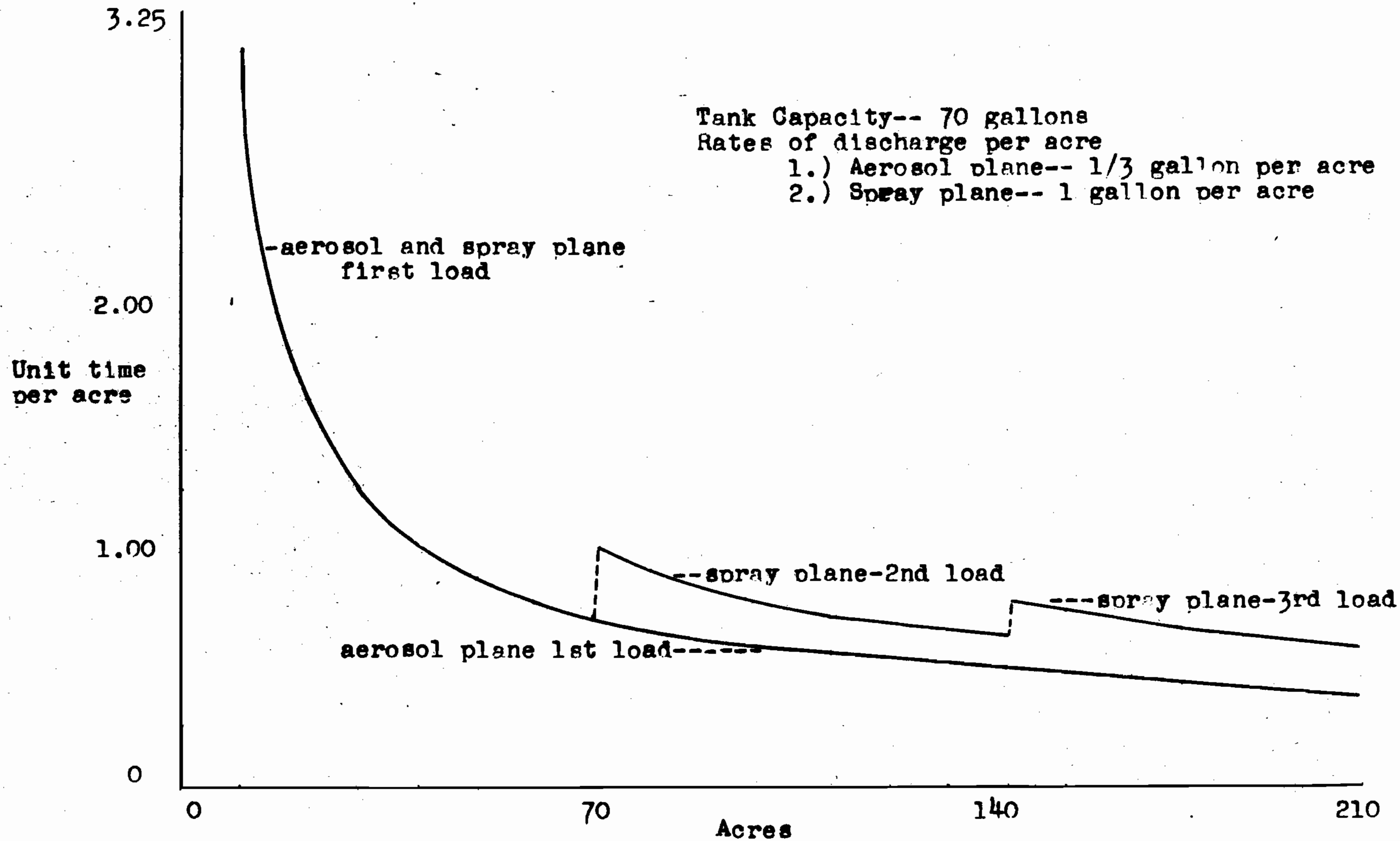
Note: A--Turning time
B--Turning time plus treatment time
Ferrying time-- equals 20 minutes for aerosol plane and as indicated for spray plane.
Total flight time-- equals A plus B plus ferrying time

Flight time analysis of rectangular fields with a base of 1000 ft. treated with thermal exhaust aerosol and spray planes at 90 MPH.

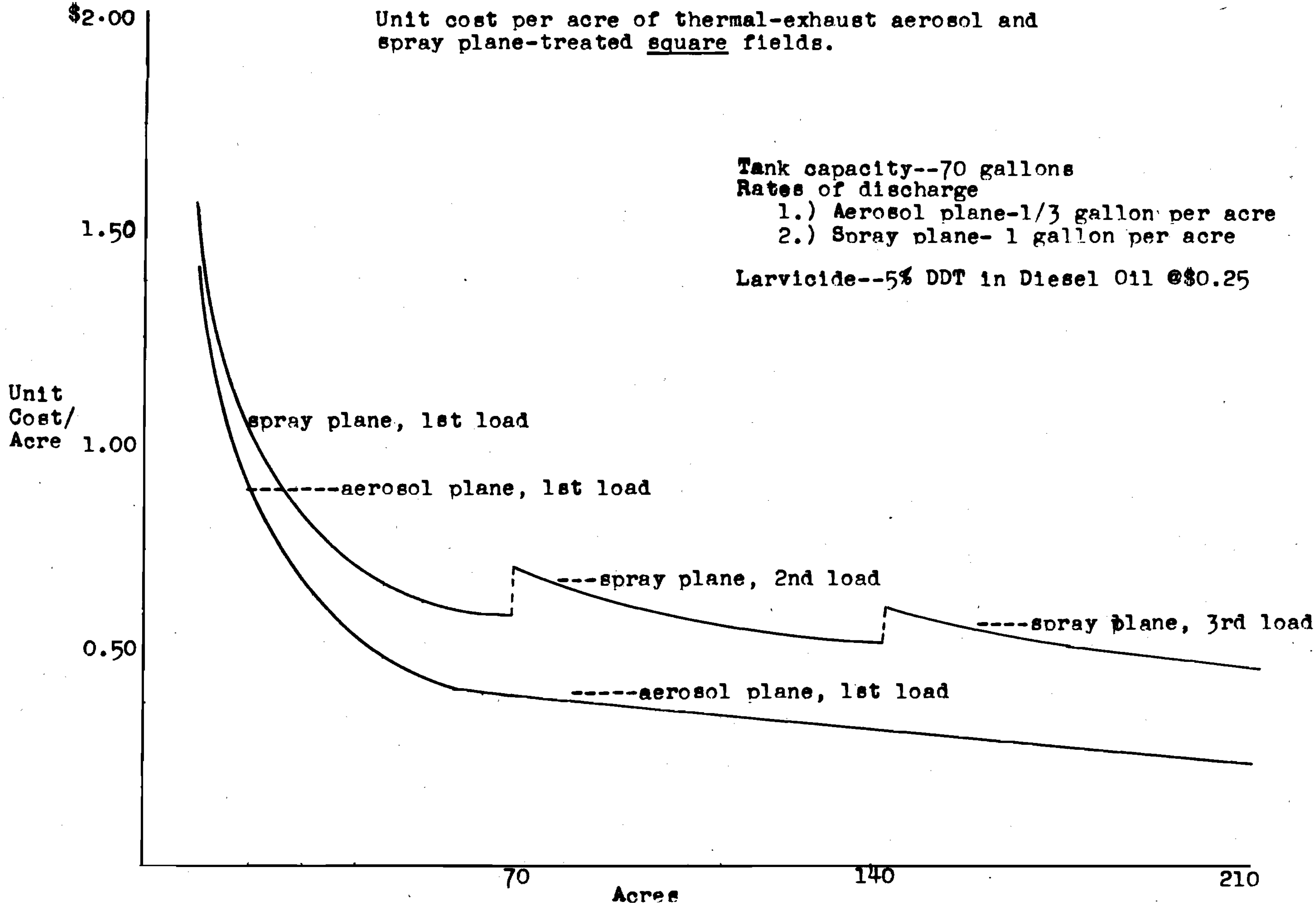


Notes:
A.--Turning time
B.--Turning time and treatment time
Ferrying time--20 minutes for aerosol plane and as indicated for spray plane
Total flying time-- A plus B plus ferrying time.

Unit flying time per acre of thermal exhaust aerosol and spray planes at 90 MPH--square fields.



Unit cost per acre of thermal-exhaust aerosol and spray plane-treated square fields.



based our total flight time.)

1. Assumptions
   a. Square fields — this assumption proved to be valid on the basis of 10,296 acres treated by both aerosol and spray plane with a 50 ft. swath, by the Kern Mosquito Abatement District, viz.:

Ranges	Average Acreage	Flight time	Total cost/acre
5–25 acres	14.9	34′ 12″	$1.07
30–60 acres	45.6	42′ 0″	.67
75–120 acres	94.0	59′ 24″	.585

   b. Aerosol plane rate of discharge — 1/3 gal./acre.
   c. Spray plane rate of discharge — 1 gal./acre.
   d. Tank capacity — 70 gallons.
   e. Ferrying time — 20 minutes for each load.
   f. Turning time is 40 seconds per turn.
   g. Mosquitoes are being controlled.
2. Concepts
   a. Actual spray time is the smallest item of time.
   b. Turning time largest portion of flight time for aerosol.
   c. Ferrying time is constant.
   d. The larger the acreage, the less time spent in flight. My third slide will bear this out.

C. *Flight time analysis of Rectangular fields.*
1. Assumptions
   a. Each acreage has a base of 1000 ft.
   b. Rate of discharge, tank capacity, ferrying time same as for square fields.
   c. Mosquitoes are being controlled.
2. Concepts
   a. Smaller the acreage, the more time spent in flight; the larger, the less time spent in flight.
   b. Spray time is the smallest item of time.
   c. Turning time is constant for all acreage.
   d. Total flight time for all acreage is less than for a square field.

D. The remainder of the discussion is based upon square acreage, as the bulk of fields that were treated in Kern County were square subsections.

E. *Unit flying time per acre of square fields.*
1. The larger the acreage, the smaller the unit flying time per acre for the aerosol plane, and the converse is true for the smaller acreage for the aerosol plane. Aerosol plane flies 210 acres on one load.
2. Spray plane — the general trend of the unit flight time is the same as for the aerosol plane, except for the increased time on reloads.
3. The initial peak on each reload for the spray plane is successively lower than the initial peak of the preceding load.
4. The increased unit time for the reloads of the spray plane is caused solely by the additional ferrying time.

F. *Unit cost per acre of square fields.*
(This is theoretical. It is not used in the evaluation of our results.)

1. Assumptions in addition to the above assumptions.
   a. Material used for both planes is the same: 5% DDT in Diesel oil at total cost of $0.25 per gallon. (This is not recommended for *Aedes.*)
2. Concepts
   a. The unit cost curve for the first load of the spray plane does not coincide with that of the aerosol plane, because the cost of insecticide is three times more per acre than for the aerosol. The difference is a cost of material difference.
   b. The general trend for the aerosol plane is for a smaller cost per acre as the acreage increases.
   c. Spray plane — the same general trend is true, except for the increased cost per acre on the reloads.
   d. The initial cost on each reload for the spray plane is successively lower than the initial peak of the preceding load.
   e. The cost/acre of this theoretically calculated cost figure closely coincides with the cost picture of the Kern Mosquito Abatement District. (Refer back to Table I.)

G. Conclusions
1. The larger the acreage, the lower flight time per acre, and the cheaper the control per acre.
2. When stating "Cost/acre treated" it would be more accurate to say "Cost/acre of a given size treated," because the cost/acre is dependent upon the cost per unit acre. The average size of your acreage should be grouped as already stated.
3. For economy of operations, planes with a large insecticide carrying capacity that can give effective mosquito control at a minimum dosage are desirable.

Mr. Raley: Thank you, Mr. Knipling, and the members of your panel for this most interesting presentation. We will now adjourn until this evening at seven o'clock at the Claremont Hotel.

(Note: The following address was presented at the annual banquet.)

SOME OBJECTIVES IN RESEARCH FOR THE CONTROL OF ARTHROPODS OF MEDICAL IMPORTANCE

(Abstract of Address at Banquet Held by California Mosquito Control Association at Berkeley, February 13, 1948)

By E. F. Knipling
United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

Mr. Chairman, and members of the California Mosquito Control Association: I consider it an honor and privilege to speak to you on this occasion. I have enjoyed the meetings and wish to commend the Association and the founders, Professor Herms and Mr. Gray, for the excellent work they have done and are doing to control mosquitoes and related pests and human disease vectors in California.

I wonder how many in this audience would have predicted six years ago that insecticides would be discovered which, when applied to surfaces, would kill flies and mosquitoes that rested on them several months or even a year later. How many would have believed it possible to destroy both adults and larvae of mosquitoes over thousands of acres of territory with less than a pint of solution per acre or as little as 0.2 pound of an insecticide per acre? How many would have believed it possible to impregnate clothing with a chemical so that the wearer would be protected from body lice and mites even after the clothing had been laundered several times? These developments represent some of the progress that has been made during recent years. I believe that those of us engaged in medical entomology work can well be proud of these accomplishments.

In view of such developments, we might well be asked — Why is it necessary that research continue? We might counter with the question — Since aircraft has been developed which will exceed a speed of 400 miles per hour, why must attempts be made to develop even faster or more efficient planes? Yet I believe that most of us will agree that research and development should continue in those directions.

There are a number of reasons why we should continue research on arthropods attacking man:

(1) There is a need for more information on the biology and habits of these arthropods. Certain insect habits that might have been considered of little importance several years ago in the light of present-day developments have become critical factors in the efficient application of control measures. The resting habit of mosquitoes and flies is a good example.

(2) We need effective ways to control certain arthropods, such as ticks, sand flies, black flies, deer flies, and eye gnats, which cannot now be controlled in a satisfactory manner.

(3) We need to adapt known measures of control for certain species of flies, mosquitoes, and other insects to the control of related species in different parts of the world.

(4) We need improvements in materials and methods that are now employed. For example, a more satisfactory water-dispersible DDT powder and more efficient sprayers for applying such powders are desirable.

(5) As new materials appear, the public demands information regarding their effectiveness, even though standard chemicals already in use are giving satisfactory results.

(6) The public will constantly demand greater efficiency in insect control.

(7) There are indications that certain arthropods may develop specific tolerance to insecticides now in use. Effective substitutes should be available in the event that this tolerance becomes an important factor.

Actually there is more research under way in the field of medical entomology today than prior to the development of control measures which I have mentioned. The recent war has demonstrated again how important insect and insect-borne diseases can be. As a result, various agencies have initiated investigations or expanded their research facilities.

Some of the objectives of the research programs of the Bureau of Entomology and Plant Quarantine will be discussed. Most of this work is being done at our Orlando, Florida, laboratory with financial support from the Department of National Defense. The investigations are directed along three major lines:

(1) Development of materials for the protection of individuals from attack by various arthropods. Work is under way on toxicants or repellents that will protect individuals from fleas, ticks, mites (chiggers), lice, mosquitoes, and related parasites. These studies are designed to develop a material or a combination of materials that will give protection even after the clothing has been washed several times. This objective has been gained for lice and chiggers (mites). Some very promising materials for use against ticks, fleas, and mosquitoes are now under investigation.

(2) Development of treatments for use in living quarters or industrial establishments to destroy such disease carriers and pests as flies, mosquitoes, bedbugs, fleas, and roaches. Various new insecticides have been tested as residual and space sprays. A more rapid acting insecticide having the residual effect and toxicity of DDT is a major objective.

(3) Continuation of studies to develop more effective materials for use against mosquitoes and related insects, as well as ticks and mites, by area-control procedures. These investigations involve the treatment of large areas in various ways. Although DDT is highly effective against mosquitoes, we can expect even better materials. Parathion, for example, in preliminary tests is indicated to control *Anopheles* larvae with about one-fifth the dosage required for DDT. As little as 1 pound to 80 acres has given good control. The toxicity of this chemical to higher animals is a serious drawback, however, and may prevent its wide use. Several of the newer insecticides are effective at rather low dosages against mites and ticks when applied to their natural habitat. Recent studies in Alaska and New Hampshire have shown that small amounts of DDT or TDE will control simuliid larvae without apparent harm to fish.

In addition to the major lines of work mentioned, special projects are undertaken. At present an extensive program is under way in cooperation with the armed services for the study of insect control in Arctic regions.

I believe that further important progress in the field of medical entomology will in large measure depend on close cooperation between agencies and between specialists in the various scientific fields. The problems that arise in connection with the development of new insect-control measures are becoming more and more complex. Entomologists cannot get the wide training necessary to carry out alone the many aspects requiring study. Parasitologists, chemists, engineers, toxicologists, specialists in wild life, and others can contribute to a solution of the many problems that arise in the field of medical entomology. The recent trend toward cooperation with these workers is a step in the right direction, but such cooperation must be continued and increased if the desired results are to be achieved.

In conclusion I should like to repeat that I have enjoyed the meetings, and I shall look forward to attending conferences that will be held by this Association in the future.

SATURDAY MORNING, FEBRUARY 14, 1948

Mr. Raley: This morning we do have many, many, many papers. I would like to move very quickly, and it may be best to shift somewhat in subject matter, but in every way we will try to get as many of them in as possible.

The first paper is entitled: "Mosquito Prevention Campaign," by M. E. Gregerson.

MOSQUITO PREVENTION CAMPAIGN

M. E. Gregerson
Superintendent, Fresno Mosquito Abatement District

Most of you have read all about the campaign we had in the "Buzz," so there is no use going into detail concerning our week for "Mosquito Prevention Campaign."

Our district has contacted the schools and put on programs to educate the children. Foster and Kleiser were contacted. Buses carried ads on it. Downtown stores featured window displays. Dairymen endorsed it. Theaters were contacted. We contacted Mr. Raley from the Consolidated District, and he was very interested in cooperating with us to include much of Fresno County.

Mr. Raley: The next contribution to this morning's program is "Headaches of California Mosquito Control in Contrast to Those of Southern United States," by Roy Wilson, Manager of the Madera County Mosquito Abatement District.

HEADACHES OF CALIFORNIA MOSQUITO CONTROL IN CONTRAST TO THOSE OF SOUTHERN UNITED STATES

By Roy Wilson

From the discussions that have taken place during the past two days it is evident that the problem of mosquito control differs greatly in each section of the country; in fact, even in the various sections of a single state. Generally speaking, unless one has had the opportunity to travel from place to place, it is difficult to thoroughly appreciate the problems or conditions under which a fellow worker may labor.

In the south central portions of the United States, the rainy season coincides with the most active mosquito breeding season. The abundance of almost daily rainfall, coupled with a high natural water table, presents problems almost unknown to the mosquito control workers in California.

Throughout the South the mosquito control worker encounters vast areas which are almost permanently flooded — producing both pest and malaria mosquitoes in great numbers. The dense umbrella of foliage covering these areas renders control from aircraft almost impossible and the inability to penetrate these areas on foot or even by boat makes control an engineering rather than an entomological problem.

In these areas, particularly when they border thickly populated sections, drainage by dikes and ditches and sometimes the use of pumps is the only practical method of control.

In addition all lowlands not drained must be inspected weekly and treated with larvicides where practical. In such sections malaria control received first consideration, and programs of residual treatments within rural housing is a matter of prime importance.

The headaches involved in a region under the state of constant flood, coupled with a semi-jungle growth, is one of real concern to the mosquito control worker in south central United States.

Despite the headaches involved in mosquito control in California, we should all be thankful our problems are not as perplexing as they found in Louisiana.

Mr. Raley: Thank you, Mr. Wilson. Our next presention will be "Comparative costs," by G. E. Washburn, manager, Turlock Mosquito Abatement District.

Mr. Washburn: I don't have a headache; I admit having whiskers. We in the Turlock District instituted a new procedure, I believe, so far as many districts are concerned. (At this point, the screen was raised, revealing the blackboard with a drawing of a bewhiskered gentleman and a poem: "Ed's whiskers need no trimmin'; He kisses kids, not the wimmin'!") To whom am I indebted? Better get a picture of that for me.

We did, I think, institute a procedure which is a little different. We employed a man under the category of administrative assistant, and we were very fortunate in the man we chose for that particular job of administrative assistant. As a result, we have been able to go over our costs of operations very carefully and to determine for many reasons, mainly selfish reasons on our own part, certain figures or costs, which I give here and which are only those pertaining to our own district. We don't think they are going to be guides necessarily for the coming season, even. We did them principally just to find out what had occurred during the past season. We found our costs rising. All of us are finding that happening. We got to wondering if there were any methods we could use to determine how to lower those costs in the coming season's operation. We have broken down our various and sundry operations into detailed cost studies. I won't bother to give this information to you because it is mostly facts and figures and most of you don't want that information. We are going to use the studies that we have made in evaluating our work for this coming season. I have no doubt but what we will be able to lower, for instance, our aircraft operations cost, presumably by a third of what we expended this past season. We found, for instance, that our hand operations costs were practically prohibitive per acre treated, in contrast with aircraft methods of mosquito control, and I believe this finding important; and there are other factors to be considered. I would like to give you a few of the costs so you can see how they compare with other districts. You will be interested in seeing how ours compare with yours and we, on our part, will be interested in knowing how yours compare with ours. We may use them or you may use ours.

So far as ground operations are concerned, we have discovered that our overall costs of power spraying, that is with our Essick rig (mounted on a jeep), is about, on the average, 46c per acre. Those costs are inclusive of everything that we can think of. They may be high or they may be low but that is actually the way they worked out this past season. This is 46c per acre for power equipment. Now compare that with hand spraying, which runs nearly a dollar an acre for operational costs. Of course in our own mind we can say then that, since the hand spraying is twice as expensive, we can certainly dismiss it, and we have done pretty nearly that. We only use hand operations in very limited situations. We use the jeep and the Essick to the greatest extent that we know how. Aerosol work has been an extremely inexpensive operation. Overall costs have been about three to five cents per acre this past season. Aircraft work, surprisingly, was not as high as we had anticipated it might be. Our aircraft work worked out at about 51c per acre. Keep in mind that in this district we do not own our own aircraft. We work on a contractual basis with a commercial operator. This cost of 51c per acre includes not only our cost for the contractual service for DDT work, but inspection and a swamper that went along with the outfit that we furnished. Whether those costs on aircraft are high or low, I don't know. Harvey Magy brought out a point yesterday. I gave you this figure of 51c per acre, which is the overall cost. His point was that perhaps we should break those down into individual fields of various sizes. But I don't know whether it is worth it. I thought of it, too, but I don't know whether it is worth it for the individual to break it down that far. The economics of the thing I don't believe justify themselves. I must admit that in the aircraft cost we did compare with at least three different types of aircraft. One was a B-13, one a Stearman and one a Cub, and those were all lumped together, which probably shouldn't be done. We have the figures for each individual ship but these are the average overall cost.

An interesting point to me was the cost of adult stations. Some of you have figured out how much that operation actually costs you in dollars and cents. We are not going into the other evaluations of it at all. On the basis of dollars and cents, it is a rather expensive operation. We discovered that the first station cost us nearly $2.50 for each inspection. We maintained fourteen stations throughout our district. With more stations you might cut that down some. That is just the pure and simple dollars and cents value of it. Gordon Smith doesn't approve of it, which is all right, but it is a rather expensive operation.

We did a considerable amount of residual work in the district. Last year we maintained two units which did nothing but residual work the year long. This year we presumably will maintain another unit, which makes three doing that type of work. It costs us in the neighborhood of approximately 90c per thousand square feet of residual area treated. It averages out to be about $1.20 for the average farm building. The average farmstead has between five and seven buildings and the average cost is between eight and nine or ten dollars or somewhere in that neighborhood, to do residual work. Of course we do it as other districts do, as a service to the people in the area. As I said earlier, most of these costs we have seen broken down into great detail, and many of these things will appear later in the proceedings. I don't believe it is necessary to give them at this time.

Mr. Raley: The next talk is on "The Place of Permanent Control in Overall Programs," by Ernie Campbell, Manager, Northern San Joaquin County Mosquito Abatement District.

THE PLACE OF PERMANENT CONTROL IN OVERALL PROGRAMS

By E. Campbell

I have been assigned a five to fifteen minute period in which to discuss "The Place of Permanent Control in Overall Program." This topic is of more importance than this would indicate in a two and a half day program.

Permanent control is a term that has been applied to work that is not always permanent, as well as other work that can be considered permanent. If a low hole is filled with earth, presumably permanent control has been accomplished. If a tide marsh has been reclaimed and farmed, the work can be classified as permanent control, even though minor or residual breeding may continue, and the reclamation work may require maintenance.

Permanent elimination of man-made mosquito breeding could be considered as a "Mosquito Prevention Campaign," which is another topic on this program. I will therefore consider here only elimination of so-called natural breeding areas.

I have nothing to add to this subject that is not already obvious to anyone who has given the matter serious consideration.

It is possible in a short time to review only briefly some of the factors involved. These fall into two groups:

(a) the over-all policy and
(b) the particular situation.

In the over-all policy we find such factors as the establishment of the policy of a higher current budget with the expectation of a lowered budget in the future. Comparative costs may to some extent be ignored in order to secure if possible a positive and 100% control, particularly near centers of habitation where this could not be achieved through larviciding. Permanent control helps eliminate short-season need of qualified personnel, which is a matter of dollars and cents as well as touching on the growing social consciousness of the undesirability of periods of peak employment and periods of idleness, with resultant evils.

There is another factor which may seem far fetched. It is hard for one who was engaged in mosquito control through the last war not to look ahead and put the District for which he is responsible in the best shape possible to weather another such calamity. In some cases, waste areas can be converted from a mosquito breeding liability into a food producing asset through land reclamation in a long range program.

Like other San Francisco Bay Districts, the Contra Costa District embraced important war activities. We were able to maintain control of breeding with a minimum of effort for the reason that, at the start of the work, the District had the courage to expend money for permanent control. Another factor is, of course, the need to consider the effect on wildlife.

The factors involved in a particular situation are: the degree of permanence and the hazard to which the work may be exposed to damage by peak floods; and the comparative costs, direct as well as overhead costs. In this connection, in the case of land reclamation there is the factor of increased land value and resultant increase of tax revenue. Land assessed at $5.00 or so an acre, when improved, may be assessed at $75.00 to $100.00 per acre with a direct contribution toward amortizing the cost to the District through increased tax revenue. In this we assume the venture is in cooperation with the land owner, in cases where the land would not be reclaimed without help from and at the instigation of the District.

The California State Subvention program has placed emphasis on immediate results. This is a condition that apparently has been recognized by the State Health Department as not always to the best interest of particular Districts. In at least one instance, the District has set up with the State's blessing a separate fund for permanent control in which the State did not participate. This gave the district an overall program embodying immediate results, and progress in a long range program of permanent control.

As stated at the beginning, nothing has been added here that is not already obvious — this is simply a review of the situation.

Mr. Raley: I would like to expand a little further on this matter of permanent control. Maybe some of you remember the release in the "Buzz" concerning the possibilities of its furtherment under the improvement act. We have been using that in benefiting drainage in our district, and we will be very happy to pass on any information we have on this matter to the other districts. Through this method of approach you not only develop very good public relations, but you save the taxpayers' money and you get permanent control.

The next discussion will be by Dick Peters.

THE "BUZZ" AND OTHER ASSOCIATION PUBLICATIONS

By Richard F. Peters

I had my opportunity to sob on the shoulders of the Association on the evening before last, but I'll repeat it — the "Buzz" simply doesn't buzz without contributions. Therefore, if you want the "Buzz" to be representative and otherwise indicative of what is going on in your District, the best way to have it that way is to do something about it by sending in your contributions. I appeal to you; I beseech you; I implore you. It sometimes gets very, very difficult when the last page is in the typewriter and I have to try to make the deadline and get original at the same time.

In addition to the *Mosquito Buzz,* you all have heard about the Operations Manual that the California Mosquito Control Association has been going to give to you over a period of the past six months. The Executive Committee began its consideration of this organ of the California Mosquito Control Association a year ago, and it has only been within the last few days that our secretarial staff, which has been dividing its time between the conference and the "Buzz," the Operations Manual, Training School, Reports, etc., has been able to complete it. So I have the Operations Manual available for distribution — one manual per mosquito control district or agency that has paid its dues. So at the conclusion of this session I will have the Operations Manuals here and I would like to have you relieve me of them in order that we will finally have rendered this service to the districts in California which we have been trying to do for quite some time.

Mr. Raley: Thank you, Dick. I think we can go back to one of our earlier papers now by Gordon Smith.

THE VALUE OF ENTOMOLOGICAL RECORDS IN MOSQUITO CONTROL

By Gordon F. Smith

The subject which I have been given to discuss today is, to me, not as simple as the title implies. There are many concrete aids to mosquito control which may be obtained from the analysis of records obtained from entomological studies, but there are also many less definable values which may also be obtained from close analysis. However, the time allotted me does not allow for lengthy discussion, so I will confine myself as far as possible to those things that are of the most direct value.

Larval Records

Among the larval records those of most direct importance to mosquito control are habitat studies and source mapping and recording.

In any attempt to control a disease through the control of its vector the most efficient and quickest method is, of course, species sanitation. Once satisfactory knowledge of the ecology and preferred habitats of the vector are obtained, a directed program may be set up against the specific insect concerned, aimed at fast reduction of the vector population.

Habitat studies may also result in the development of naturalistic control methods such as changing salinity or other characteristics of the water in the breeding places, and indicate those places unsuitable for breeding due to unsatisfactory conditions.

The volume of spot mapping of those larval sources which continually cause trouble is, I believe, self-evident. It aids in planning district breakdown according to the problems present, in training new men in any given area, and, if properly maintained, serves as a basis for a replacement to work from should any operator become suddenly unavailable.

In many areas of the United States, especially in areas primarily interested in *Anopheles* control, larval population records are maintained. However, I believe that the problems in the large part of California do not readily lend themselves to such recording. The exception being *Anopheline* breeding in rice field areas.

Adult Records

In the setting up of adult records the first study which must be made is that of the ecology of the adult mosquito. This information is of primary importance in the intelligent selection of adult resting stations for the purpose of obtaining population records. Information from such records should also be of considerable value in the organizing of a residual spray program in that it will indicate those places least likely to serve as resting places, and which may well be left unsprayed.

The adult records of primary overall importance to mosquito control are, of course, the adult population records. It is only through the obtaining of such records that any index of the efficiency of operations may be obtained. Aside from this, these records have a number of other uses.

In the Kern Mosquito Abatement District these records are broken down for analysis into individual stations; control areas and district graphs and summaries are made up for each station, area, and the district.

Individual station studies serve to indicate the amount and type of breeding near the station, and, with the control area records, serve to indicate where intensification of control efforts is necessary. They also show, in conjunction with larval habitat studies, which types of breeding places are of the most importance near the station or stations affected and indicate the importance and extent of effect of such environmental changes as irrigation cycles and crop production.

Control area studies indicate the overall efficiency of operators in the various areas and the need for intensification of control in parts of the district. In correlation with the individual station studies these records give aid in planning district breakdown for control on the basis of problems present in the various portions of the district. Also, these studies may serve to indicate the effect of irrigation and crop cycles on mosquito breeding.

The overall district studies serve as an index of district control efficiency, and, with the area records, aid in determining the value of materials and methods being used in the fields.

When set up against time, temperature, relative humidity curves over a period of time, the district and area records serve also to indicae the effective breeding season of the various mosquitoes and the points at which more intensive breeding, or larger adult carry-over, may be expected.

Aside from the above uses of entomological records, I will only mention in passing the value of records in publicity and in combatting adverse publicity.

This has been a very brief summary of a large subject, and for the purposes it will appear that I have drawn rather definite lines between various types of analysis of records. However, to get the greatest benefit from entomological records they must be used as a whole and interrelated group. It is also most important that they be made carefully and accurately to eliminate all possible error.

Mr. Raley: We will have Mr. Dickinson, Entomologist for the Consolidated District, give you a résumé of how we work in our District with the TIFA Aerosol Generator.

OBSERVATIONS ON A *TIFA* USED BY THE CONSOLIDATED MOSQUITO ABATEMENT DISTRICT

WESLEY H. DICKINSON
Entomologist, Consolidated Mosquito Abatement District

DONALD MERRITT
Superintendent, Concolidated Mosquito Abatement District

JAMES HOUGH
Field Operator, Consolidated Mosquito Abatement District

The insecticidal fog applicator manufactured by the Todd Shipyards Corporation, known as the TIFA model 40-E-46, was used to excellent advantage by the Consolidated Mosquito Abatement District during the peak of the 1947 mosquito producing season.

Before purchasing the TIFA, its possible use as an adjutant to our standard and specialized equipment was considered. With 21 jeeps, 2 cars, 2 pickups, and a truck, and all of he field trucks fitted with a thermal aerosol generator,[1] it was decided to add this new-type unit. The thermal aerosol generator was attached to the exhaust pipe of the jeep. In an attempt to achieve a one-man unit, our jeeps also contain an Essick spray rig, a spray boom, and a hand spray unit. The District also has an airplane which is fitted wtih an exhaust aerosol generator, as well as a spray boom.

With the experience of 21 one-man spray units, and the assistance of the remainder of our equipment, it was decided that a volume production of adulticiding fog was needed for those areas too extensive to be covered economically by the jeep units. After evaluating the various types available, a TIFA was added to the District's equipment. This was assigned to one man and could be called upon whenever needed. It was of special value in areas where undiscovered larval sources had produced flights of adult mosquitoes which would then move into heavily inhabited areas, where individual fogging of buildings was impossible. It has also been used to great advantage in areas infested with flights of mosquitoes from outside the control area of the District. Previous work with the 21 one-man spray units has well qualified us to compare results of the TIFA with results obtained in the past from our units.

Use of the TIFA for larviciding has been limited, therefore we do not feel in a position to discuss the TIFA's application to larvicidal phases of mosquito control operations at this time.

In going over our experience with this machine, we feel that it has admirably fulfilled a need for volume production of an adulticiding fog. The TIFA has been used in many situations, and has performed with satisfactory ability in all. It was phenomenal, to be in a field producing large numbers of *Aedes,* when the TIFA was turned on, and the clouds of fog would roll by; then, after the passing of the cloud, it would be noticed that the mosquitoes had stopped biting, and then — there would be none!

The ease with which the TIFA can be installed on a jeep makes this an ideal piece of equipment for field work. We have many irrigated pastures here, and the larger vehicles will bog down in these areas, so we are forced of necessity to rely on a light truck. The larger the spraying rigs, and the heavier they are, the more restricted are their uses in the field. This, then. is a great advantage which the TIFA has; it is light enough to mount on a jeep, and still effective enough to cover large areas with fog, where even the jeep can not go.

The TIFA has been used on many different types of terrain in this District, including over-irrigated pastures, sewer farms, river bottom land, and in fogging whole towns; it has also been very effectively used in large buildings. Using the TIFA in town has been a tremendous asset to us in public relations with our supporters in the many towns which are a part of he Consolidated Mosquito Abatement District.

The following is some information on the treatment of one hundred and sixty acres of irregular-surfaced irrigated pasture, treated for the emergence of adult *Aedes nigromaculis.* This was undertaken October 30, 1947.

It should be noted that this wasn't an ideal irrigated pasture. No refined leveling was accomplished, leaving the field with a disrupted natural drainage. So disturbed was its surface that many clod and pot holes existed throughout its entire area. To adequately irrigate one section, it was necessary to flood another. This practice creates a proper environment for the incubation of *Aedes* eggs, and the maintenance of an ideal habitat for larval survival. Areas of land remain moist or wet, as the case may be, from one flooding until the next. The close location of an abundant food supply, well-fed cattle, increased the well-being of the mosquitoes, as well as increased their fertility. Previously no treatment had been given this area, inasmuch as it is outside of the Consolidated Mosquito Abatement District's necessary control area. It was intended to use this acreage as an experimental ground for our equipment, all during the year, even though it was much beyond the District.

In attempting control treatment of this area it was determined to try to ascertain the efficiency of the TIFA as an adulticidal fog generator at a distance of one-quarter mile from the site of application.

Pre-treatment inspection of the farm land revealed an over-all infestation of from fifteen to twenty adults landing on the visible side of the operator's pants leg at a time. Moving ten to fifteen feet away would again excite another average of fifteen to twenty mosquitoes to land; this observation was consistent throughout the one hundred and sixty acres of irrigated pasture land.

For the purpose of treating this land the TIFA was mounted on a jeep, the insecticidal solution being fed from a ten-gallon milk can installed where the right front seat is usually placed.

A five percent technical-grade DDT in diesel oil was adjudged most suitable as an insecticide, and this was used both in trials, test runs, and in the actual experiment. The TIFA was traveled for one mile along the road adjacent to the infested property, covering it with one swath in two sections each using ten gallons of material, making a total deposition of twenty gallons of the five percent DDT in diesel oil. The total operating time was twenty minutes, with the jeep traveling at three miles per hour during the time of application. It was noted that the "lay" of the fog was ideal, i. e., it would remain on or near the ground, rolling along, with a "hang" right next to the surface. Sometimes when the fog is used and the proper ratio of air temperature and ground temperature isn't available, the fog will float anywhere from six inches to six feet above the surface; in fact, one can stoop and look under the fog layer. It truly forms a blanket. There was no, or very little wind, though the fog would drift, but very slowly; and it remained visible for over an hour afterward.

The irrigated pasture land was given a twenty-four-hour post-treatment inspection the next day, when weather conditions were approximately similar, and no adults were observed. Throughout the mile-long strip, and to a depth of one-quarter of a mile, the mosquitoes were apparently controlled. At distances greater than one-quarter of a mile, the surface features changed abruptly, theerfore no observations were made on the back section, beyond this arbitrary limit.

The relative humidity at the time of application was 58, the temperature was 68° F., and the wind velocity measured nearby was 2 miles per hour. Fuel pressure on the TIFA was 50, and the formulation number was 40, with air pressure at 4. The maximum air temperature during the day was 73° F., and the minimum air temperature was 50° F., with a Fahrenheit mean temperature of 62°.

Work in the Consolidated Mosquito Abatement District with the TIFA was at its peak during July, August, September, and October. Through these four months the District used 1,235 gallons of insecticidal material, 5% DDT in diesel oil, taking 284 hours of labor to cover 11,140 acres. At this rate of application we used .11 of a gallon per acre, or .04807 pounds of DDT per acre. This is at a cost of 11½ cents per acre for labor and materials. There were times when greater and lesser amounts were used, often when only a few acres were covered by fog at a time; this, however, was mainly due to our early experiments composed of trial and error. In operating the TIFA, we had to learn just the proper time, or rather the proper combination of tempeature, humidity, wind, and, of especial importance, the relation of temperature between the air and the ground. The question might be raised that October was rather late in the year to be citing an experiment designed to measure the far-reaching effect of fthe TIFA. In reply we have this from the weather man: "The month of October was warmer than usual, with a mean temperature of 62.5° F., 2.9° above normal. The highest temperature of the month, 100° F., set a new record, surpassing the previous high mark of 99° F. set in 1933."

For the period of operations from July 3 to November 1, 1947, the mechanical upkeep of the TIFA was very nominal. During the above-mentioned period of operation, the only mechanical trouble encountered was in maintaining the recommended 75 pounds of fuel pressure.

Upon the recommendation of the field representative in this area, the orifice on the fuel injection valve was changed, and the fuel pressure easily maintained at 50 pounds thereafter. Another difficulty encountered then was the accumulation of dirt in the fuel by-pass regulating valve.

A minor trouble worthy of mention was the rapid acmumulation of carbon at the fog discharge nozzle, though this is possibly due to the material used, which has been mentioned above.

Cost of upkeep was minimal, less than one-half of one percent of the initial cost of the machine, for parts. Structurally the TIFA remained sound, despite the necessary shock, bump, and jolt, and shaking over rough ground — plus many miles of travel over our widespread District; no apparent damage was found in the delicate gauge and valves, in spite of this usage.

Operational investigation has indicated to us that the early morning hours, just at dawn, were best, both in effect on mosquitoes and in the thermodynamic properties of the fog's application.

The fundamental plan of operation of a TIFA, plus the ease and simplicity of its use, made it available even in these early hours at dawn, or in the evening just at dark. A more elaborate machine would have defeated its purpose if used at these times, the need for light to do mechanical work on a fog dispenser would have made it impossible to use. The TIFA, on a jeep, can be used before dawn, and after dark in the evening, with assurance that uninhibited operations will continue, even if we only have our headlights to illuminate our way.

With six hunderd and forty square miles of territory to control, by our 21 operating units, and a very successful season behind us, it is felt that a portion of the gratitude often expressed is due to the assistance gained by our widespread use of the TIFA.

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Mr. Raley: The next paper is on "Weasels," and is by Tom McGowan.

USE OF MILITARY AMPHIBIOUS VEHICLES, "WEASELS," IN MOSQUITO ABATEMENT OPERATIONS

By T. F. McGowan

Assistant Engineer, Alameda County Mosquito Abatement District

The Alameda County Mosquito Abatement District has for a long time realized that a light-weight amphibious vehicle equipped with caterpillar-type tracks, would be of great value in mosquito abatement operations on the marshes lying within this District. If left uncontrolled, the marshes quickly develop enormous numbers of mosquitoes. Therefore constant patrolling is necessary. These lands lie adjacent to the Bay and extend the full length of the county shore line. They are soft and muddy and are criss-crossed with an intricate network of drainage ditches, dikes, and sloughs. Although they lie in a relatively level plane, they nevertheless present effective obstacles for convntional wheel-type vehicles.

Recently this District purchased two amphibious full track three-quarter ton cargo vehicles designated as "weasels." They were formerly U. S. Marine Corps craft and were sold as surplus equipment through War Assets Administration. They are powered with 70-h.p. engines, equipped with a boat-like body and are capable of traveling over dry land, wet land, shallow or deep water. Field tests have confirmed the opinion that areas which were formerly inaccessible by boat or by walking can now be reached easily with the "weasels."

Quite often, extensive areas of marsh are flooded by high tides. These sections often remain inundated for prolonged periods, due to deficiencies in the marsh drainage system. Deficiencies are inherent even in a well-planned drainage system, because high tides deposit debris which causes clogging of the drains. Frequent patrolling to prevent development of mosquitoes in these badly drained areas requires walking over the marsh and diligently checking all areas of standing water. Such inspections often indicate the necessity for application of larvicide. Until acquisition of the "weasels," it was our practice to bring a supply of oil to the closest point accessible by vehicle and then carry the oil in knapsack sprayers to the point of application. Many trips to and from the supply point were required before adequate larviciding was accomplished. This procedure demands great expenditure of physical effort, and when repeated day after day it is very fatiguing and discouraging. It has the characteristic of never-ending drudgery, and the labor cost is high.

The ability of "weasels" to travel over marsh should eliminate this undesirable feature of mosquito abatement. In larviciding operations, "weasels" can move the supply point right up to the point of application. Furthermore, they can accomplish a better spraying job because of their ability to go far beyond the limits which are safe for walking. Physical area limitations are entirely eliminated. It is our intention to equip the "weasels" with a spray boom operated by a power sprayer. This will accomplish rapid area-spraying. A York-Hession smoke generator will also be mounted when there is necessity for adulticiding.

In addition to serving as patrol vehicles for inspection and larviciding, the "weasels" will be used for ditch maintenance processes. Maintenance of drainage ditches is an extremely important phase of marsh drainage. As indicated above, this is a continuous problem due to tidal deposition of debris, and to growth of marsh grass (*Salicornia ambigua*). Development of a satisfactory device for cleaning ditches mechanically is still in the experimental stage. Our most successful experiments to date are with the "Martin V-Ditchers." A "weasel" can successfully pull a Standard Martin Ditcher, #20 over soft marsh where a tractor can not safely operate.

Our present ditch maintenance practice is manual removal of the debris and vegetation from the ditches. Until recently we have not regarded this as too much of a handicap in our operations because this task represented steady winter employment for crews which would otherwise lack productive winter projects. Prevailing wage scales, plus recent changes in materials, equipment, processes and scope of activities, have all added to increase the value of labor. The use of "weasels" to reduce manual labor promises to release personnel for assignment to maintenance of equipment and depots.

Another utilization of this released labor is for residual DDT spray programs. Residual spraying entails application of DDT to interiors of culverts, dairy barns and other structures. This is a highly desirable phase of our activities which has suffered curtailment because of personnel shortage. Use of "weasels" for marsh work will directly benefit the residual spray program.

Mr. Raley: I think that the gentlemen from out of state will agree with me that California has the variety of conditions to try everything that looks promising.

We will now have a report from Dr. Dow on his encephalitis activities during 1947.

VIRUS RECOVERIES

Richard P. Dow

What I have to say on encephalitis is in the progress report stage, because the State Virus Laboratory has not finished all the specimens submitted to it as yet.

Up to the present time, some 514 pools of mosquitoes have been tested and the results on 12 are still inconclusive.

Now I might say a word as to the history of this survey last summer. The truth of the matter is that up until last winter no virus had been recovered from California mosquitoes except in Kern County. In August, 1946, I had chased up and down San Joaquin Valley collecting mosquitoes and turning them in to the Virus Laboratory, and the results were negative. No recoveries were made. We decided that was perhaps due in part to not starting the survey until August, so last year we got an early start with four men in the field. They were Ernie Meyers, Don Grant, Bill Wirth, and Julie Fine. They were assigned to different areas up and down the length of the valley. The virus recoveries would suggest that they didn't go very far from their headquarters. That, I don't think, is quite a fair assumption, but I should say that the survey was made not on a real systematic survey basis; that is, it was not so many mosquitoes from each section, or done on any basis like that. The point was to get as many *tarsalis* as possible, because that was what we expected to get virus from, and to get them from all parts of the valley so far as possible. In Tulare and Kings County, 8,000 mosquitoes were collected, of which 3,000 were *tarsalis*. This is not collecting strictly; this is the actual number of mosquitoes identified in the field laboratory and sorted and identified. Anybody who has seen the work at any of the laboratories knows that it is a rather tedious process and must be performed with great accuracy. Consequently it is not just a matter of seeing how many mosquitoes you can collect. In the Fresno area, there were 3,000 *tarsalis* and over 13,000 other species col-collected. In the area centering around Chet's abatement district in Modesto, 7,000 *tarsalis* and 11,000 of other species were taken. In the Sacramento Valley, mostly in Yolo County and Sacramento County, 10,000 *tarsalis* and 2,000 of other species were collected. The grand total of *tarsalis* identified, frozen, was 24,130 and other mosquitoes, 36,034; the total of all mosquitoes was, of course, over 60,000.

The numbers of recoveries to date from these pools: I might say a word about that first. Specimens are identified and sorted into tubes, mostly according to the stations where they were taken. Subsequently those tubes are combined into pools, usually on the basis of the single day's collections made within a short period of time of each other within a definite region. So the number of pools tested does not represent strictly either the geographical or time relationship. However, out of the 514 pools tested, there to date 48 recoveries of western equine virus from *Culex tarsalis* and 2 of St. Louis from *Culex tarsalis*. Out of approximately 93 pools of *stigmatasoma*, there have been two recoveries of western equine virus and two of St. Louis virus. Out of 38 pools of *Aedes dorsalis*, there was only one recovery of western equine. I must emphasize that the work is still not complete on the different species. The testing on *freeborni* is not complete and there are miscellaneous collections of other species which have not been tested. I should also say that too much emphasis should not be put on figures from a statistical viewpoint because, in the first place, the men were after *tarsalis*; the methods they used did not give them a fair representation of other species; and finally, the work has not been completed at the Virus Laboratory. The complete report on the encephalitis study program of last summer will be published by the State.

Mr. Raley: The next presentation will be "Mosquito Insectary Problems," by Bernard Brookman.

ATTEMPTS AT INSECTARY REARING OF *CULEX TARSALIS*

By Bernard Brookman*

As many of you may know, Dr. Reeves and I have been trying to find out more about the habits of *Culex tarsalis* and of other mosquitoes which are known to transmit encephalitis. Yesterday Bill reported on the results of our flight range studies and on the relation of several species of mosquitoes to malaria in wild birds in our study area in Kern County.

Last year we decided to tackle the problem of rearing *Culex tarsalis* in a cage in order to be able to observe some of the habits of this species at closer range than is possible in the field. Surprisingly enough, this very common mosquito has not proved to be at all adaptable to laboratory conditions. After pondering the problem for some time, and checking the literature, we found a design for a large outdoor insectary which had been built by members of the Rockefeller Foundation in India and Albania for rearing *Anophelines*. Using the Rockefeller cage as a model, we modified it to suit what we thought were the requirements of *tarsalis*.

I might quote here that, without the help of Art Geib and his men, the structure might never have been completed.

Essentially, our insectary is a screened enclosure, 18 x 12 x 12 feet in dimensions, within which are a chicken shed — the fowl to serve as food supply for the adult mosquitoes; several ponds, each of different character, to serve as oviposition sites and larval habitats; a small cave for shelter during extereme weather; and flowering vegetation for shelter and to serve as a source of food for the males. A constant recording hygrothermograph keeps a record of the conditions of temperature and humidity within the cage.

We first attempted to stock the insectary with the offspring (4th instar larvae) of one gravid field-caught *Culex tarsalis*, but this attempt failed, probably due to the small numbers used. Following this failure, we decided to start with large numbers and continue introducing additional larvae until we were certain that the mosquitoes had become established. Between June 14 and August 25, 1947, 1st instar larvae from 92 egg rafts were placed in the insectary. By the first week in September egg rafts from resident mosquitoes began to appear in the insectary ponds. From then until the middle of October new egg rafts were found, and the colony maintained itself at a rather low level. Larvae were found in the ponds, and small numbers of adults occurred in the cage. However, by the end of December, all larvae and adults of *Culex tarsalis* had disappeared.

We do not know why the mosquitoes disappeared. Perhaps it was due to a sudden cold snap which occurred at that time, or it may have been due to the activities of predators — spiders and ants — particularly at a time when the mosquitoes became sluggish because of the colder weather.

It is our plan to restock the insectary within the next few months — at least as soon as we may again find gravid females of *Culex tarsalis* in our collection stations.

Mr. Raley: Since this program is divided into equal parts, at this time we will have a short recess. I hope that you will make it short so that we can get back and continue on with the papers.

RECESS

Mr. Raley: I will ask Harold Gray to read now the proposed amendment to the Health and Safety Code that has been prepared.

*U. S. Public Health Service, C. D. C., assigned to the Neurotropic Virus Unit of the George Williams Hooper Foundation, San Francisco, California.

SUGGESTED DRAFT OF A LEGISLATIVE BILL TO PERMIT THE ANNEXATION OF A CITY TO A MOSQUITO ABATEMENT DISTRICT UPON INITIATION OF PROCEEDINGS BY THE GOVERNING BODY OF THE CITY

Sec. 2344. Any city whose boundaries are in whole or in part contiguous to and coincident with the boundaries of a mosquito abatement district may be annexed in its entirety to the district by the procedure set forth in this section. Such procedure is alternative to the annexation procedures set forth in this article. The governing body of the city shall by motion announce its intention to request annexation to the district, and shall set a place, and a time not less than 14 days nor more than 30 days subsequent to the passage of the motion, at which place and time any citizen of the city may appear and be heard by the governing body thereon. Notice of the hearing shall be published once in a newspaper of general circulation within the city, at least seven days prior to the time of hearing. If, upon hearing, it shall appear to a two-thirds majority of the governing body that it is advisable to have the city annexed to the district, it shall pass a resolution reciting such fact, and petitioning the district board to annex the city to the district. A certified copy of such resolution and petition shall thereupon be transmitted by the clerk of the governing body of the city to the district board, which shall set a place and time of hearing on such resolution and petition, which time shall be not less than 30 nor more than 90 days from the time of receipt of the resolution and petition by the district board. The district board shall publish the resolution and petition with a statement of the time and place of hearing thereon, at least twice in a newspaper of general circulation in the district, the second publication to be at least seven days prior to the time of hearing. Thereafter the annexation procedures shall be conducted in accordance with Sections 2334, 2335, 2336, 2337, 2338, 2339, 2341, 2342 and 2343 of the Health and Safety Code.

Mr. Raley: This, as presented by Mr. Gray, is to be presented to the Legislature for inclusion in the Health and Safety Code at the next session. Is there a motion?

Mr. Kimball: I so move.

Mr. Raley: Jack Kimball has moved. Is there a second to that motion? Chester Robinson seconds. Ready for the Question? Those in favor? Those opposed the same sign? Carried.

There are some committees already instructed in their duties, and meeting places and times have been fixed now. Ed Smith will now report on the different entomological phases of the Entomology Committee and instruct the various members.

Mr. Smith: The sub-committee on insecticidal formulations has arranged a meeting at Tulare on the 27th of February, which is Friday. The sub-committee on insecticidal formulations has arranged a meeting at Tulare on the 27th of February, which is Friday. The sub-committee on mosquito survey methods has agreed to meet at the Bureau of Vector Control office in Berkeley on March 8th, and the sub-committee on public relations and education has scheduled a meeting at Madera on March 15th. It is my understanding that all of those meetings are open to all who may be interested. It is important to bring out the time of the day that they are meeting. Nine o'clock in the morning, except the Madera meeting, which will be at noon. All of you know which committee you are on, and you should now know the time, the day and the place, and I hope that you can all attend.

Mr. Raley: Are there any other committees that would like to announce a future meeting date? Are there any other announcements? Is there anything else that should be brought before the house?

Mr. Peters: The first formal meeting of the Executive Committee is on March 5th, to be held in Fresno at the Hotel Californian at 11:30. It will probably extend until 11:30 p.m., with the size of the agenda.

Mr. Raley: How about a report from the Resolutions Committee, Ed?

Mr. Washburn: This is the resolution presented last night by Harold Gray and other members. I will read it again.

RESOLUTION

The following resolution was passed by unanimous vote at the Sixteenth Annual Conference of the California Mosquito Control Association held at Berkeley, California, February 13, 1948:

> *Whereas:* DDT, a wartime development of the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Division of Insects Affecting Man and Animals, was used so successfully by our armed forces for the control of mosquitoes, and
>
> *Whereas:* public demand has required the use of DDT by mosquito abatement districts in California without the benefit of adequate research and direction for civilian use,
>
> *Therefore Be It Resolved:* that the California Mosquito Control Association in convention assembled in Berkeley, California, this 13th day of February, 1948, does hereby petition the Congress of the United States to provide adequate funds as may be required by the said Division of the United States Department of Agriculture to set up and develop the safest and most practical methods for the dispersion of DDT and similar insecticides for civilian use in the control of mosquitoes, flies, and other Arthropods.
>
> (Sent to Congress following this Conference.)

Mr. Russell: Congress will soon be over and I think it should be gotten before our representatives and senators. I move this.

Mr. Raley: Mr. Gray seconded the motion which Mr. Russell made. Any questions? All those in favor say aye. Those opposed the same sign. It is so ordered. The secretary is instructed to get that into the proper hands.

There are other business matters, but we will keep trying to push along and get anything else that anyone might want to bring up at this time before the conference. Yes, Don.

Mr. Murray: How about the rest of the report of the Resolutions Committee?

Mr. Raley: Yes, I think the Chairman will be glad to continue his report, Ed.

Mr. Washburn: We have two resolutions which are not in their proper form at present. They read thusly:

Resolution to the University of California.

RESOLUTION

The following Resolution was adopted by unanimous vote of the 16th Annual Conference of the California Mosquito Control Association at Berkeley, California, on February 14, 1948.

Whereas: the University of California, Department of Entomology and Parasitology, has so generously given of its time and facilities to further the interests of mosquito control and,

Whereas: members of the above said department have unstintingly given of their time and talents to this conference,

Therefore Be It Resolved: that the California Mosquito Control Association in Convention assembled at Berkeley this 14th day of February, 1948, do hereby express their deep appreciation and gratitude to the University of California and its Department of Entomology and Parasitology for their efforts in behalf of the Association.

Resolution to the Director of the State Department of Public Health.

RESOLUTION

The following resolution was passed by unanimous vote of the Sixteenth Annual Conference of the California Mosquito Control Association held at Berkeley, California, February 14, 1948:

Whereas: the State Department of Public Health, Bureau of Vector Control, has so generously given of its time and facilities to further the interests of mosquito control, and

Whereas: members of this Bureau have unselfishly given of their talents for the furtherance of a successful conference this year;

Therefore Be It Resolved: that the California Mosquito Control Association assembled at Berkeley, California, this 14th day of February, 1948, does hereby express its deep appreciation and gratitude to the State Department of Public Health, Bureau of Vector Control, for its efforts in behalf of the Association.

Prof. Herms: I move their adoption.

Mr. Ewing: Second.

Mr. Raley: Any opposition? So ordered.

Mr. Gray: I think we might send a letter to the Pasaaic Valley Conference. After all, they sent Bob Vannote all the way out here, and it would be only courteous to express our appreciation. We are going to have to write a letter to Don Rees. These will require a little careful consideration. Shall we make one motion to include those resolutions that have already been presented and those others that have been brought from the floor, these resolutions and the letters of thanks to be sent at the earliest possible moment in proper form?

Mr. Raley: The Chairman of the Resolutions Committee has made that motion and Mr. Gray has seconded it. Question? All those in favor. I won't even bother with the opponents. Carried.

Is there other business that either came out last night, or that was overlooked at an earlier date? If not, we will move into the program and keep going. The next topic is "Rice Field Control, Present and Future," by T. M. Sperbeck. I don't think a lot of you know what "T. M." stands for. It is really Dick Sperbeck.

RICE FIELD CONTROL, PRESENT AND FUTURE

T. M. Sperbeck

Manager, Sutter-Yuba Mosquito Abatement District

This is really a big assignment — rice field control — and I wish I knew the answer to it and how to accomplish it. In Sutter and Yuba Counties last season we had 40,000 acres of rice and about 30,000 of that was within the boundaries of our abatement district, and the rest all around it. There are two big problems in the rice fields — the Anopheline problem in the fall of the year, starting on a small scale from the 15th of August on until the rice fields are drained, usually in the latter part of September. We feel, as you heard in the report yesterday by Mr. Harvey Magy, that we know the answer to Anopheline control. The fact is, I believe, that if next year we just fly the plane over the rice fields, that alone is going to kill the Anopheline larvae. We got down to such minute amounts of DDT this last fall that we couldn't put it out much thinner with the equipment we had, but we got a kill as low as we went, which was 26/1000 of a pound of DDT per acre, or at the rate of a pint to an acre.

But our big headache and the big problem, and the one that we haven't got the answer to yet, is the *Aedes* problem in the spring when the rice fields are first flooded. When they turn the water onto the checks, in a few days the rice checks are literally black with Aedes larvae. Now that is where our future plans come in. We got the brain storm that we might be able to get control more economically and more satisfactorily than we were able to do last spring. We had fairly good success last spring, but there is just too much acreage to cover in the time that we had before emergence. We lost a lot of them last year.

Our method last year was putting DDT into the incoming water. We used gallons of the War Assets 25% emulsion (xylene emulsion), puncturing the tins with a small nail and placing them in the inlets of the rice checks themselves, so it would mix with the water. Bob Portman can testify that this method worked, because we took him around and showed him some of the fields we were working on at that time, and he endeavored to get pictures of the larvae that piled up in piles at the bottom of those checks. But it was a hit and miss affair. I don't know how much we got on per acre, but we got enough on to do the job. The real handicap was getting around to all of the checks fast enough.

People say that in a dry spring we have an easy time and not much of a mosquito problem, but a dry year is just what causes our big problem. As soon as the water is turned into the irrigation system, the rice growers start flooding their rice, and also the irrigated pastures need irrigating, so they all cut loose at once on it.

The Sutter-Yuba District was fortunate in securing the services of Mr. Herb Herms as Entomologist late last fall. He is going to carry on the experiments that we hope are going to be the answer to the *Aedes* problem. That is, the application of 50% wettable powder — it may be DDT and it may be DDD or both — direct on the seed rice on different test plots. Our idea is to get the plane operators and the growers to cooperate, and put the powder right into the seed rice in the hopper. The planting method now is to soak rice before it is planted. About 95% of the rice is soaked for approximately 24 hours right in the sack, then allowed to drain for about 12 hours before loading it into the hopper from which the plane is loaded. The plane will carry approximately 1,000 lbs. per load and sow about 7 acres of rice. It would take very little powder, so additional weight would not be a factor, to control first and second and possibly third instar larvae. One thing that is liable to cause our plans to miscarry is that the field may have been flooded for several days, as some of the large fields may take from five to six days or even a week to flood. The larvae in those first checks may get too far along before the field is seeded. Then sometimes we may have to wait for a plane. There is sometimes a big rush for operators and sowers all at one time, too. That is something we will just have to see. This year we are going to do it on a limited scale. We are going to keep exact reports. Herb Herms is going to carry out experiments an a scientific basis so we will be able to give Dick Peters some news for the "Buzz" when the tests are completed. Regardless of whether this method works or not, we will let you know how it comes out.

We anticipate the first question the farmer is going to ask is "Will DDT injure the rice seed and affect the germination?" That will be the first experiment that we will work on. We are satisfied in our own minds that the DDT has no effect whatever. We have just unofficially germinated 98 rice seeds out of 100, which were treated with DDT.

This is exceptionally high germination. They grew and developed healthy sprouts. We are satisfied that DDT doesn't effect the germination of the rice, but in order to make that official we are going to do the experiments with all the various dosages of DDT on the different seeds and we are going to have our two farm advisors — one from each county — come along and see that they develop, because the farmer swears by what the farm advisor tells him, and not what the mosquito people tell him. We are going to have them work right along with us on it so that when the farmers ask them about it, they can say definitely they have seen the test. Now I hope that this will be the answer, because this is a terrifically big problem, which was just too much to keep up with by hand labor. It would be fine if the rice fields could all be flooded at one time and they could just turn the water in and flood in a matter of days. Then we could feed the solution in one place. But you know how rice is flooded. One check is filled, then it is released through the box into the next check, so you almost have to place these dispensers in from one to three or four in a check, depending upon the size of the check, because of he fact that it takes too long for the circulation of water to get over those checks and still retain the potency of your mixture. It did work last year. It is just a case of having enough labor to get around and do it, but if this other plan works out, it is going to be a very economical way of controlling the first hatching upon the first flooding of rice.

Mr. Ewing: I wonder if it would be in order for me to ask something about the *Culex* problem in rice fields? Has anything been done on *tarsalis?*

Mr. Sperbeck: We haven't had any problem through the summer. The breeding has been in the rice checks themselves. It is a minor matter, a minor problem with us. Magy would have the figures on that regarding the percentage of kill.

Mr. Raley: This is a very serious problem because there is no rhythm to it. You never know just what each farmer is going to do and how long he is going to do any particular thing that he does do. And you have never seen *Aedes* until you have seen *Aedes* coming out of the rice fields. I don't think anything compares with the numbers that are produced, and I don't think there is anything that leaves you quite as helpless. You can't drain, you can't dike, you can't direct it, you can't do a thing except as Dick is doing — be a little ingenious and take advantage of circumstances that are available.

The next contribution is on "Modesto Rice Field Study," by B. Markos, from the U. S. Public Health Service.

MODESTO RICE FIELD STUDY

By B. Markos

Entomologist, C.D.C.A., U. S. Public Health Service

Dr. Markos: I should like very much to forego recording of this material, because much of it is derived from studies in progress which are not as yet available for publication.

Mr. Raley: We will have now the paper on "Problems of Administration of a large District," by Wesley Ewing.

Mr. Ewing: The time is growing short and I would like to set the precedent for the rest of the speakers on the program — turn in my paper to the secretary. say a few words and sit down.

When I was employed by the Merced County District some two years ago, I had two very good crutches to lean on. One was our friend Harold Gray and the other is getting to be a perennial crutch in the State, Dick Peters. I have followed Mr. Gray's method of administration and decentralization, expanded somewhat to fit our local conditions. We have set up a supply and repair division to take care of all supplies and repairs, and have set up decentralized depots under what we choose to call division foremen. In terms of the smaller districts, these men are actually district superintendents, and function as such. The other important factor in regard to operating a large ditrict is this: you must select and train personnel. You cannot go according to remarks I have heard made throughout the year and the year before, "Well, we've got men — my men can't read or write; we take them off the street and we can't teach them anything; they've got to work together." You have to select men of the higher intellectual value of the lesser strong back value, because this work is becoming more scientific. You are dealing with poisons and not oils, and as long as this larviciding and adulticiding program continues as it has been in the past, as against a permanent control program, you have to have men who are capable of understanding what they are working with and who will be able to sell the program to the public.

PROBLEMS OF ADMINISTRATION OF A LARGE DISTRICT

By Wesley C. Ewing

Manager, Merced County Mosquito Abatement District

Yes, Merced County has a large mosquito abatement district. It is one of the largest in terms of area in the State of California, covering nearly 2,000 square miles, 1400 square miles of which is intense mosquito problem area. In terms of financial ability, about $125.00 per square mile of problem area, it is one of the smaller districts. The current annual budget is $183,250.00, of which $50,000 is state subvention and the balance is raised with a 23.6 cent tax rate.

This combinaion of large physical size and small financial ability presents some problems of administration. In order to get the maximum amount of mosquito control service for the money available, it was necessary to adopt some new innovations in control procedure.

The district is divided into three operational divisions and one headquarters or service and supply division; and operates out of one main depot and four sub-depots. All district spray units are operated by one-man crews and are under the supervision of division foremen.

In order to operate the district efficiently, it was necessary to separate the district's functions into operational units and to assign the responsibility for them to competent personnel. The personnel selected for employment by the district has to be capable of being schooled in the proper performance of their job, and must be of such character and integrity as to work efficiently and faithfully with the minimum amount of direct supervision from administrative personnel.

The employees of the district are trained in all phases of operation at an annual "off season" school, supplemented by periodic classes held throughout the mosquito season. In addition, a sincere attempt has been made to standardize as much as possible all operational equipment. The key to the entire problem of administration of a large district is, in the final summary, the proper selection and training of personnel.

Mr. Raley: We will now hear from Jack Kimball of Orange County on "Problems Encountered in Getting Orange County Mosquito Abatement District Under Way."

PROBLEMS ENCOUNTERED IN GETTING ORANGE COUNTY MOSQUITO ABATEMENT DISTRICT UNDER WAY

By J. H. Kimball

Mr. Chairman and members, I can't follow out Wes Ewing's precedent by turning in my paper because I haven't got one written. I was depending on the wire recorder. But I will go so far as to write it up when I get home and send it in, and just make this talk short.

Our District was officialy organized on July 10th. The Board was faced with the situation of not having funds, because the first tax assessment will not be in until September of next year. Naturally they were interested in the state law providing immediate loans, and this problem was taken up with the County Counsel, but we found that we couldn't get funds from the County Treasurer as a loan, and therefore we went to the bank. There money was available to the District at 2% interest, and we asked for fifty thousand dollars. The only trouble was that the commercial bank would not take our County Counsel's interpretation of the state law, and required a special opinion from their lawyer's office in Los Angeles, including a complete review of the organization of the District. The whole negotiation ended up in a simple document that was prepared to obtain this money, and, as I understand it, the original draft written for our particular situation would apply to any other new district. It was a matter of stating the fact that we were making the loan, and at the bottom of the draft they inserted the interest due. We have gone on the basis of obtaining money in ten thousand dollar allotments as we need them, and it is just a matter of typing up a new warrant on regular typing paper, having it signed by the Board and going to the bank and getting our money. I will give you this in detail when I send in my publication.

Mr. Raley: Thank you, Jack. Next, we are to hear from Elmo M. Russell on "Special Devices for Facilitating Mosquito Control." Elmo Russel is from the Hanford District.

SPECIAL DEVICES FOR FACILITATING MOSQUITO CONTROL

By Elmo M. Russell

Mr. President and fellow workers, looking at the map you had here until yesterday, I mean until now, I find myself in a rather peculiar position. My district is just a dot on your map. I want to make some observations on the things that have transpired here and the things I think I see, but I find myself somewhat in the position of the mouse and the elephant. You remember the mouse and the elephant crossed the bridge together and when they got to the other side the mouse said, "We sure shook that bridge, didn't we?" I am not going to try to shake some of your districts, but it seems to me from what I have been hearing, that we are getting away from the fundamentals and the reason for the organization of mosquito disricts. We are relieving the property owner of his responsibility, and as we are relieving him of his responsibility we are taking on too much work, and we will find ourselves swamped one of these days.

Now in my district we point out to all property owners — as a matter of fact we send out an officer of the law to them — that all man-made places of mosquito breeding are the responsibility of the property owners or the house owners. We see that they take care of this breeding and we show them how they can do so. We even aid them in doing so, so we are working on a permanent correction, and we have eliminated many of our places that way. I think it is very valuable for us to come back to that idea. Then observation is very useful to us. I know from previous experience with insecticides that the mosquito becomes immune pretty soon, just like you do from a vaccination. I have seen conditions where crankcase oil was used in outside toilets, and the housefly hatched out in the oil and crawled up on the sides and dried and then flew away afterwards. I have seen such things. I know from actual observation that facts begin to knock theories, and so I think observation of facts is useful in our work.

There is one thing I want to tell you that I think is very valuable. If we cooperate wih our various officers in the county and they cooperate with us, we are cleaning up the town in general of cans' garbage, and things of that kind. We find that by going to the door and letting them know that we are there, that we represent the mosquito district, and tell them of their responsibility in this work, that we are taking a picture of their place because of he hazards they have on their place, which we will turn over to the Health Department, why next day the place is cleaned up.

Mr. Raley: The next paper will be on "Cemetery Control with Aerosols," by Ted Aarons.

Mr. Aarons: I think I'll just follow the precedent of some of the others, and present this paper for publication in the Proceedings.

CEMETERY MOSQUITO CONTROL BY AEROSOL

By THEODORE AARONS

Entomologist, Alameda County Mosquito Abatement District

A mosquito source peculiar to most mosquito abatement agencies is the cemetery. Degree of maintenance, size, and proximity to ppulation are factors which determine the relevance of the cemetery as a mosquito source.

During the summer of 1941, under the direction of Professor Herms, Thomas F. Kelley, Pedro Galindo, and the speaker, conducted a mosquito survey involving over thirty cemeteries. The group, starting in Sacramento, worked south through the Central Valley to Los Angeles and then north along the coast to the Ventura-Oxnard region.

The cemeteries surveyed varied in size, ranging from those of the larger cities such as Sacramento, Fresno, and Los Angeles, which often included hundreds of acres, to others of various Valley communities which were a few acres in extent.

A striking relationship was noted between the degree of maintenance of a cemetery and the mosquito density of the area. Due to the continual watering of many cemetery grounds throughout the summer, a water level was maintained in the flower containers which became the immediate larval sources. Frequently this situation made available the only surface water within a large territory.

Often cemeteries within or adjacent to metropolitan areas presented the greatest fault in mosquito conrol neglect. Finding 50% of the water-filled flower containers in the larger cemeteries positive for larvae was not unusual.

Three types of flower receptacles are in common use. The reversible container is essentially one can unit within another, the larger of the two being sunk into the ground. The inner unit flower container can be reversed when not in use. The second, the ordinary heavy can type, was the most numerous, and also sunk into the ground, so that the opening is even with the surface. Glass jars, cans, and vases were found both sunk into the ground and on the surface. Larvae were found in all containers. There was no illustration of a type preference.

The Alameda County Mosquito Abatement District has for a number of years been aware that some of the 18 cemeteries in or near the control area were sources of appreciable numbers of mosquitoes. In the past other more serious problems had to be met. Also, the District felt that it was not desirable to make any special attempt to handle the situation, particularly in view of the type of public sentiment involved. It was formerly believed that no public health problem existed; however, when the excellent mosquito survey of three Alameda County cemeteries was completed in the fall of 1941 by Thomas F. Kelley and Pedro Galindo, it was noted that certain species were present which had been implicated as highly probable disease vectors of one or more of the virus encephalitides.

The various material and man-power shortages during the war necessitated a delay in approaching the problem.

For the purpose of this paper, one cemetery will be discussed. Basically the problem in all the cemeteries was the same, namely that of mosquito larvae pupating and emerging as adults from the flower containers.

The cemetery is situated in the center of a large residential neighborhood and contains over 80,000 graves. Throughout the grounds are some 27,000 flower containers, all potential mosquito sources. The cemetery, which is the largest in the county, can be divided into two sections, since it contains newer and older parts.

While the grounds as a whole are well watered the entire year, thus providing a ready medium for larval forms in the flower containers, it is apparent that the graves in the newer plots are more frequently watered. Accordingly, a higher larval density is found in the newer parts. Graves in these plots are placed close together, often lack upright headstones, and occupy less space per grave, thus increasing the potential number of breeding containers in a given plot.

The most common species collected was *Culex pipiens,* which represented about 70% of all the larvae. For the most part, it was found in containers with clear water.

Culiseta incidens represented about 25% of all collections during the summer. During the winter months of December through February, this species was frequently the only one encountered.

Culex stigmatosoma and *Culex tarsalis* in the larval form were found only occasionally.

The general topography of each individual plot plays a part in determining the potentiality of the plot as a mosquito source. Those plots located on the slopes of the hills hold considerably less water than those on level ground. Surface runoff removes a considerable portion of the water sprinkled on those situated on the slopes. Occurrence of larvae is generally more common at the foot of the hill, where most of the surface water accumulates.

Water sprinkled on plots situated on very flat ground normally accumulates in the containers, so that practically every one has some water in it, thus greatly increasing the potentialities of the plot as a mosquito source.

In the past the District on occasion sent crews into the cemetery to oil the containers. This proved to be a painstaking job and was not satisfactory for more than a few weeks at a time. Oiling or spraying DDT by hand into the containers was not feasible. The effectiveness of the insecticide would tend to be destroyed as a result of frequent waterings the year round, and in the winter season the additional rainwater would also have to be considered. As a result, frequent hand spray applications would be necessary, and the cost of labor and materials would mount excessively over a period of time while still failing to provide a permanent solution to the problem. In one section of the cemetery there are actually some 7,600 containers which are kept full of water most of the year.

The Director of the cemetery association, while professing a desire to clear up the pest condition, was unable to bring about any changes in the established use of flower containers. The suggestion of the District was to urge the use of only the reversible type and request that the gardeners keep them turned upside down when not in use. The suggestion proved unworkable. It was necessary to interfere as little as possible with the established practices.

Mr. Harold F. Gray suggested that thermal ground aerosol be tested on the situation. An entomological survey revealed that as high as 20% of the water-filled containers in certain plots were positive for larvae. Three ground aerosol applications were made at 6-day intervals. Each application was carried out in the morning prior to 7:00 a.m. The reduction of adults was noted immediately; however, it was not until the third application that the number of positive containers was reduced to 2%.

A check in January of this year of the same observational plots gave a positive count of less than 1%.

Throughout this period another cemetery outside the District was checked for mosquito density. During the summer, 50% of the water-filled containers were positive for larvae. In January, 20% of the containers were positive for larvae of *Culex pipiens* and *Culiseta incidens*.

Prior to the application of aerosol, over two hundred man-hours were spent in spraying the cemetery with the use of hand equipment. Each aerosol treatment requires approximately one hour. The material used consisted of a 5% DDT emulsion in diesel oil.

This type of control measure has proved highly satisfactory both from a practical and public relations standpoint. In no way does it restrict or interfere with the practice of placing flowers on graves, nor does it otherwise offend public sentiment.

Mr. Raley: Next is "Three Years' Use of DDT," by E. C. Robinson from the East Side District.

THREE YEARS' USE OF DDT

By E. C. Robinson

We are organized under the Pest Abatement Act, but we are a mosquito abatement district. I want to get that correctly stated. We are a separate and distinct organization all our own.

I think most of you have available the proceedings of last year, when I gave a talk on two years' use of DDT. You can take that and change it to three years, and that talk ends my speech.

I might mention this, though, for those who haven't that talk available, that we plan on continuing on in the same way and plan to spray at least once a year the farm buildings in the entire area with residual spray.

Mr. Raley: Mr. Jones will now talk on "Marin County Mosquito Abatement District's Rebirth"—Mr. Jones.

MARIN COUNTY MOSQUITO ABATEMENT DISTRICT'S REBIRTH

By Paul Jones

I'll try to make this snappy. Marin County has had a bad reputation as far as mosquitoes are concerned. People around the Bay Area seem to think when they talk about mosquitoes that they come out of our county over there. Anyway, at the start of the 1947 fiscal year I have been given the responsibility of modernizing the district.

The Marin County Mosquito Abatement District was formed primarily as a pest-control agency. It has been the policy of the board to encourage farmers to reclaim and farm large acreages of former tideland. This encouragement was provided by the giving and installing of flood gates, and by their maintenance and replacement. There are still large areas of partially reclaimed land which are not properly drained or protected by levees. It is these sections, together with unreclaimed sections, which give us our trouble.

The drainage sloughs which carry the flood water out to the bay and the Petaluma Creek have been gradually filling in, and unless the sloughs are dredged, large pumps will have to be installed. The Board has been reluctant to go in with farmers on any program of ploughing and leveling of marsh lands because of the cost, and because the flood gates would probably not completely drain the lands.

The district's budgets have been modest, as these figures will prove: 1943-44, $13,487.57; 1944-45, $17,363.40; 1945-46, $22,031.47; 1946-47, $25,329.04.

At the start of the 1947 fiscal year the board appointed a working superintendent to investigate and install new techniques which could be adapted to the needs of the district. Prior to this time the secretary of the board acted as superintendent in his spare time. This district has changed from the use of diesel oil to the use of DDT and DDD emulsions in ½ of 1% strength as a larvicide. The results have been excellent. The district bought one jeep, and hopes to buy two more. Two power sprayers were purchased; one was mounted on the jeep, the other on a G.M.C. pick-up. Aerosol generators were placed on three of the trucks. A small office was built next to the warehouse. A hot-water shower was installed. The operators were put on a monthly salary of $230 for a 5½-day week. A survey is being made concerning a pension plan for the employees under the State Plan. A mapping system has been worked out showing the various large breeding places and the dates on which they are sprayed and checked. A monthly report of the activities in the district is prepared for the board, and a financial report grouping the expenditures and showing the budget balance.

That is about the extent of my report. However, before closing I would like to thank Mr. Gray, Mr. Robinson, Mr. Raley, and the many others who have given me valuable information, also Mr. Peters.

Mr. Raley: I think this is very gratifying to a good many people in California to know that Marin County is going through a rebirth.

The next paper will be "Aerosol on a Large Scale," by H. C. Pangburn.

AEROSOL ON A LARGE SCALE

By H. C. Pangburn

After hearing all these excellent papers in the last couple of days I really haven't anything to offer. We are all fairly convinced that aerosoling is an economically sound way to control mosquitoes, and we certainly intend continuing.

Mr. Raley: The next report will be "Statistics and Reports," by Wm. J. Buchanan, from the State Health Department.

Mr. Buchanan: I will leave this report here for the records for those of you who may be interested in knowing something of the magnitude of operations which have been reported by the State Department of Public Health during the last year and a half.

A YEAR AND A HALF OF PROGRESS IN VECTOR CONTROL

By WM. J. BUCHANAN

Previous speakers have informed you of the over-all picture of mosquito abatement in California. You have learned that it is a big business in this state. Forty-one year-round agencies participate in this business, wherein are expended in excess of two million dollars annually, and whose benefits extend to probably five or six million people residing within the 16,000 square miles encompassed within its boundaries.

More than forty-four percent of these agencies currently participate with the State Department of Public Health in a program of Vector Control, involving approximately seventy percent of the 16,000 square miles protected by all districts and approximately sixty percent of the State total expenditures. It is to those agencies which participate in Vector Control with the State Department of Public Health assistance that we refer hereafter.

It may be interesting to examine some of the factual information revealed by the monthly operational reports submitted by these districts.

During the fiscal year ending June 30, 1947, a total of twenty organizations reported 8,415 square miles under control or surveillance. During the first and second quarters of the present fiscal year a total of eighteen organizations report 11,205 square miles, so you can see that Vector Control is a growing practice.

The twenty agencies participating in fiscal year 1947 report that they used 37½ tons of DDT and 47,201 gallons of oil in their larviciding programs, and 8¾ tons of DDT in their adulticiding programs. Contrast this with the report from the eighteen agencies for only the first half of the current fiscal year, wherein more than 37¾ tons of DDT and 16,908 gallons of oil were used on the larviciding programs and over 14 tons of DDT were expended on adulticiding work. In view of the fact that we have another six months to go this year, is it not apparent that the trend is toward more and more use of DDT and an increase in the attack on adult mosquitoes by residual spraying and ground aerosoling methods?

As for physical accomplishment during the 1947 fiscal year, 322 square miles of water surface and 159,384 mosquito breeding sources, such as cesspools, catch basins, etc., were larvicided, whereas during the first half of this year 406 square miles of water surface and 41,141 mosquito breeding sources were larvicided. Here, again, it appears that the emphasis has shifted, in that larviciding of field and rural breeding areas has been expanded, and, as indicated by the following figures, adulticiding in the form of residual or aerosol sprays has notably increased in the urban or residential areas. During the fiscal year 1947, 327 acres of building surface were residual-sprayed and 7,516 buildings and 93 square miles of area were space-treated, i. e., ground-aerosol sprayed. However, during only the first half of the current fiscal year, 4,073 acres of building surface were residual-sprayed and 6,940 buildings and 76 square miles of area were aerosol-sprayed.

Although less new drainage has been constructed so far this year (6¾ miles as against 30½ miles during fiscal year 1947), it is noteworthy that 55 miles of existing drainage structures have been maintained during the first half of fiscal year 1948, as against 46 miles maintained during the entire fiscal year 1947.

Cognizant of the value of entomological observation and surveys, engineering reconnaissance and surveys, closer field supervision, and the desirability of full-time clerical or administrative personnel, 111,507 man-hours have been expended on these efforts for the reported half of fiscal year 1948, as against a total of 157,780 expended during all of fiscal year 1947.

We might also note that, as would be expected of this type service rendered to the public during any period of low endemicity, these tax-supported agencies' efforts are directed so that about sixty percent of their time is expended directly on rural operations, seventeen percent on urban operations, and twenty-three percent on various unclassified operations which may not readily be charged to either urban or rural abatement.

The above figures, we believe, factually disclose some of the healthy indications of progress during the past year and a half of Vector Control in California.

Mr. Raley: I think all of you are beginning to realize that some of your correspondence with the State, particularly with regard to financial matters, is beginning to kick back a little faster. I think we have Buck to thank for that.

Next we will have a paper on a "Camellia — Aerosol Study," by G. Umberger of the Sacramento-Yolo District. Jack Fowler, I think, will present the paper.

Mr. Fowler: Gentlemen, this too will be short and sweet. I have here for distribution to the various managers and entomologists of the districts a report of progress on an experiment to determine the effect of DDT aerosol on camellias. If there are no questions, that is it. The copies are here on the desk.

AN EXPERIMENT TO DETERMINE THE EFFECT OF AEROSOL ON CAMELLIAS

GEORGE UMBERGER, *Superintendent*
Sacramento-Yolo County Mosquito Abatement District

JACK FOWLER, *Entomologist*
Sacramento-Yolo County Mosquito Abatement District

On September 12, 1947, the Sacramento-Yolo County Mosquito Abatement District announced plans to aerosol the City of Sacramento as an adult mosquito control measure, using 5% DDT in diesel oil. Several nurserymen and camellia fanciers expressed concern regarding the use of DDT, believing that damage to the camellia trees would result. These views were expressed to the local newspapers, and, being good copy, became front-page news.

The District took the position that this method of mosquito control was being used by a number of other Districts in the State and could be considered a standard control procedure. In addition, we had no knowledge of undesirable effects to plant or animal life by an aerosol operation.

The nurserymen countered with a claim that another mosquito abatement district in our Central Valley, aerosoling a community, had done a great amount of property damage at a nursery which specialized in camellias. This nursery claimed that several weeks after their property was aerosoled, a large percentage of their camellia plants began to show ill effects. In less than 10 weeks it was felt that half of the plants would die.

Those interested in camellia culture pointed out that Sacramento was known as the Camellia City, and there were about $3,000,000 worth of the plants in the community. Due to the claimed damage as stated above from an aerosoling operation they felt that if we went ahead as planned any plant damage arising in Sacramento would be attributed to our control work.

Our district contacted the State Department of Public Health, adjacent Mosquito Abaement Districts, Agricultural Agencies, and other possible sources for specific data on broad-leaf plant tolerance of DDT. Other than some general observations, no persons or agencies could give our District specific data which would assist us in making a positive decision. It is realized that the camellia is a very sensitive plant and reacts unfavorably to a number of conditions, and that a decision to carry on our control program meant, in essence, the underwriting of the well-being of all the camellia plants of Sacramento for the winter season. In a final analysis, the District decided that, much as it wanted to serve the people in mosquito control, it could not allow itself to be placed in such an unfavorable position. Therefore, plans for the aerosoling of the City of Sacramento and North Sacramento were cancelled.

The following week a meeting was held to which all interested parties were invited. In calling this meeting, it was hoped that information could be obtained that would assist the District in planning its control procedures for other urban areas in the District.

In addition, there would be an opportunity to examine the assertions that were being made regarding the possible damage by DDT. The meeting was held on the evening of September 23, 1947, at the Sacramento County Courthouse and was well attended by nurserymen, camellia growers, members of garden societies, and a number of private citizens who were interested in this subject. To summarize briefly the agenda of the meeting, the District representative explained the aerosol method of mosquito control, with the materials used and the history of this type of operation throughout the State.

The nurserymen and those concerned about the aerosol operation were asked to express their point of view. An officer of the Camellia Society took the floor and related an incident which he claimed happened in another community. The incident in question was the aerosoling of a town in the southern part of the valley, and the damage done at a nursery located in the community which specialized in the sale of camellia plants. Several weeks after the aerosoling, it was noted that the plants were acting unfavorably. As a little more time went by thet plants developed a condition classical of DDT poisoning. As of the past weekend the nurseryman felt he would take a 50% loss in his plants, which represented well over $1,000.00. The speaker stated that he had gone to the community, examined the nurseryman's plants and in addition had visited a number of private homes throughout the city where camellias were known to be growing. A close examination of the many plants at private residences had shown definite burning, and they were reacting in a similar manner to those which were damaged at the nursery. Examination was also made of other broad-leaf plants such as Rhododendron, Azalea, Bougainvillea, etc. Many of these plants showed evidence of burning. The speaker then showed damaged camellia plants which were at the nursery. Branches were shown of Rhododendron and other plants showing serious burning which he had gathered. These branches had been cut from the affected plants. The contention of this speaker was that this aerosol operation had done the plant damage, and a similar condition would result in Sacramento after an aerosoling, and the damage would run well in excess of $1,000,000. The people present examined the plants, branch specimens, and the other cut specimens. Those qualified on the subject stated that the plant damage looked like that caused by DDT. The classical reaction of camellia plants to DDT poisoning is as follows: Within two weeks to five months damage begins to show on the plants. The leaves begin to burn characteristically at the tip end. Eventually the leaf drops. In extreme cases, the stem begins to turn brown and die back until the branch or even the plant is dead. In less extreme cases there is a partial drop of old leaves and a new growth showing chlorosis. Eventually this new growth may turn brown and drop. Not all varieties are affected alike.

Another speaker told of an incident that happened in Huntington Park, in which oak trees were sprayed with a DDT solution. Underneath the oak trees were many fine camellias. Some of these were over twenty years old. A number began to drop their leaves and react in the classical manner of camellias poisoned by DDT. The ultimate result was the death of several of these fine old trees. Several nurserymen stated their experience with the use of DDT on Camellia plants. They stated that literature advised that light concentrations could be used to fight several diseases on camellia plants. However, whether certain varieties were more susceptible or whether they were more susceptible during growth periods was a matter for further study. The several nurserymen stated they had a certain amount of loss due to DDT poisoning in their nursery spraying operations.

The District representative then suggested that as a matter of public interest, to clarify the picture and to satisfy all interested parties, a test be run to determine the reaction of camellias to an aerosol operation. It was pointed out that the minute quantity of DDT deposited by aerosol should not adversely affect growing plants. The actual spraying of a plant with a two to five percent mixture of DDT meant the depositing of several thousand times the amount of DDT as would be done by aerosol method. As a further precaution, the district had studied the advisability of using a highly refined summer oil such as nurserymen use themselves on many broad-leaf plants as a base for the DDT, instead of diesel oil. The nurserymen present agreed to cooperate in the experiment by furnishing the camellia plants. The District representative stated that they would carry on the experiment, and that as soon as the plants were assembled all interested parties would be advised of the time and place of the experiment so they might attend and watch the actual operation.

Procedures

The test was conducted on September 25, 1947, beginning at 5:15 p.m. Thirty-eight varieties of camellias were represented in the 128 plants used. They ranged from two to over 10 years old. Several of the varieties had new growth, while some were in poor condition and a few were under-fertilized. These sub-standard plants were deliberately selected to se if they were more susceptible to DDT poisoning.

This time of year was very appropriate for the test, as it was the beginning of the fall flight of the *Anopheles freeborni* mosquito and the time when our district would begin extensive urban aerosol operations. This is also the season when many varieties of camellias start their new growth. As has been previously stated, it is believed that the new growth is the part of the plant most susceptible to DDT poisoning.

The plants were divided into six groups for the tests. The site for the test was a new subdivision south of Sacramento and adjacent to the city airport. Other than having streets and sidewalks and a few houses under construction the land was bare.

The plants for each test were placed as shown on the following pages. The intent was to simulate as closely as possible normal urban conditions. A vacant block separated each test plot, thus assuring no drift of aerosol fog from one test to the other.

Jeeps having aerosol attachments were used, and two units were used in each test as that is the usual procedure in our operations. One unit followed the other at a distance of about 30 feet.

The location of the plants and the various distances given are measured from the inside edge of the sidewalk. The jeeps while aerosoling usually travel along the street about 8 feet from the curb. This distance plus the sidewalk. which was 4 feet wide, placed the closest plants about 22 feet from the operating units.

The plants were placed on the ground and smoked microscope slides were placed beside most of the camellias. These slides were placed on wooden blocks about 4 inches off the ground facing the wind and at an angle of about 20 degrees. Three sets of measured glass plates having a total area of 144 square inches were placed at distances of 10 feet, 20 feet, and 50 feet. These plates were set about 18 feet off the ground facing the wind and at an angle of about 20 degrees. After the test these plates were placed in jars containing solvent for quantitative analysis. Two smoked slides accompanied each set of glass plates. Although the number of quantitative analyses was limited, it was hoped that a ratio could be established which could be correlated with the data of the other smoked glass slides.

Following each test a few leaves were cut from the front (windward) side of each camellia. A total of 100 leaves were collected from each test group and a quantitative analysis was made for DDT and oil residue.

Slides used in the experiment were ordinary glass microscope slides coated on one side with carbon from the flame of an acetylene torch used without oxygen. The The diameter of the microscope field was 2.04 mm. at a 50-power magnification. In the examination of the slides 5 fields were counted and an average was taken. An ocular micrometer was used in determining the size of the crater made by the falling particle on the carbon slide.

In selecting aerosol materials for the several tests, the district had the following in mind:

TEST A. 5% DDT in a good-quality summer oil (Barn Tox). We believe an oil of this type is the most ideal for urban aerosol work. It has an unsulphonated residue 90.0 minimum, viscosity 46 S.S.V. at 100° F. DDT 4½% standardized at 40° F. (The manufacturer advised that the product actually contains 5+% DDT.) This is confirmed in our analysis, and in this respect we consider the product as 5% DDT. Nurserymen advise that a light summer oil of this type is the least toxic to plant life that is available. The product shows a lack of phytotoxicity.

TEST B. The same material as Test A except the plants are given a double concentration.

TEST C. Using the material of Test A and B and fortifying it with one gallon of 25% DDT concentrate to 14 gallons of Barn Tox. In some operations we might want a DDT concentration slightly greater than 5%.

TEST D. The use of one gallon of 25% DDT concentrate plus four gallons of diesel oil.

TEST E. The same mtaerial as Test D, except in this test we tried to deliberately destroy the test plants if it were possible to do so by aerosoling with 5% DDT in diesel oil. As shown on page 17, three trips were made past the test plot. The units were parked about 4 feet from the curb and in such manner that all plants were completely enveloped by the drifting aerosol fog. The units were opened up and the test plot was heavily aerosoled for over 1½ minutes.

TEST F. Twenty plants were placed at a private rural residence and set about the yard. Using "Barn Tox" 5% DDT, the camellias were aerosoled eight times at five-day intervals. One jeep was used, making three passes in front of the property. This test was to see if a residual might be built up or a plant shock might develop from a number of operations of normal intensity.

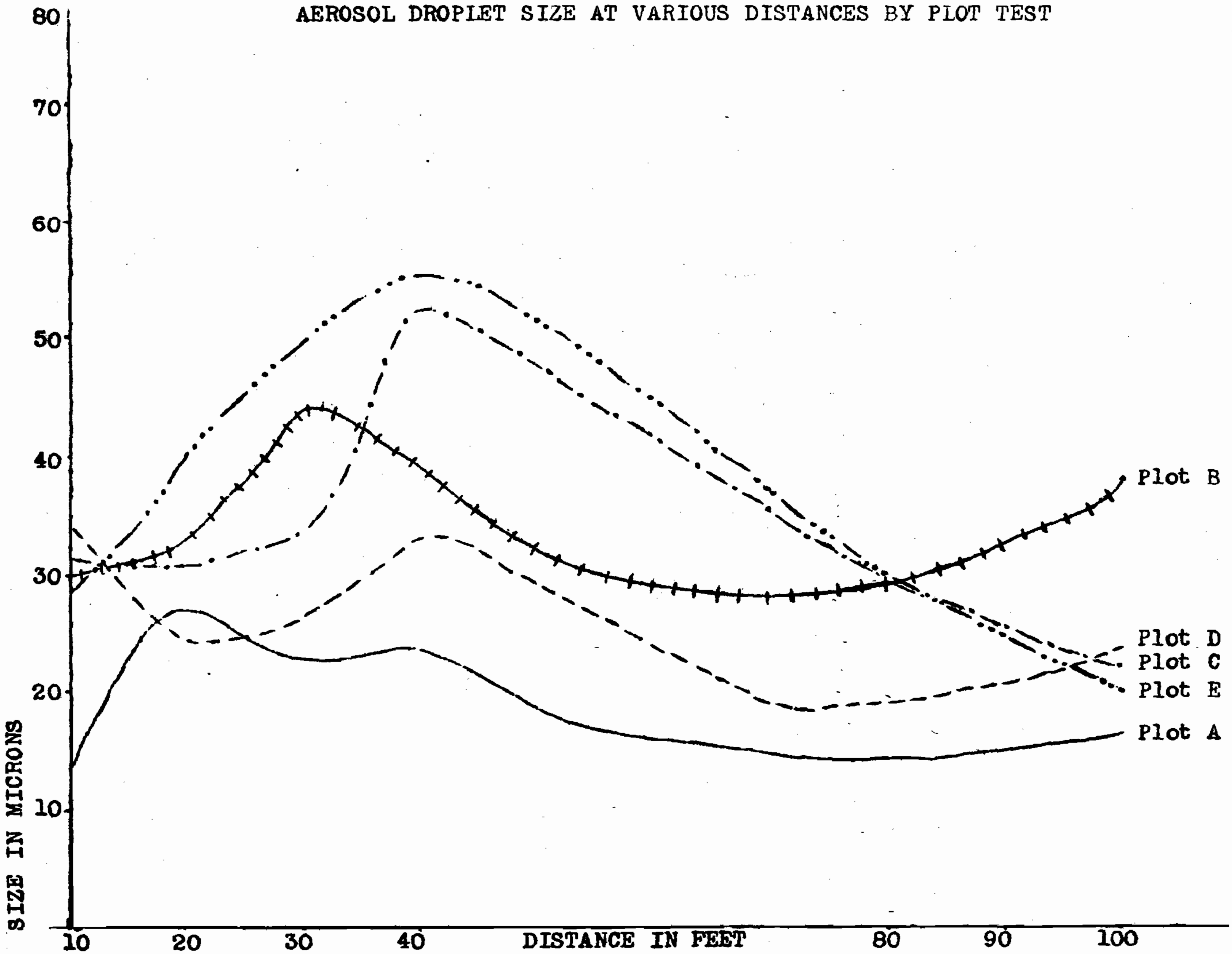
The preceding pages present the problem that confronted our Mosquito Abatement District and the procedures we have followed in endeavoring to arrive at a correct solution. We appreciate the many variable factors involved and the limitations of our experiment to date. It is our intention to expose a large portion of our camellias to additional tests this spring when they are in their spring growth period. It should be possible to evaluate the results of this spring test by next August. If the plants react in the same manner as they have in our tests to date, and with the background of experience derived from the extensive aerosoling operations we have been doing in this area, we believe definite conclusions can be made at that time.

To those who are using aerosol in their mosquito control operations the portion of this report dealing with droplet size and deposition may be of more than passing interest. Prior to this camellia incident our district had carried on a number of such tests to determine the functional factor (concentration and range) of our equipment. These factors can be partially measured and evaluated in an aerosol. This knowledge applied in actual field operations will result in greater efficiency and mosquito kill.

It is not our intent to subordinate the principal theme of this report; however, the matter is of fundamental importance and deserves serious consideration.

As previously stated, we do not fee justified in drawing any conclusions at this date. However, if the incident with the attendant work and studies allows a few observations in passing, they are:

AEROSOL DROPLET SIZE AT VARIOUS DISTANCES BY PLOT TEST



(1) The use of 5% DDT in summer oil or diesel oil as an aerosol by automotive unit, where the unit does not approach closer than 20 feet, has not, under controlled conditions, harmed camellias.

(2) The desirability of having approved DDT tolerances, or concentrations, used in standardized mosquito control operations. The correlation of the many independent studies of DDT and its effect on various forms of life, together with the experience gained in its use in mosquito control, should give responsible agencies enough data to formulate approved concentrations for standard control operations.

(3) A light, highly refined summer oil saturated with DDT, having no special DDT solvents, is a more desirable type of oil base to use in urban aerosoling.

(4) It is desirable that Districts check the functional factor and rate of aerosol deposition of their various aerosol units. This should be done on individual units, and if several units work together to check them as an operating group. The aerosol deposition patterns will show marked variations when two or more units operate together.

Mr. Raley: Mr. Russell has a piece of his equipment that he will be more than glad to show and explain to anyone who is interested. It is a burner for weed control.

I want to thank all of you for the way you have responded with these papers. I know that all of us would like to hear them in more detail, but we also realize that time and our bottoms are a factor, and with the hope, of course, of those from far-distant points getting home at a more convenient time, I again thank all of you for your indulgence in getting these papers completed.

You have heard of these manuals and have commented on them. They are ready for distribution to those districts which have paid their dues or who have a gold bond in promise or security, and at this time we will begin to distribute these manuals. The preface to the Operations Manual I think should be read, and, if I may, I am going to have Dick Peters read this because he has probably already read it so many times that he can read it with much more meaning than I can.

Mr. Peters: With pleasure, Ted.

PREFACE TO OPERATIONS MANUAL

The considerable number of experimental studies, improvisations, and technical developments in California mosquito control, many of which have resulted in unique accimplishment, have for some time needed a medium for systematically making such information available to local mosquito control agencies and accessible to the individual mosquito control worker.

It is with this purpose in mind that the Executive Committee of the California Mosquito Control Association has elected to prepare and distribute this Operations Manual to agencies and persons likely to derive benefit from its content. From time to time, Technical Memoranda will be released for inclusion within this Manual. Each Technical Memorandum will be labeled as to the section within the Manual where it should be entered. Over the years the information compiled should serve as a text of mosquito control progress in California.

The maximum of service can be rendered by this Manual if each mosquito control agency and other interested persons will make their novel mosquito control observations, improvisations, and technical findings available to the California Mosquito Control Association. Significant innovations may then be included in the Operations Manual and thereby be shared with neighboring agencies and fellow mosquito control workers.

Mr. Raley: It is now my pleasure as President of the Association to present the first two copies of this manual that I am sure this Association will be proud of. Generally when a presentation is made of some honor, the recipient is requested to walk down or walk up to get it. This time I am going to make the walk to present these to them. The first copy, of course, is presented to Professor William B. Herms. And the second copy is presented to the other half of that team, to Harold F. Gray. (Both made brief thanks for the presentation.)

The others will now be distributed. Before we get that final gong, are there any other comments? Since there are no other comments, I declare this meeting adjourned.

THE SEVENTEENTH ANNUAL CONFERENCE OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION WILL BE HELD JOINTLY WITH THAT OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION IN BERKELEY, CALIFORNIA, FEBRUARY 7, 8, AND 9, 1949.